Brockman Operation Mine Closure Plan

Version 2

15 May 2023

IODMS #	RTIO-0214255 (v2)
Mineral Field Numbers	47-West Pilbara
Environmental Group Site	Brockman 2 Environmental Group, S0223560 Brockman 4 Area Environmental Group, S0225607
Proponent	Hamersley Iron Pty Limited ACN 004558276
Contact Details	Level 18, Central Park, 152-158 St Georges Terrace, Perth WA 6000 T: +61 (08) 9327 2000

Jurisdiction	Tenement Number
Iron Ore (Hamersley Range) State Agreement Act 1963 (WA) (Hamersley State Agreement)	ML4SA (AML70/4) Sections 102, 103, 104, 107-110, 112, 113, 115-117, 118-125, 162-166, 239-243, 244-247, 265, 266, 279-283 ML272SA (AM70/272) Sections 003
Mining Act 1978 (WA) (Mining Act)	L47/00139, L47/00140, L47/00141, L47/00151, L47/00152, L47/00153, L47/00159, L47/00160, L47/00161, L47/00178, L47/00184, L47/00185, L47/00207, L47/00647, L47/00880, L47/00855, L47/00948, L47/00949, L47/00958, L47/00959, L47/00961 G47/01225, G47/01227, G47/01232, G47/01242, G47/01243, G47/01269 E47/00031, E47/01038, E47/03593, E47/03995, E47/04049, E47/4219, E47/04220, E47/04221, E47/04476 P47/01924, P47/01948, P47/01971 M47/369, M47/370, M47/371, M47/372
Land Administration Act 1997 (WA) (Land Administration Act)	G848898, G848907, G848909, G848902 I123646 Karratha to Tom Price Powerline Area covered by Pastoral lease Diversification Permit s120.15-010 - Nammuldi Irrigated Agricultural Area

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Disclaimer and Limitation

This Mine Closure Plan has been prepared by Rio Tinto's Iron Ore Group (Rio Tinto), on behalf of Hamersley Iron Pty Ltd (the Proponent), specifically for the Brockman Operation. This Brockman Mine Closure Plan represents a merge of three existing Mine Closure Plans.

Closure Plan Submission History		
Date	**Purpose**	**Status**
Brockman Syncline 4		
2018 (v3)	RTIO-HSE-0205402 Compliance with condition 6 of MS 1000	Compliant – DWERA-000386
Brockman 2-Nammuldi		
2017 (v1)	RTIO-HSE-0181030 Compliance with condition 4 of MS 131. Condition 10-2 of MS 867 and condition 10-1 of MS 925	Compliant – DWERA-006419
Silvergrass East		
2018 (v2)	RTIO-HSE-0293538 Compliance with condition 10 of MS 925	Compliant – 2018-1527149018676
Brockman Syncline (Brockman Operation)		
October 2022 (v1)	RTIO-0214255 Compliance with condition 6 of MS 1000 Compliance with condition 4 of MS 131. Condition 10-2 of MS 867 and condition 10-1 of MS 925 Compliance with condition 10 of MS 925 Supporting document for assessment of the Brockman Syncline Proposal under Part IV of the EP Act.	MCP v1 (reviewed by regulator, changes required to address feedback)
May 2023 (v2)	RTIO-0214255_v2 Compliance with condition 6 of MS 1000 Compliance with condition 4 of MS 131. Condition 10-2 of MS 867 and condition 10-1 of MS 925 Compliance with condition 10 of MS 925 Supporting document for assessment of the Brockman Syncline Proposal under Part IV of the EP Act.	This MCP v2 (under assessment)

Acknowledgement of Country

Rio Tinto would like to acknowledge the Puutu Kunti Kurrama and Pinikura People and the Muntulgura Guruma People as the Traditional Custodians of the country upon which the Brockman Operation is located.

We would like to pay our respects to their Elders: past, present, and emerging.

Rio Tinto is committed to working in collaboration with the Puutu Kunti Kurrama and Pinikura People and the Muntulgura Guruma People and their representatives towards a closure strategy that minimises impacts to the environment, social, cultural and heritage value.

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EXECUTIVE SUMMARY

The Brockman Operation is in the Pilbara region of Western Australia, approximately 60 km from Tom Price town in the Shire of Ashburton and is within the traditional lands of the Puutu Kunti Kurrama and Pinikura People and the Muntulgura Guruma People. The Proponent for the Brockman Operation is Hamersley Iron Pty Limited, a wholly owned member of the Rio Tinto group forming part of Rio Tinto integrated network of iron ore mines in the Pilbara.

The Brockman Operation consists of three existing iron ore mines (Brockman Syncline 4 [BS4], Brockman Syncline 2 [BS2] and Nammuldi-Silvergrass) as well as new developments proposed in the Brockman Syncline Proposal (BSP) at BS2, Nammuldi and BS4. This Mine Closure Plan (MCP) describes the strategies to be implemented for closure of these existing and proposed operations at Brockman. As such, this MCP incorporates the existing above and below water table mining operations and associated infrastructure as approved via Ministerial Statements (MS) 131, 867, 925 and 1000 and the proposed BSP developments at BS4, BS2 and Nammuldi.

This Brockman Operation MCP was submitted to the Environmental Protection Authority (**EPA**) to meet the Ministerial Statements (1000, 925, 867 and 131) conditions and to support assessment of the Brockman Syncline Proposal under Part IV of the *Environmental Protection Act 1986* (**EP Act**). Upon approval, this MCP will supersede the existing MCPs for BS4, Brockman 2-Nammuldi (B2N) and Silvergrass East (SGE). Subject to approval, the Brockman Operation is scheduled to cease mining in 2054, however this is subject to mine planning and scheduling changes.

Purpose

This Mine Closure Plan (MCP) has been developed to describe the strategies to be implemented by Rio Tinto Iron Ore (Rio Tinto) on behalf of Hamersley Iron Pty Limited to manage closure of the Brockman Operation. This MCP follows the form and content requirements for MCPs as required in the Department of Mines, Industry Regulation and Safety (DMIRS) *Mine Closure Plan Guidance - How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans* (DMIRS 2020a) and *Statutory Guidelines for Mine Closure Plans* (DMIRS 2020b).

This MCP has been prepared to achieve the following:

- Support assessment of the Brockman Syncline Proposal (BSP) referred to the Environmental Protection Authority (EPA) under s38 of the *Environmental Protection Act 1986* (EP Act) in August 2019.
- Reflect the current knowledge and requirements for closure, identify knowledge gaps and inform the closure task register to reduce risk and progress towards a planned and managed closure of operations.
- Assist Rio Tinto in the planning and management of rehabilitation and closure requirements across current and proposed Brockman Operation by informing life of mine planning, operational activities and the development of closure provisions.
- Inform Traditional Owners and key stakeholders on how Rio Tinto plans to meet its mine rehabilitation and closure requirements for the Brockman Operation.

- Meet internal requirements of the Rio Tinto Closure Standard (Rio Tinto 2021a).

Scope

This MCP is applicable to mine developments and all associated infrastructure at the existing operations (BS4, B2N and SGE) and is required to be submitted with the environmental review document (ERD) to support the environmental impact assessment of the Brockman Syncline Proposal. The closure boundary associated with this MCP is 63,878 ha in area and encompasses the three approved MCP boundaries as well as the BSP Development Envelope. This MCP is anticipated to be reviewed and updated every three years or as required by the Ministerial Statement (MS) following issue of a MS.

Deposits and pits included within this MCP are listed in Executive Summary (ES Table 1). Summarising:

- Mining of iron ore deposits via conventional drill-and-blast and load-and-haul mining methods, including:
  - 42 pits with mining above water table (AWT); and
  - 46 pits with mining below water table (BWT), seven of which are predicted to form pit lakes at closure.
- Ore processing and mineral waste management, including:
  - 64 permanent external waste rock landforms (WRLs) including landbridges and stockpiles;
  - nine temporary external WRLs, three at BS1 and six at SGE;
  - Low Grade Pilot Plant and associated temporary waste fines cell at BS4;
  - one permanent external waste fines storage facility (WFSF) at Nammuldi and three in-pit WFSFs, Pit 5 and Pit 8 at BS2 and Lens A pit at Nammuldi;
  - two overland conveyors, one between BS1 and BS4 and one between SGE and B2N; and
  - two processing hubs (BS2, BS4) to facilitate ore processing and train loading, including crushers, stackers and reclaimers and two standalone crushers at BS1 and SGE.
- Supporting facilities, linear infrastructure, and infrastructure for surface water management.

ES Table 1: Deposits and pits at the Brockman Syncline

Deposit	Pits	Approved / Proposed	Native Title Determination
Brockman Syncline 4 – 37 Pits			
BS4 Main	1-19	Approved via MS 1000	Puutu Kunti Kurrama and Pinikura

Deposit	Pits	Approved / Proposed	Native Title Determination
BS4 Marra Mamba (BS4MM)	M1, M2, N1, N2, O1, O2, O3, Q, R	Proposed (Note Pits Q and R are approved for AWT via MS 1000)	Puutu Kunti Kurrama and Pinikura (M1, M2, N1, N2, O1, O2, O3, Q, R) Muntulgura Guruma (O1 eastern portion
Brockman Syncline 1 (BS1)	E1, E2, E3, W1, W2	Proposed	Puutu Kunti Kurrama and Pinikura
Brockman Syncline 3 (BS3)	S1, S2	Proposed	Muntulgura Guruma
Endeavour	Endeavour 1, Endeavour 2	Proposed	Muntulgura Guruma
Brockman Syncline 2 – 39 Pits			
BS2 Main	1-3, 4/6, 5, 6X, 7	Approved via MS 131 / 867	Muntulgura Guruma
Brockman Syncline 2 Extension (BS2EXT)	8 – 13, 14a, 14b	Approved via MS 131 / 867 / 925	Muntulgura Guruma
BS2EXT	9b, 14c, South East	Proposed	Muntulgura Guruma
Brockman Syncline 2 West (BS2W)	1a, 1d, 2b, 3a, 3b	Proposed	Muntulgura Guruma
Brockman Syncline 3 Extension (BS3EXT)	Brokenwood, Creekside 1&2, Diesel, Lauriston, MM J1, MM J2, MM J3, Monkey 1-3, Orbe 1&2, Sandleford 1-3	Proposed	Muntulgura Guruma
Nammuldi-Silvergrass – 12 Pits			
Nammuldi	Lens A, B, C-D, E-F, LF5	Approved via MS 925	Muntulgura Guruma
Nammuldi	Lens G	Proposed	Muntulgura Guruma
Silvergrass East	1, 2, 3, 5, 7, 8	Approved via MS925	Muntulgura Guruma

This MCP excludes:

- Other Rio Tinto mining operations in the Brockman region (e.g. Tom Price and Western Turner Syncline) which are subject to separate MCPs, including future mine developments beyond those within the defined MCP scope.
- The rail line beyond Crest North that connects the Brockman Operation to the Rio Tinto ports, including the mainline railway infrastructure and rail corridor disturbance areas; and linear

infrastructure that is connected to an integrated network (e.g. power, communications), which are subject to separate closure plans.

- All exploration disturbance and infrastructure outside of the closure boundary.
- Third party infrastructure.

Approved Operations

The three existing operations are open cut and utilise conventional drill-and-blast and load-and-haul mining methods. Ore is processed onsite before being transported via rail to either Dampier or Cape Lambert ports.

The existing operation at BS4 is subject to MS 1000 (2015) which authorises AWT and BWT mining with associated infrastructure and controlled surplus water discharge to Pulykati Wuntu (Boolgeeda Creek) (37km wetting front).

BS2 and Nammuldi were approved as separate operations, with mining commencing in 1992 and 2006 respectively, however they are operated as a single operation (B2N). BS2 is approved via MS 131 (1991) and MS 867 (2011) which include above and below water table mining of Pits 1-7 and associated infrastructure, and surplus water discharge to Pit 5.

The Nammuldi and SGE operations are approved via MS 925 (2013) which authorises above and below water table mining at Nammuldi, irrigated agriculture at the Nammuldi Agriculture Project (NAP), and discharge of surplus water to Kartajirri Wuntu (Duck Creek).

Post-mining land use

The Brockman Operations closure boundary is on land that is subject to different native title determinations (NTD):

- The Puutu Kunti Kurrama and Pinikura People Native Title determination (WAD126/2005), covering the majority of the BS4 area.
- The Eastern Guruma People Native Title determined claim area (WAD6208/1998) representing the Traditional Owner group Muntulgura Guruma, which includes the eastern portion of the BS4 area and all of the B2N, and SGE areas.
- The Robe River Kuruma People Native Title determination (WAD6090/1998) (though not directly within the closure boundary, this is approximately 20 km west of SGE).

These NTD recognise each Traditional Owner group's non-exclusive right to continue to access, use and enjoy their country.

Other land use within the closure boundary includes pastoral activities, and public and private infrastructure such as roads. Primary activities within the broader region relate to mining activities, commercial land use and pastoral activities. Post-mining land use options in the Pilbara are generally limited due to the remote location.

The proposed final land use assumes that the operations will be rehabilitated to create a safe, stable and non-polluting landscape revegetated with native species, which considers environmental and

cultural heritage outcomes and ensures the site does not adversely impact on the current surrounding land use.

Due to the nature of the mining activity undertaken, the final landform will include large voids and waste rock landforms and will therefore be unlikely to support pastoral activities in the immediate disturbed areas. However, it is recognised that surrounding areas are likely to remain subject to pastoral activity.

For this MCP, it is assumed that the post-closure landform will be shaped and rehabilitated to support ongoing pastoral activity where the underlying tenure is pastoral, and elsewhere be returned to native vegetated land. The final land use will be confirmed in consultation with key stakeholder as the operations progress towards closure.

Closure outcomes

Closure outcomes and objectives have been developed with consideration of DMIRS (2020c) objective for rehabilitation and closure is that mining activities are rehabilitated and closed in a manner to make them physically safe to humans and animals, geo-technically stable, geo-chemically non-polluting/non-contaminating, and capable of sustaining the proposed post-mining land use without unacceptable liability to the State. Outcomes are also aligned to Rio Tinto's general vision for closure in the Pilbara.

The following closure outcomes have been set for the Brockman Operation:

1. The final landform is stable, and its design considers hydrological and ecological factors.
2. Contamination risks have been appropriately managed and do not preclude the agreed post-mining land use(s).
3. Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use.
4. Public health and safety hazards have been appropriately managed.
5. Pit lakes do not represent a significant ecological risk.
6. Infrastructure has been appropriately managed.
7. Cultural heritage values have been preserved where possible.
8. Acid and metalliferous drainage and fibrous material risks are compatible with post-mining land use.
9. The hydrological function of Boolgeeda Creek, Duck Creek and Narraminju Wuntu (Caves Creek) are maintained post-closure.
10. The environmental values of the Themeda grassland threatened ecological community (TEC) are maintained.
11. Groundwater systems support phreatophytic vegetation at Palm Springs.

Preliminary completion criteria have been proposed for each of these outcomes; however, these are not yet agreed with key stakeholders at this point, which Rio Tinto considers is acceptable given the long timeframe for these operations.

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Risk assessment and management of key issues

The closure risk assessment for the Brockman Operation has been updated in support of drafting this MCP. The closure risk profile includes 17 active risks, of which: two are a Class IV (critical) risk; nine are Class III (high) risks and the remainder are Class II and Class I risks.

The causes, controls, consequences and actions of all risks associated with closure of the Brockman Operation are appended to this MCP as the Closure Risk Register and the Closure Action register.

Closure Strategy

To manage risks associated with closure of the Brockman operation, the following closure strategies will be implemented:

- Alignment with the Puutu Kunti Kurrama and Pinikura BSP Social, Cultural, and Heritage Management Plan (SCHMP) and Muntulgura Guruma BSP SCHMP to ensure agreed social and cultural heritage values and sites are protected, and adequate post-mining land access is facilitated.
- Rehabilitation of waste landforms, with design informed by waste characterisation, ecological and hydrological factors to ensure long term stability and minimise the risk of erosion. This includes targeting areas of pits that require backfill to manage hazardous materials, to prevent the formation of pit lakes, and/or pit buttressing to surface in areas that intersect floodplains.
- Waste fines are currently stored at an existing ex-pit facility at B2N; these fines are benign and will be deposited back into pit or encapsulated in external storage facility.
- Surface water and groundwater modelling undertaken on an iterative basis during the life of the project to inform operations, closure planning and design and ensure no unacceptable impacts to sensitive receptors, including the environmental and cultural values of Duck Creek and its major tributaries of Caves and Boolgeeda Creeks, including the phreatophytic vegetation along Caves Creek and at Palm Springs
- Maintenance of heritage and environmental exclusion zones and management plans implemented for relevant environmentally and culturally significant values.
- Implementation of progressive rehabilitation to promote revegetation and monitoring of progressive rehabilitation to inform closure planning, closure outcomes and refinement of completion criteria.
- Placement of abandonment bunding around mine pit voids to manage risks associated with inadvertent public access post closure. Strategies will consider the need for ongoing public access resulting from a portion of the mining area being underlain by pastoral stations and access requirements of local indigenous groups.
- All infrastructure will be removed, but this will be subject to negotiation with the Western Australia (WA) State Government as per State Agreement Act obligations. All disturbed areas, except for pits (unless backfilled to 10 m or less from surface), will be rehabilitated.
- Revegetation of disturbed areas, including the spreading of topsoil, where available, the ripping and seeding with local native (local provenance) species.

- Ongoing engagement with internal and external stakeholders regarding closure planning to ensure closure aspects and stakeholder input is considered and incorporated, where appropriate, into life of mine and closure planning and decision-making processes

Mine Closure Plan Review

The October 2022 v1 MCP has been updated to this May 2023 v2 MCP to address the preliminary draft comments on the Brockman Syncline Draft Environmental Review Document received from the Department of Water and Environmental Regulation (DWER) (reference: DWERT4195) . Response to the comments specific to the MCP (comments 27 to 32 in DWERT4195) are summarised in Table 13-2 and fully integrated into the text and appendices of this MCP.

Corporate endorsement:

I hereby certify that to the best of my knowledge, the information within this Brockman Operation MCP is true and correct and addresses the relevant requirements of the *Statutory Guidelines for Mine Closure Plans* (2020) approved by the Director General of Mines, Industry Regulation and Safety.



Sarah Carroll

General Manager – Studies & Technology

Date:07/10/2022

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ABBREVIATIONS

ABA	Acid Base Accounting
AH Act	*Aboriginal Heritage Act 1972*
ACH Act	*Aboriginal Cultural Heritage Act 2021*
AEP	Annual Exceedance Probability
AGM	Alternative Growth Media
ALARP	As Low as Reasonably Practicable
ALUM	Australian Land Use Management
AMD	Acid and Metalliferous Drainage
AMPL	Acid and Metalliferous Pit Lake
ANC	Acid Neutralising Capacity
ANFO	Ammonium Nitrate / Fuel Oil
ANZECC	Australian and New Zealand Environment and Conservation Council
ASR	Aquifer Storage and Recovery
AWT	Above Water Table
B2N	Brockman 2 Nammuldi
BC Act	*Biodiversity Conservation Act 2016*
BIF	Banded Iron Formation
BOM	Bureau of Meteorology
BS1	Brockman Syncline 1
BS2	Brockman Syncline 2
BS2W	Brockman Syncline 2 West
BS3	Brockman Syncline 3
BS4	Brockman Syncline 4
BS4MM	Brockman Syncline 4 Marra Mambas
BSP	Brockman Syncline Proposal
BST	Batter Selector Tool
BWT	Below Water Table
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity Conservation and Attractions
DMIRS	Department of Mine, Industry Regulation and Safety
DOH	Department of Health
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation (including EPA Services, Water, and Environmental Regulation)
EC	Electrical conductivity (unit of measurement for Salinity)

EMP	Environmental Management Plan
EIA	Environmental Impact Assessment
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ESP	Exchangeable Sodium Percentage
FMG	Fortescue Metals Group Limited
FMMP	Fibrous Minerals Management Plan
FS	Feasibility Study
GAI	Global abundance indicator
GDE	Groundwater Dependent Ecosystem
GISTM	Global Industry Standard for Tailings Management
GL	Gigalitres
HPB	High Phosphorous Brockman
IBRA	Interim Biogeographic Regionalisation for Australia
IHMP	Integrated Heritage Management Process
ILUA	Indigenous Land Use Agreements
IODMS	Iron Ore Document Management System
IPCC	Intergovernmental Panel on Climate Change
JTSI	Department of Jobs, Tourism, Science and Innovation
K-factor	Erodibility
LIC	Local Implementation Committee
LIG	Lignite
LOM	Life of Mine
LOMP	Life of Mine Planning
MAR	Managed Aquifer Recharge
mbgl	m Below Ground Level
MCP	Mine Closure Plan
MEZ	Mining Exclusion Zone
Mining Act	*Mining Act 1978 (WA)*
MMIF	Marra Mamba Iron Formation
MMP	Monitoring and Management Plan
MMW4	Marra Mamba West 4
MNES	Matters of National Environmental Significance
mRL	Metres above relative level
MRZ	Mining Restriction Zone
MS	Ministerial Statement

MTS	Mount Sylvia Formation
NAF	Non-acid Forming
NAP	Nammuldi Agriculture Project
NATA	National Association of Testing Authorities
NEMP	National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)
NMD	Neutral Mine Drainage
NT Act	*Native Title Act 1993*
NTA	Native Title Agreement
NTD	Native Title Determination Area
NVCP	Native Vegetation Clearing Permits
OoM	Order of Magnitude
PAF	Potentially Acid Forming
PBC	Prescribed Body Corporate
PCO	Present Closure Obligation
PEC	Priority Ecological Community
PFS	Pre-feasibility Study
PKKPAC	Puutu Kunti Kurrama and Pinikura People Aboriginal Corporation
PUPEZ	Potentially Unstable Pit Edge Zone
Rio Tinto	Rio Tinto Iron Ore
ROD	Red Ochre Detritals
RRKAC	Robe River Kuruma Aboriginal Corporation
RUSLE	Revised Universal Soil Loss Equation
S38	Section 38
SCARD	Spontaneous Combustion and Acid Rock Drainage
SCHMP	Social Cultural Heritage Management Plan
SD	Saline Drainage
SGE	Silvergrass East
SID	Siderite
SME	Subject Matter Expert
SOC	Soil Organic Carbon
SPR	Source-Pathway-Receptor
SR	Sulfur Risk
TDS	Total dissolved solids
TEC	Threatened Ecological Community
TPC	Total Projected Closure
UCL	Unallocated Crown Land
WA	Western Australia

WABSI	Western Australian Biodiversity Science Institute
WAOL	Western Australian Organism List
WEPP	Water Erosion Prediction Project
WF	Wittenoom Formation
WFSF	Waste fines storage facility
WGAC	Wintawari Guruma Aboriginal Corporation
WQR	White Quartz Road
WRL	Waste Rock Landform
WoNS	Weed of National Significance

1. PURPOSE AND SCOPE

1.1. Mine Closure Plan Purpose

This Mine Closure Plan (MCP) has been developed to describe the strategies to be implemented by Rio Tinto Iron Ore (Rio Tinto) on behalf of Hamersley Iron Pty Limited to manage closure of the Brockman Operation. This MCP follows the form and content requirements for MCPs as required in the Department of Mines, Industry Regulation and Safety (DMIRS) *Mine Closure Plan Guidance - How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans* (DMIRS 2020a) and *Statutory Guidelines for Mine Closure Plans* (DMIRS 2020b).

This MCP has been prepared to achieve the following:

- Support assessment of the Brockman Syncline Proposal (BSP) referred to the Environmental Protection Authority (EPA) under s38 of the *Environmental Protection Act 1986* (EP Act) in August 2019.
- Reflect the current knowledge and requirements for closure, identify knowledge gaps and inform the closure task register to reduce risk and progress towards a planned and managed closure of operations.
- Assist Rio Tinto in the planning and management of rehabilitation and closure requirements across current and proposed Brockman Operation by informing life of mine planning, operational activities and the development of closure provisions.
- Inform Traditional Owners and key stakeholders on how Rio Tinto plans to meet its mine rehabilitation and closure requirements for the Brockman Operation.
- Meet internal requirements of the Rio Tinto Closure Standard (Rio Tinto 2021a).

Subject to approval, this MCP will supersede the MCPs for the current operations at Brockman Syncline 4 (BS4) (Rio Tinto 2018a), Brockman Syncline 2 (BS2) – Nammuldi (collectively B2N) (Rio Tinto 2017a) and Silvergrass East (SGE) (Rio Tinto 2018b).

1.2. Mine Closure Plan Scope

This MCP covers the development of the Brockman Operation within a defined closure boundary (Figure 1-1) which includes the current approved operations at BS4, B2N, and SGE as well as all mining operations and associated infrastructure proposed within the BSP. The closure boundary associated with this MCP is 63,878 ha in area and encompasses the three approved MCP boundaries as well as the BSP Development Envelope. Tenure within the closure boundary is listed in Table 1-1 and presented in Figure 1-2 to Figure 1-5.

The scope of this MCP can be divided into the following deposits:

- BS4 Deposits:
    - Brockman Syncline 1 (BS1) (proposed);
    - BS4 Main (existing);
    - BS4 Marra Mamba (BS4MM) (existing and proposed);
    - Endeavour (proposed);
    - BS4 MN (BS4MN) (proposed); and
    - BS3 (proposed).
- B2N deposits:
    - BS2 Main (existing and proposed);
    - BS2 Extension (proposed);

  - Nammuldi (existing); and
  - Brockman Syncline 3 (BS3) Extension (proposed).
- SGE deposit (existing).

Activities and infrastructure associated with implementation of the Brockman Operation may include, but are not limited to:

- Mining of iron ore deposits via conventional drill-and-blast and load-and-haul mining methods, including:
  - 42 pits with mining above water table (AWT); and
  - 46 pits with mining below water table (BWT), 7 of which are predicted to form pit lakes at closure.
- Ore processing and mineral waste management, including:
  - 64 permanent external waste rock landforms (WRLs) including landbridges and stockpiles;
  - permanent storage of waste rock within disused pit voids;
  - nine temporary external WRLs, three at BS1 and six at SGE;
  - low Grade Pilot Plant and associated temporary waste fines cell at BS4;
  - one permanent external waste fines storage facility (WFSF) at Nammuldi and three in-pit WFSFs at Pit 5 and Pit 8 at BS2 and Lens A pit at Nammuldi;
  - two overland conveyors: one between BS1 and BS4; and one between SGE and B2N; and
  - two processing hubs (BS2 and BS4) to facilitate ore processing and train loading, including crushers, stackers and reclaimers and two standalone crushers at BS1 and SGE.
- Support facilities, including:
  - heavy and light vehicle workshops, wash bays, hydrocarbon storage and oily water treatment facilities;
  - Ammonium nitrate – fuel oil (ANFO) facilities;
  - fuelling facilities;
  - laydown areas, offices, accommodation facilities and wastewater treatment plants; and
  - an aerodrome at BS4 only.
- Linear infrastructure, including:
  - heavy and light vehicle access roads;
  - conveyors;
  - pipe and power lines (including sub-stations);
  - utilities and communications distribution networks;
  - rail and associated infrastructure; and
  - renewable energy infrastructure.
- Infrastructure for surface water management, including:
  - temporary and permanent diversion drains;
  - levees; and

- culverts.

- Infrastructure for groundwater abstraction and utilisation to enable BWT mining, including bores and pipelines.
- Surplus water management and associated infrastructure, including:
  - use in ore processing across Brockman Operations;
  - on-site use, including discharge to and storage in disused pits;
  - use for irrigation at the Nammuldi Agriculture Project (NAP);
  - aquifer storage and recovery (ASR);
  - aquifer injection trial to the Silvergrass Caves Creek catchment via managed aquifer recharge (MAR); and
  - controlled discharge to surface water systems Pulykati Wuntu (Boolgeeda Creek) and Kartajirri Wuntu (Duck Creek).

This MCP is applicable to areas and mine development features within the tenements listed in Table 1-1.

Table 1-1: Tenements within the Brockman Operation closure boundary

Jurisdiction	Tenement Number
Iron Ore (Hamersley Range) State Agreement Act 1963 (WA) (Hamersley State Agreement)	ML4SA (AML70/4) Sections 102, 103, 104, 107-110, 112, 113, 115-117, 118-125, 162-166, 239-243, 244-247, 265, 266, 279-283 ML272SA (AM70/272) Sections 003
Mining Act 1978 (WA) (Mining Act)	L47/00139, L47/00140, L47/00141, L47/00151, L47/00152, L47/00153, L47/00159, L47/00160, L47/00161, L47/00178, L47/00184, L47/00185, L47/00207, L47/00647, L47/00880, L47/00855, L47/00948, L47/00949, L47/00958, L47/00959, L47/00961 G47/01225, G47/01227, G47/01232, G47/01242, G47/01243, G47/01269 E47/00031, E47/01038, E47/03593, E47/03995, E47/04049, E47/4219, E47/04220, E47/04221, E47/04476 P47/01924, P47/01948, P47/01971 M47/369, M47/370, M47/371, M47/372
Land Administration Act 1997 (WA) (Land Administration Act)	G848898, G848907, G848909, G848902 I123646 Karratha to Tom Price Powerline Area covered by Pastoral lease Diversification Permit s120.15-010 - Nammuldi Irrigated Agricultural Area

This MCP excludes:

- Other Rio Tinto mining operations in the Brockman region (e.g. Tom Price and Western Turner Syncline) which are subject to separate MCPs, including future mine developments beyond those within the defined MCP scope,
- The rail line beyond Crest North that connects the Brockman Operation to the Rio Tinto ports, including the mainline railway infrastructure and rail corridor disturbance areas; and linear infrastructure that is connected to an integrated network (e.g. power, communications), which are subject to separate closure plans.
- All exploration disturbance and infrastructure outside of the closure boundary.
- Third party infrastructure.

1.3. Closure Planning Process

Closure planning at Rio Tinto is an iterative process integral to achieving a closure vision and specific strategies for each operation. Closure planning commences during the planning phase of a project and is regularly updated and refined during the operational phase. The detail of each MCP increases as the knowledge base develops. Closure plans are updated to account for changes resulting from:

- Amendments to the mine plan including pit designs and scheduling modifications.
- Improvements of the site closure knowledge base (e.g. through daily activities, technical studies, research actions and progressive rehabilitation).
- New or amended regulation.
- Changes to surrounding land uses.
- Evolving stakeholder expectations.

The review brings subject matter experts together to discuss the status of current closure risks and opportunities, proposed mine changes and opportunities to improve closure outcomes. At the end of the review, improvement actions are assigned, and the MCP is updated.

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

As part of the *Rio Tinto Closure Standard* (2021a), closure studies are required at intervals as the site, or a discreet area of the site suitable for partial closure, approaches the end of mine life. Like development projects, closure studies are progressed through several evaluation stages: from OoM to PFS and FS level.

Progressive rehabilitation is also planned, undertaken and monitored to inform the closure planning process and closure outcomes, as detailed in Section 9.3. The final closure plan will be prepared as an output of the Feasibility stage of closure study and submitted to the relevant Government agencies to approve for implementation. In the final closure plan, location specific management plans will be provided for each closure domain. These detailed plans cover the physical closure, dismantling and subsequent rehabilitation implementation requirements. The supporting technical reports that have been used to define the post-closure outcomes will be appended to the final closure plan.

1.4. Mine Closure Plan review and update

Whilst the October 2022 v1 of this MCP has not been the subject of prior regulatory reviews, it does incorporate the existing three operations at BS4, B2N and SGE and therefore reflects progress in closure knowledge gaps in response to prior regulatory review and progress of closure tasks for those operation. Appendix 1 provides a summary of feedback from regulatory agencies on the approved three MCPs, Rio Tinto's response to comments and how these comments have been considered in this MCP.

The October 2022 v1 MCP has been updated to this May 2023 v2 MCP to address the preliminary draft comments on the Brockman Syncline Draft Environmental Review Document received from the Department of Water and Environmental Regulation (DWER) (reference: DWERT4195). Response to the comments specific to the MCP (comments 27 to 32 in DWERT4195) are summarised in Table 13-2 and fully integrated into the text and appendices of this MCP.

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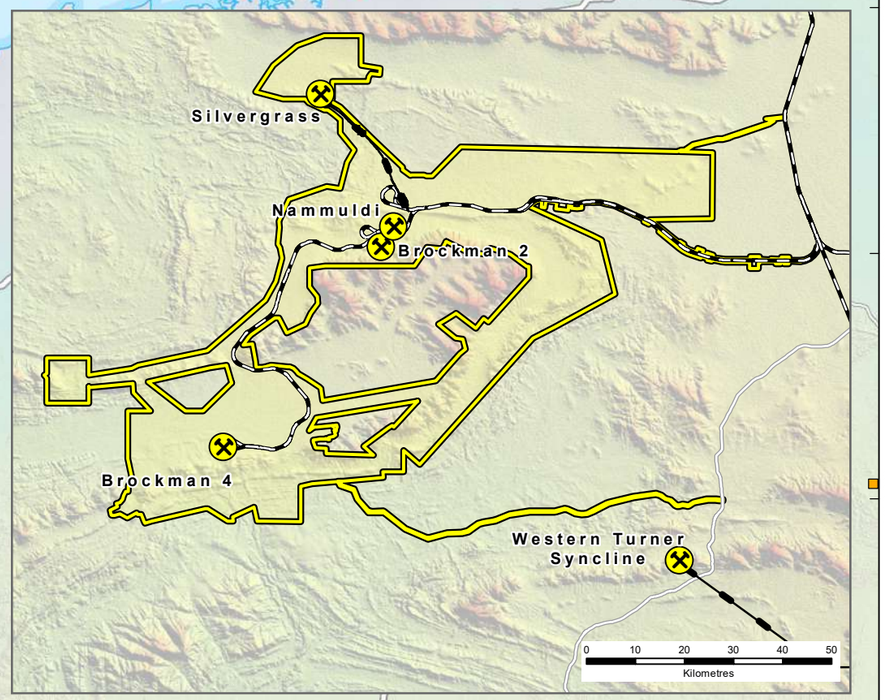
Figure 1-1
Brockman Operation
Regional Location

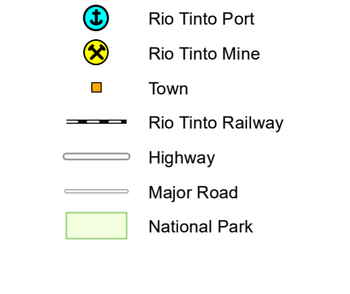
Drawn: L.Fuentes
Plan: PDE0172859v2
Date: July 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:1,250,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Rio Tinto Port
- Rio Tinto Mine
- Town
- Rio Tinto Railway
- Highway
- Major Road
- National Park





N

0 10 20 30 40 50
Kilometres

Map units in metres

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Figure 1-2
Brockman Operation Tenure

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Legend

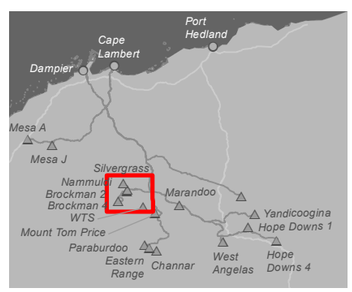
- Closure Boundary
- Permit S120.15-010
- Third Party Mining Act Tenure

Rio Tinto Mining Act Tenure

- State Agreement Mining Lease
- Live Mining Act Tenure
- Pending Mining Act Tenure

Land Administration Act Tenure

- Rio Tinto General Lease
- Pastoral Lease
- Unallocated Crown Land
- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Major Creek
- Rio Tinto Railway
- Conveyor
- Major Road
- Minor Road



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Kilometres

Map units in metres

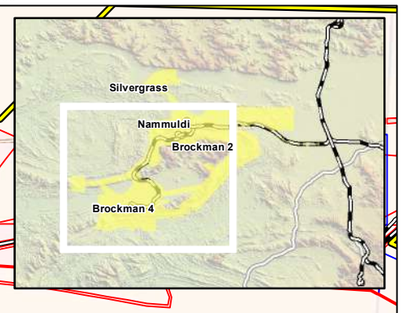
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Figure 1-3
Brockman 4
Tenure

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Date: May 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:125,000 @A3
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Legend

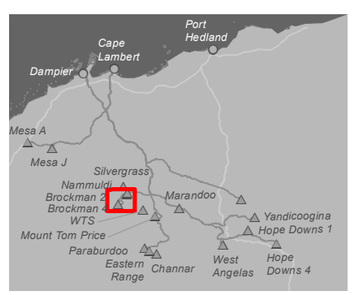
- Closure Boundary

Rio Tinto Mining Act Tenure

- State Agreement Mining
- Live Mining Act
- Pending Mining Act

Land Administration Act

- Rio Tinto General Lease
- Pastoral Lease
- Unallocated Crown Land
- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Major Creek
- Conveyor
- Site Access



N

0 2 4 6

Kilometres

Map units in metres

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7,520,000 7,510,000 7,500,000

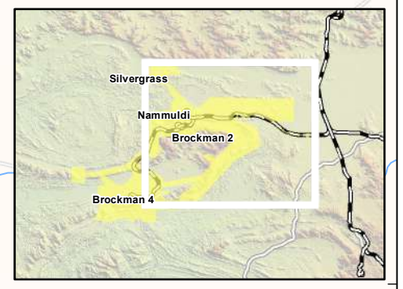
Brockman 2 Camp
Jerriwah Camp
Nammuldi
Brockman 2
L47/00152
L47/00961
L47/00948
L47/00141
ML4SA Sec 104
ML4SA Sec 102
ML4SA Sec 103
E47/01038
L47/00880
N050438 Hamersley Station
L47/00153
Boolgeeda Airport
L47/00185
L47/00184
ML4SA Sec 118
BOOLGEEDA CREEK
G47/01225
G47/01232
Nammuldi Village
West Pilbara Village
Brockman 4 Village
Brockman 4
ML4SA Sec 279
ML4SA Sec 120
ML4SA Sec 119
ML4SA Sec 122
ML4SA Sec 121
ML4SA Sec 283
ML4SA Sec 244
ML4SA Sec 123
N050372 Rocklea Station
ML4SA Sec 245
ML4SA Sec 124
ML4SA Sec 125
ML4SA Sec 162
ML4SA Sec 163
ML4SA Sec 281
ML4SA Sec 166
ML4SA Sec 164
ML4SA Sec 165
ML4SA Sec 282
ML4SA Sec 246
ML4SA Sec 280
ML4SA Sec 247
BEASLEY RIVER
L47/00161

RioTinto

Figure 1-4
Brockman 2 - Nammuldi Tenure

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Plan: PDE0172860v2
Date: May 2022

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Scale: 1:125,000 @A3
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530,000 540,000 550,000 560,000

7,530,000 7,520,000 7,510,000

Mount Brockman Road
CAVES CREEK
Silvergrass
G47/01242
L47/00159
L47/00786
G848898
Brockman 2 Camp
G47/01269
Jerriwah Camp
M47/00369
M47/00372
M47/00370
M47/00371
G848902
E47/04476
L47/00139
G848907
L47/00140
N050438
Hamersley
Station
ML4SA
Sec 108
L47/00160
L47/00207
L47/00855
L47/00178
G848909
L47/00958
E47/03995
Nammuldi
ML4SA
Sec 107
ML4SA
Sec 241
ML4SA
Sec 239
Brockman 2
ML4SA
Sec 112
ML4SA
Sec 113
ML4SA
Sec 242
ML4SA
Sec 110
ML4SA
Sec 109
E47/04220
ML4SA
Sec 240
L47/00141
L47/00841
E47/04219
L47/00959
L47/00178
L47/00157
P47/01971
E47/04049
L47/00958
N050372
Rocklea
Station
ML4SA
Sec 115
ML4SA
Sec 243
L47/00184
E47/00031
E47/04221
E47/04221
ML4SA
Sec 116
ML4SA
Sec 117
BOOLGEEDA CREEK
BEASLEY RIVER
Nanutarra - Munjina Road
Boolgeeda
Airport
ML4SA
Sec 118
Nammuldi Village
West Pilbara Village
Brockman 4 Village

Legend

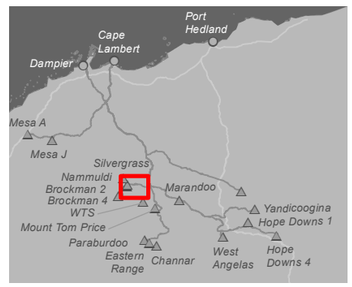
- Closure Boundary
- Permit S120.15-010

Rio Tinto Mining Act

- State Agreement Mining
- Live Mining Act
- Pending Mining Act

Land Administration Act

- Rio Tinto General Lease
- Pastoral Lease
- Unallocated Crown Land
- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Major Creek
- Railway
- Conveyor
- Major Road
- Minor Road
- Site Access
- Rail Access



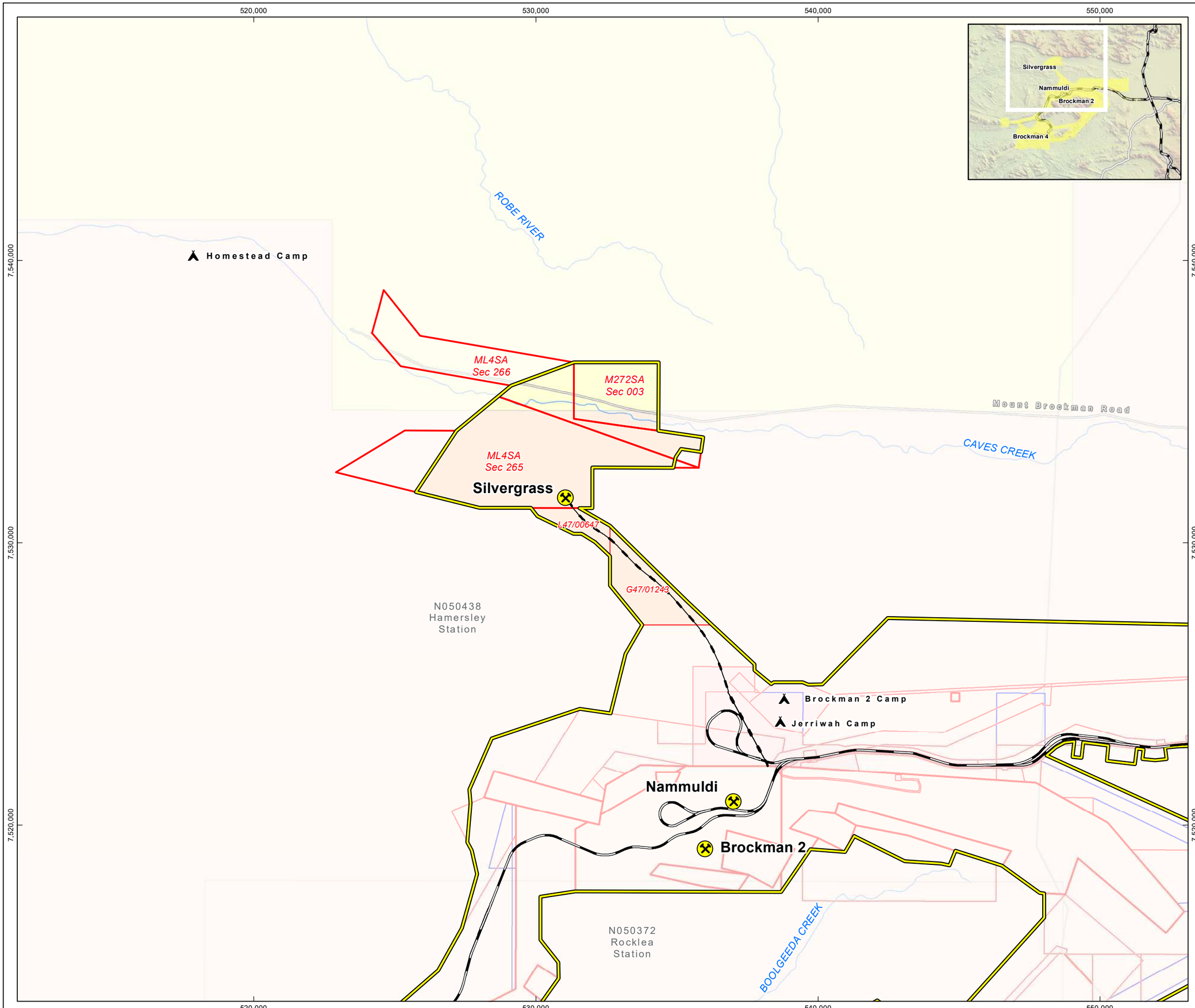
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Kilometres

Map units in metres

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Figure 1-5
Silvergrass Tenure

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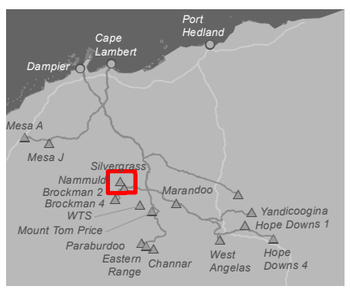
- Closure Boundary

Rio Tinto Mining Act

- State Agreement Mining
- Live Mining Act
- Pending Mining Act

Land Administration Act

- Rio Tinto General Lease
- Pastoral Lease
- Unallocated Crown Land
- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Major Creek
- Rio Tinto Railway
- Conveyor
- Minor Road



N

0 2 4 6

Kilometres

Map units in metres

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2. PROJECT SUMMARY

2.1. Proponent Information

Brockman Operation is owned and operated by Hamersley Iron Pty Limited, which is wholly owned by Rio Tinto. The site is not subject to any Joint Venture arrangements.

2.2. Site History

The three existing operations are open cut and utilise conventional drill-and-blast and load-and-haul mining methods. Ore is processed onsite before being transported via rail to either Dampier or Cape Lambert ports.

- BS4 is subject to Ministerial Statement (MS) 1000 (2015) which authorises AWT and BWT mining with associated infrastructure and controlled surplus water discharge to Boolgeeda Creek. Subject to approval of the BSP, mining of the BS4 deposits is scheduled to cease in 2045.
- BS2 is approved via MS 131 (1991) and MS 867 (2011) which authorise AWT and BWT mining of Pits 1-7 and associated infrastructure, and surplus water discharge to Pit 5 (no longer proposed). Subject to approval of the BSP, mining of the B2N deposits is scheduled to cease in 2047.
- The Nammuldi - Silvergrass operations are approved via MS 925 (2013) which authorises AWT and BWT mining at Nammuldi and SGE, irrigated agriculture at the NAP, and periodic discharge of surplus water to Duck Creek. Subject to approval of the BSP, mining of the SGE deposit is scheduled to cease in 2054.

2.3. Location and Setting

The Brockman Operation is in the Pilbara region of Western Australia, approximately 60 km west north-west of Tom Price town in the Shire of Ashburton (Figure 1-1) and forms an integral part of the Rio Tinto integrated network of iron ore mines in the Pilbara.

The Brockman Operation closure boundary intersects boundaries of the recognised Native Title determination areas of two Traditional Owner groups of the Pilbara region: the Puutu Kunti Kurrama and Pinikura People and the Muntulgura Guruma (Eastern Guruma) People (Figure 2-1). Some culturally significant sites and intangible cultural values associated within the Brockman Operation are important to the Robe River Kuruma People, whose Native Title determination area is located approximately 20 km north-west of the closure boundary (Figure 2-1). There is no mining activity on the Robe River Kuruma Native Title determination area.

The closest Aboriginal community is Wakathuni which is located 20 km south of Tom Price. There is a private camp located along White Quartz Road (referred to as the White Quartz Culture Camp) with one permanent Muntulgura Guruma resident, and it is used intermittently by the Muntulgura Guruma People during lore time and for educational activities.

The closure boundary is predominantly underlain by pastoral leases, with a small portion underlain by Unallocated Crown Land (UCL) as shown in Figure 2-2. Most of the closure boundary is on Hamersley Station (N050438) and Rocklea Station (N050372), both of which are wholly owned by Rio Tinto. A portion of BS4 lies on Cheela Plains Station (N050545) which is third party owned and operated. Further west (outside of the closure boundary but within the approved 37 km wetting front of Boolgeeda Creek) is Mt Stuart Station (N050169) which is also a third party owned and operated pastoral station.

The closure boundaries for the approved B2N, BS4 and SGE MCPs are displayed in Figure 2-3 as well as the new and consolidated Brockman Operation closure boundary and the proposed development envelope for the BSP.

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Figure 2-1
Brockman Operation
Native Title Determination Areas

Drawn: L.Fuentes
Plan: PDE0172861v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:300,000 @A3
GIS.Team@riotinto.com

480,000 500,000 520,000 540,000 560,000

7,540,000 7,520,000 7,500,000 7,480,000

Kuruma Marthudunera (Part A)

Eastern Guruma

Puutu Kunti Kurrama People and Pinikura People #1 and #2

Yinhawangka People (Part A and B)

Caves Creek
Robe River
Calwynginna Creek
Weelumurra Creek
Serpentine Creek
DUCK CREEK
Duck Creek
Wacklina Creek
Barrett Creek
Pinarra Creek
Boolgeeda Creek
Beasley River
Beasley River West
Nanutarra - Munjina Road
Hardey River

Silvergrass
Nammuldi
Brockman 2
Brockman 4
Western Turner Syncline

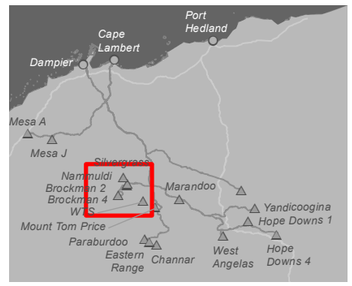
Legend

- Closure Boundary
- Maximum Duck Creek Wetting Front
- Maximum Boolgeeda Creek Wetting Front

Native Title Determination Area

- Eastern Guruma
- Kuruma Marthudunera (Part A)
- Puutu Kunti Kurrama People and Pinikura People #1 and #2
- Yinhawangka People (Part A and B)

- Rio Tinto Mine
- Major Creek
- Rio Tinto Railway
- Conveyor
- Major Road
- Minor Road



N

0 2 4 6 8 10
Kilometres

Map units in metres

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Figure 2-2
Brockman Operation
Underlying Pastoral Leases

Drawn: L.Fuentes
Plan: PDE0172862v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:300,000 @A3
GIS.Team@riotinto.com

480,000 500,000 520,000 540,000 560,000

7,540,000 7,520,000 7,500,000 7,480,000

ROBE RIVER
CALWINGA CREEK
CAVES CREEK
SERPENTINE CREEK
DUCK CREEK
BOOLGEEDA CREEK
BEASLEY RIVER
HARDEY RIVER
Homestead Silvergrass Road
Munjina Road

Silvergrass
Nammuldi
Brockman 2
Brockman 4
Western Turner Syncline

N050438
Hamersley Station

N050169
Mt Stuart Station
Station

N050545
Cheela Plains
Station

N050372
Rocklea Station

Legend

- Closure Boundary
- Maximum Duck Creek Wetting Front
- Maximum Boolgeeda Creek Wetting Front

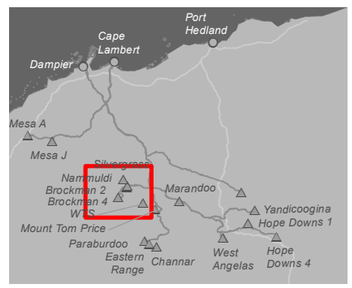
Rio Tinto Pastoral Station

- Hamersley Station
- Rocklea Station

Third Party Pastoral Station

- Cheela Plains Station
- Mt Stuart Station

- Rio Tinto Mine
- Major Creek
- Conveyor
- Major Road
- Minor Road



N

0 2 4 6 8 10
Kilometres

Map units in metres

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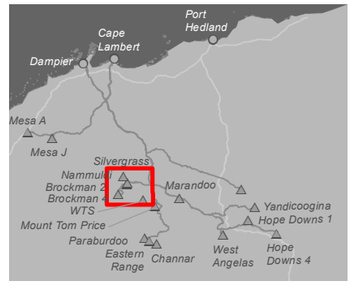
Figure 2-3
Approved Site Closure Boundaries Brockman Operation Closure Boundary and BSP Development Envelope

Drawn: L.Fuentes
Plan: PDE0189331v1
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:210,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- BSP Development Envelope
- Approved 2018 Brockman 4 Closure Boundary
- Approved 2018 Silvergrass Closure Boundary
- Approved 2017 Brockman 2 Nammuldi Closure Boundary
- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Railway
- Conveyor
- Major Road
- Minor Road



N

0 2 4 6 8 10

Kilometres

Map units in metres

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2.4. Environmental, Social and Cultural Values

The closure boundary includes or is in proximity to various sensitive environmental and cultural heritage receptors, including:

- Cultural catchment areas associated with creeks that intersect the closure boundary;
    - Narraminju Wuntu (Caves Creek) Cultural Catchment Area;
    - Kartajirri Wuntu (Duck Creek) Cultural Catchment Area;
    - Pulykati Wuntu (Boolgeeda Creek) Cultural Catchment Area;
    - Maliwartu Wuntu (Beasley River) Cultural Catchment Area; and
    - Wakkulinha Cultural Catchment Area (partial intersect)
- Juukan Gorge, which contains several significant heritage sites. On May 24th, 2020, a blast at the BS4 Main Pit 1 significantly impacted the Juukan Gorge area, resulting in the destruction of two highly significant rock shelters, Juukan 1 and Juukan 2. As an immediate response to the incident, a mining moratorium boundary was agreed to with the Puutu Kunti Kurrama People. The moratorium boundary reflects the current disturbance footprint exclusion based on ongoing consultation with the Puutu Kunti Kurrama. The closure boundary extends over Juukan Gorge as closure implementation of the Brockman Operation includes remediation of this area (further discussed in Section 9.5);
- Potential Groundwater Dependent Ecosystems (GDEs) within the Caves Creek catchment area at SGE, noting Caves Creek and its tributaries is a registered heritage site;
- Ephemeral creeks and semi-permanent or permanent pools that exist adjacent to the operational areas, having elevated environmental value for local biodiversity and cultural value for local indigenous peoples including:
    - Purlykuti Creek (located immediately west of BS4 Pit 1);
    - Kurwillinha Pool (Ephemeral Pool) (south of the Endeavour deposit);
    - Plunge Pool (located 1 km south of the BS3 pits);
    - Ridge Pool (south of the West Pilbara Village);
    - Snake Pool (located in the Juukan Gorge valley);
    - Caves Creek (located immediately north of SGE); and
    - Mallumallu Spring (Palm Springs) (located approximately 20 km west of SGE).
- Threatened and Priority Ecological Communities (TECs/PECs) including:
    - Brockman Iron cracking clay communities of the Hamersley Range PEC near SGE;
    - riparian flora and plant communities of springs and river pools with high water permanence of the Pilbara PEC; and
    - Themeda grasslands on cracking clays (Hamersley Station) TEC at SGE.
- Conservation significant flora and Commonwealth Matters of National Environmental Significance (MNES) listed fauna species with supporting fauna habitats.

These sensitive receptors are described further in Section 5 of this MCP.

2.5. Mine Operations

The approved and proposed life of mine (LOM) layout for the Brockman Operation is presented in Figure 2-4, including broad deposit areas and all associated pits and WRLs. The LOM mine layouts for BS4, B2N and SGE and their associated proposed expansions presented in Figure 2-5, Figure 2-6, and Figure

2-7 respectively. As this is a consolidated MCP for the Brockman Operation, the delineation of approved and proposed development areas is considered within one closure boundary following this chapter.

RioTinto

Figure 2-4
Brockman Operation
Approved and Proposed LOM Layout

Drawn: L.Fuentes
Plan: PDE0172863v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:200,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Mine Facilities

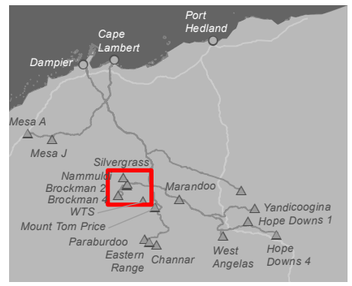
Approved Mine Layout

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Stockpile
- Landbridge
- Nammuldi WFSF
- Nammuldi Agricultural Project
- Infrastructure

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Infrastructure

- Airport
- Rio Tinto Mine
- Major Creek
- Major Road
- Minor Road



N

0 2 4 6 8 10

Kilometres

Map units in metres

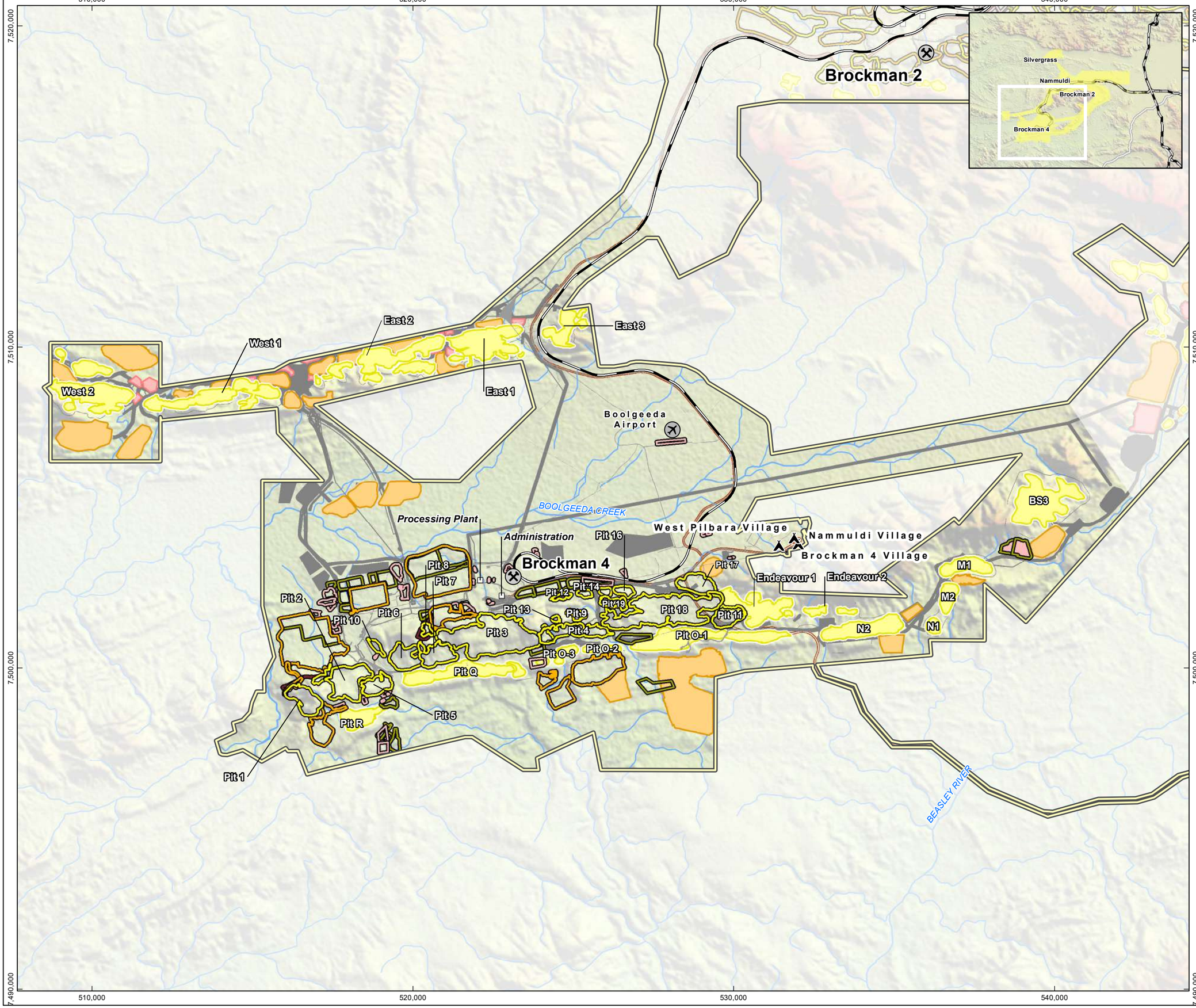
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Figure 2-5
Brockman 4
Approved and Proposed LOM Layout

Drawn: L.Fuentes
Plan: PDE0172860v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:110,000 @A3
GIS.Team@riotinto.com



Legend

- Closure Boundary
- Mine Facilities

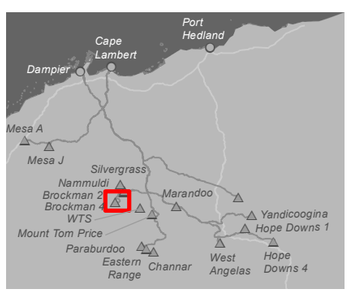
Approved Mine Layout

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Stockpile
- Landbridge
- Infrastructure

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Infrastructure

- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Railway
- Conveyor
- Site Access
- Major Creek
- Minor Creek



N

0 2 4 6

Kilometres

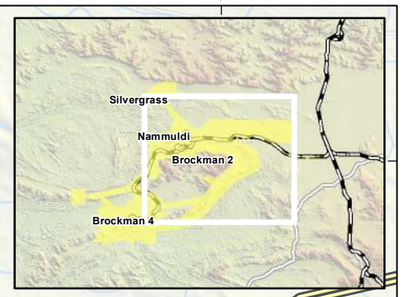
Map units in metres

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Figure 2-6
Brockman 2 - Nammuldi Approved and Proposed LOM Layout

Drawn: L.Fuentes
Plan: PDE0172863v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:110,000 @A3
GIS.Team@riotinto.com



530,000 540,000 550,000 560,000

7,530,000 7,520,000 7,510,000

Silvergrass
Processing Plant Phase 2
Processing Plant BWT
Mine Operations Centre
Brockman 2 Camp
Jerriwah Camp
Administration
Processing Plant
Lens CD
Lens B
Lens A
Nammuldi
Pit 08
Lens EF
LF5
Processing Plant
Pit 05X
Brockman 2
Pit 2
Pit 3a
Pit 3b
Pit 03
Pit 2b
Pit 01
Pit 01a
Pit 04
Pit 1d
Pit 06
Pit 07
Pit 09
Pit 09c
Pit 10
Pit 11
B2ED South
Pit 12
Pit 13
Pit 14A
Pit 14B
Pit 14c
Lens G
Sandleford 2
Sandleford 1
Monkey 2
Diesel
Monkey 1
Lauriston
Brokenwood
Creekside 2
Orbe 2
Creekside 1
Orbe 1
MM-J-1
MM-J-2
MM-J-3
Administration
Boolgeeda Airport
Nammuldi Village
West Pilbara Village
Brockman 4 Village

Legend

- Closure Boundary
- Mine Facilities

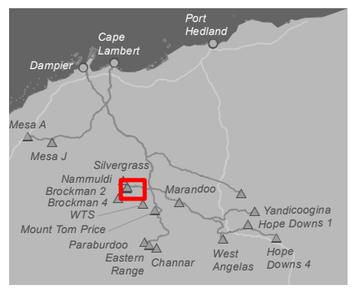
Approved Mine Layout

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Stockpile
- Landbridge
- Nammuldi WFSF
- Nammuldi Agricultural
- Infrastructure

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Infrastructure

- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Railway
- Conveyor
- Minor Road
- Site Access
- Major Creek



N

0 2 4 6
Kilometres

Map units in metres

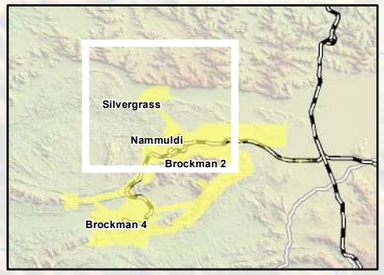
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Figure 2-7
Silvergrass Approved LOM Layout

Drawn: L.Fuentes
Plan: PDE0172863v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:110,000 @A3
GIS.Team@riotinto.com



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ROBE RIVER

Homestead Camp

Homestead Silvergrass Road

Mount Brockman R

CAVES CREEK

Pit 5
Pit 2
Pit 2
Pit 1
Pit 8
Pit 7
Pit 3
Silvergrass

Brockman 2 Camp

Jerriwah Camp

Nammuldi

Brockman 2

BOOLGEEDA CREEK

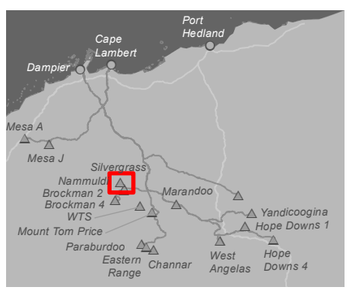
Legend

- *Closure Boundary*
- Mine Facilities

Approved Mine Layout

- Pit
- Waste Rock Landform
- Topsoil / Subsoil
- Stockpile
- Landbridge
- Levee
- Infrastructure
- Nammuldi WFSF
- Infrastructure
- Nammuldi Agricultural

- Rio Tinto Mine
- Rio Tinto Camp
- Rio Tinto Railway
- Conveyor
- Minor Road
- Major Creek
- Minor Creek



N

0 2 4 6
Kilometres

Map units in metres

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2.5.1. Mining voids

Subject to approval of the BSP, the Brockman Operation is scheduled to cease mining in 2054. The scheduled completion date for each mining location is indicated in Table 2-1. Mine planning schedules are continuously revised to maximise efficiencies, optimise performance and incorporate approved new deposits.

Table 2-1: Pit void characteristics and indicative mining schedule

Pit	Operational Status	Anticipated Completion Date	Description	Regulatory Status	Native Title Determination
BS1 (5 pits)					
E1	2026	2036	BWT	Proposed	Puutu Kunti Kurrama and Pinikura
E2	2028	2037	BWT		
E3	2031	2039	AWT		
W1	2028	2040	BWT		
W2	2031	2040	BWT		
BS4 Main (19 pits)					
1	Operating	2025	AWT	Approved	Puutu Kunti Kurrama and Pinikura
2	Operating	2039	BWT		
3	Operating	2029	BWT		
4	Operating	2026	BWT		
5	Operating	2025	BWT		
6	2027	2038	BWT		
7	2023	2038	BWT		
8	Operating	2029	AWT		
9	2023	2026	AWT		
10	2023	2039	BWT		
11	2023	2036	BWT		
12	2025	2026	BWT		
13	2038	2038	AWT		
14	2023	2025	AWT		
15	2023	2024	BWT		
16	2023	2026	BWT		
17	Operating	2032	BWT		
18	Operating	2039	BWT		
19	2023	2026	AWT		
BS4 MM (5 pits)					
O1	2025	2038	BWT	Proposed	Puutu Kunti Kurrama and Pinikura, and Muntulgura Guruma
O2	2027	2028	BWT		Puutu Kunti Kurrama and Pinikura
O3	2027	2029	BWT		
Q	2024	2043	BWT	AWT Approved	

Pit	Operational Status	Anticipated Completion Date	Description	Regulatory Status	Native Title Determination
				BWT Proposed	
R	Operating	2045	BWT	AWT Approved BWT Proposed	
Endeavour (2 pits)					
Endeavour 1	2025	2035	BWT	Proposed	Muntulgura Guruma
Endeavour 2	2034	2037	AWT		
BS4MN (4 pits)					
M1	2028	2030	AWT	Proposed	Muntulgura Guruma
M2	2030	2037	BWT		
N1	2033	2037	BWT		
N2	2031	2037	BWT		
BS3 (2 pits)					
Stage 1	2030	2038	AWT	Proposed	Muntulgura Guruma
Stage 2	2038	2042	AWT		
BS2 Main (7 pits)					
1	Completed	Completed	AWT	Approved	Muntulgura Guruma
2	Completed	Completed	AWT		
3	Completed	Completed	AWT		
BS2 (4/6)	Completed	Completed	AWT		
	Completed	Completed	BWT		
5	Operating	Completed	AWT		
6X	Operating	2022	AWT		
7	Completed	Completed	AWT		
BS2 West (5 pits)					
1a	2027	2034	AWT	Proposed	Muntulgura Guruma
1d	2027	2034	AWT		
2b	2027	2034	AWT		
3a	2028	2034	AWT		
3b	2027	2031	AWT		
BS2 Extension (11 pits)					
8	Operating	2022	BWT	Approved	Muntulgura Guruma
9	Operating	2029	AWT		
10	Operating	2026	BWT		
11	Operating	2022	BWT		
12	Operating	2022	BWT		
13	Operating	2027	BWT		
14a	2024	2028	AWT		
14b	2024	2028	AWT		
9c	2026	2029	AWT	Proposed	
14c	2040	2041	AWT		

Pit	Operational Status	Anticipated Completion Date	Description	Regulatory Status	Native Title Determination
South East	TBC	TBC	AWT		
Nammuldi (6 pits)					
Lens A	Operating	2043	BWT	Approved	Muntulgura Guruma
Lens B	Operating	2034	BWT		
Lens CD	Operating	2036	BWT		
Lens EF	Operating	2047	BWT		
LF5	Completed	Completed	AWT		
Lens G	2024	2035	BWT	Proposed	
BS3 Extension (16 pits)					
Diesel	2024	2032	BWT	Proposed	Muntulgura Guruma
Sandleford 1	2027	2031	AWT		
Sandleford 2	2027	2031	AWT		
Sandleford 3	2027	2031	AWT		
Monkey 1	2027	2041	AWT		
Monkey 2	2027	2041	AWT		
Monkey 3	2027	2041	AWT		
Creekside 1	2027	2031	AWT		
Creekside 2	2027	2031	BWT		
Orbe 1	2025	2041	AWT		
Orbe 2	2025	2041	AWT		
Lauriston	2027	2041	AWT		
Brokenwood	2027	2041	AWT		
MM-J-1	2027	2041	BWT		
MM-J-2	2027	2041	AWT		
MM-J-3	2027	2041	BWT		
SGE (6 pits)					
Pit 1	Operating	2052	BWT	Approved	Muntulgura Guruma
Pit 2	Operating	2050	BWT		
Pit 3	Operating	2031	BWT		
Pit 5	2024	2054	BWT		
Pit 7	Completed	Completed	AWT		
Pit 8	2025	2026	BWT		

2.5.2. Waste rock landforms

Mineral waste generated by mining will be placed in permanent external WRLs as well as progressively backfilled into pit voids as they become available. Low grade ore is stockpiled on site and, where not required for the mine plan, will be used to meet pit backfill commitments or will remain at closure as permanent landforms which will be rehabilitated.

Waste rock landform inventory are provided in Table 2-2. The construction and rehabilitation design criteria for all WRLs are discussed in Section 5.7.5 and, where available, the final rehabilitation designs and proposed closure landform is presented in Appendix 2. The material required to backfill mine pit

voids to the levels prescribed is yet to be incorporated into the mining schedule and therefore the number and size of some ex-pit WRLs proposed to be permanent features may reduce once this has been completed.

Table 2-2: Waste rock landform characteristics and anticipated completion dates

Landform	Type	Description	Anticipated Completion Date	Current Status
BS1				
BS1E – DP1	External WRL	Inert	Not scheduled	Proposed (BSP)
BS1E – DP2	External WRL	Inert		
BS1E – DP3	External WRL	Inert		
BS1E – DP4	External WRL	Inert		
BS1E – DP5	External WRL	Inert		
BS1E – DP6	External WRL	Inert		
BS1W – DP7	External WRL	Inert		
BS1W – DP8	External WRL	Inert		
BS1W – DP9	External WRL	Inert		
BS1W – DP10	External WRL	Proposed PAF Material Storage		
BS1W – DP11	External WRL	Proposed PAF Material Storage		
BS1W – DP12	External WRL	Proposed PAF Material Storage		
BS1W – D13	External WRL	Inert		
BS1W – DP14	External WRL	Inert		
BS1S DP1 – DP3	Temporary external WRL	Inert		
BS1S DP1 – DP3	Temporary external WRL	Inert		
BS1S DP1 – DP3	Temporary external WRL	Inert		
E1 Backfill WD	In-pit Dump/Backfill	Proposed PAF Material Storage		
E2 Backfill WD	In-pit Dump/Backfill	Inert		
E3 Backfill WD	In-pit Dump/Backfill	Proposed PAF Material Storage		
W1 Backfill WD	In-pit Dump/Backfill	Proposed PAF Material Storage		
W2 Backfill WD	In-pit Dump/Backfill	Inert		
BS4 Main				
DP1	External WRL	Fibrous Minerals Storage	2041	Active

Landform	Type	Description	Anticipated Completion Date	Current Status
DP2	External WRL	Potentially Acid Forming (PAF) Material Storage	2048	Active
DP4	External WRL	Fibrous Minerals Storage	2029	Active
DP5	External WRL	Fibrous Minerals Storage	2036	Active
DP6	External WRL	Fibrous Minerals Storage	2036	Active
DP8	External WRL	Fibrous Minerals Storage	2042	Active
DP17	External WRL	Inert	Not Scheduled	Proposed (BSP)
DP22	External WRL	Inert	2023	Active
Pit 1 LB 1	Landbridge	Inert	2032	Active
Pit 1 LB 2	Landbridge	Inert	2032	Active
Pit 8 LB	Landbridge	Inert	2027	Active
BS4 MM				
DP9	External WRL	Inert	Not scheduled	Proposed (BSP)
DP11	External WRL	Inert	Not scheduled	Proposed (BSP)
BS4 MN				
DP12	External WRL	Inert	Not scheduled	Proposed (BSP)
DP13	External WRL	Inert	Not scheduled	Proposed (BSP)
DP14	External WRL	Inert	Not scheduled	Proposed (BSP)
BS				
BS3 - DP1	External WRL	Inert	Not scheduled	Proposed (BSP)
B2 Main & Extension				
Pit 1 WD	In-pit backfill & External WRL	PAF Material Storage	2030	Active
Pit 2 WD	External WRL	Inert	< 2010	Rehabilitated
Pit 4 WD	In-pit backfill & External WRL	PAF Material Storage	2030	Active
Pit 6 WD	External WRL	Fibrous Storage	2017	Rehabilitated

Landform	Type	Description	Anticipated Completion Date	Current Status
Pit 7 Backfill WD	In-pit Dump/Backfill	Inert	2017	Inactive
Pit 10 Backfill WD	In-pit Dump/Backfill	PAF Material Storage	2025	Active
PIT10 LB	Landbridge	Inert	2030	Active
West WD	External WRL	Inert	< 2010	Rehabilitated
Central WD	External WRL	Inert	< 2010	Rehabilitated
B WD	External WRL	Inert	< 2010	Rehabilitated
SPOD WD	External WRL	Inert	2016	Rehabilitated
Pit 1 LG SP	Stockpile	Inert	2030	Active
Pit 5 LG SP	Stockpile	Inert	2018	Inactive
Pit 8 LG SP	Stockpile	Inert	2030	Active
BS2 LB	Landbridge	Inert	Not scheduled	Inactive
Nammuldi				
Lens AB WD	External WRL	Fibrous Storage	2035	Active
Lens CD WD	External WRL	PAF Material Storage	2035	Active
Lens D Backfill WD	In-pit Dump/Backfill	PAF Material Storage	2028	Active
Lens EF Backfill WD	In-pit Dump/Backfill	Inert	2040	Approved – not scheduled
Lens EF2 WD	External WRL	Inert	2020	Inactive
Lens EF4 WD	External WRL	Fibrous Storage	2030	Active
Lens EF5 Backfill WD	In-pit Dump/Backfill	Fibrous Storage	2035	Active
Lens EF6 WD	External WRL	Erodible	2035	Proposed (BSP)
LENS G_DP1	External WRL	Inert	2025	Proposed (BSP)
LENS G_DP2	External WRL	Inert	2037	Proposed (BSP)
Lens AB LG SP	Stockpile	Inert	2035	Active
Lens C LG	Stockpile	Inert	<2010	Rehabilitated
Lens C LB	Landbridge	Inert	2039	Active
Lens EF4 LG SP	Stockpile	Inert	2030	Active

Landform	Type	Description	Anticipated Completion Date	Current Status
Lens EF BWT LG SP	Stockpile	Inert	2040	Approved – not scheduled
NAWT ROM	ROM Pad	Inert	2039	Active
NBWT ROM	ROM Pad	Inert	2039	Active
BS3 Extension				
Diesel DP1	External WRL	Inert	2031	Proposed (BSP)
Creekside DP1	External WRL	Inert	2039	Proposed (BSP)
MMJ DP1	External WRL	Inert	2042	Proposed (BSP)
Diesel LG	Stockpile	Inert	2031	Proposed (BSP)
MMJ LG	Stockpile	Inert	2031	Proposed (BSP)
SGE				
DP1	Temporary External WRL	Inert	2048	Active
DP2	Temporary External WRL	Inert	2055	2026
DP3	Temporary External WRL	Inert	2055	Approved - not scheduled
South WD	Temporary External WRL	Inert	2048	Active
Low grade stockpile 1	Stockpile	Inert	2027	Active
SLVE DHW WD	Temporary External WRL	Fibrous Storage	2040	Active
ROM / Skyway	ROM Pad	Inert	2018	Active
Pit 1 Backfill WD	In-pit Dump/Backfill	Inert	2060	Approved - not scheduled
Pit 2 Backfill WD	In-pit Dump/Backfill	Inert	2060	2023
Pit 3 Backfill WD	In-pit Dump/Backfill	Inert	2030	2024
Pit 5 Backfill WD	In-pit Dump/Backfill	Inert	2060	Approved - not scheduled
Pit 7 Backfill WD	In-pit Dump/Backfill	Inert	Completed	Beneath South WD
Pit 8 Backfill WD	In-pit Dump/Backfill	Inert	2048	Approved - not scheduled

2.5.3. Waste fines tailings storage

Ore from B2N and SGE is processed at the BS2 hub; where some lower grade ores are beneficiated through the Nammuldi wet processing plant, with tailing material deposited in the ex-pit Nammuldi WFSF. The Nammuldi WFSF was commissioned in 2014 and is located to the north-west of the Nammuldi mine (Figure 2-6). It is a valley fill design with a single cross valley embankment constructed on the northern side of the structure and consists of one cell of approximately 230 ha in final waste fines inundation area.

The beneficiation process involves crushing, wet screening and separation of fines in cyclones and spirals and does not involve grinding or chemical alteration of the ore. Excess water from the deposited tailings is collected in a decant pond and pumped back into the process plant for re-use. The separated, inert waste fines (averaging approximately 2.6 Mt per year for the LOM) are thickened and pumped to a WFSF.

All waste fines produced at the Nammuldi wet plant are currently deposited at the Nammuldi WFSF which is expected to reach capacity in approximately 2027. Beyond this, additional capacity is required to manage tailings from B2N, SGE and to support the mining across the Brockman Operation. Rio Tinto is proposing a transition to in-pit deposition at three B2N pits (Pit 5, Pit 8 and Lens A [Figure 2-6]). In-pit deposition will reduce the need for further lifts to the existing facility, negate the need for additional clearing, and will support partial backfill of pit voids at closure.

In addition, a small historical tailings cell associated with a trial plant has been decommissioned at BS4 (Figure 2-5). This cell will be rehandled in full to one of the B2N WFSFs during operations.

Characterisation of tailings is discussed in Section 5.9.1 and closure strategies for the approved and proposed WFSFs is discussed further in Section 5.9.2 to 5.9.4.

2.5.4. Proposed water management strategy

The Brockman Operation currently abstracts groundwater from two aquifer systems: the Brockman Syncline aquifer; and the Caves Creek aquifer. Both aquifers are within the Hamersley Group with groundwater predominantly hosted within fractured Marra Mamba Iron and Wittenoom Formations and overlying detritals.

Groundwater is abstracted to facilitate BWT mining at BS4, B2N and SGE. Abstracted groundwater is currently preferentially used for mineral ore processing, dust suppression and potable water supply. Water surplus to these demands is currently managed differently across two discrete operational water management hubs:

- BS2 hub: surplus water is utilised in irrigated agriculture at the NAP with 19 of 41 approved pivots installed and operational. The remaining 22 pivots approved are unlikely to be installed. If the NAP scheme cannot utilise all the surplus water available on any given day (due to maintenance or seasonal constraints), the excess water is discharged to Duck Creek. Currently all surplus dewatering from SGE is transferred to the BS2 Hub via a pipeline.
- BS4 Hub: surplus water is discharged to Boolgeeda Creek with the authorised maximum wetting front of 37 km from the discharge point during natural no-flow conditions.

Rio Tinto is proposing to connect mining areas by pipelines to develop a fully integrated system to allow flexibility for surplus water to be transferred to mining areas which are in water deficit. Abstracted groundwater will be preferentially used according to the Water Management Strategy hierarchy presented in Figure 2-8.

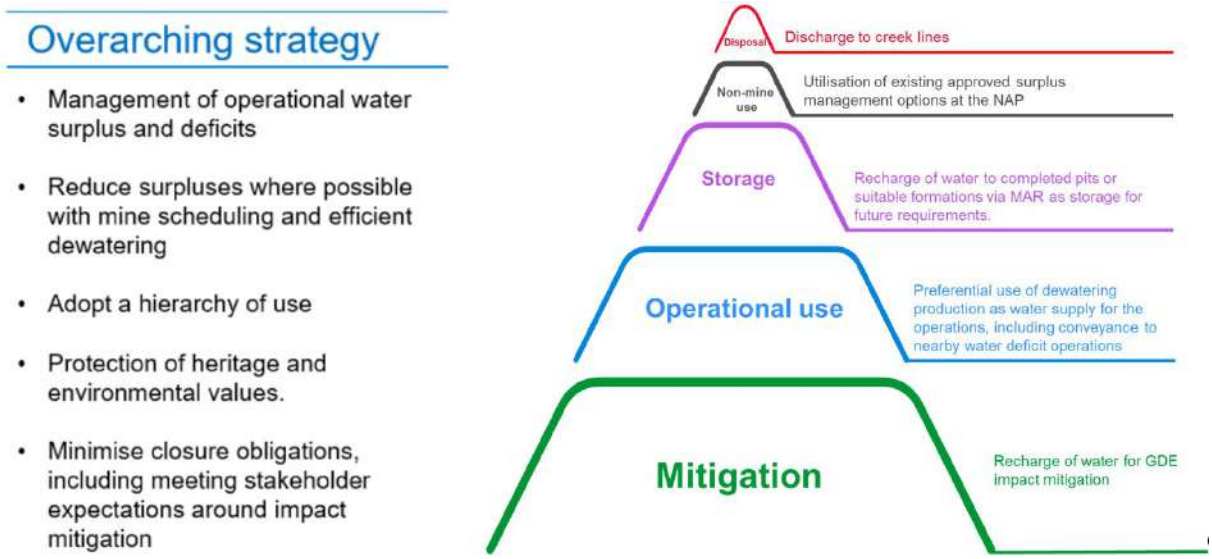


Figure 2-8: Brockman Operation water management strategy and surplus use hierarchy

Across the Brockman Operation dewatering volumes initially exceed operational water demand; however, as mining progresses into later years of the LOM, water demand exceeds dewatering volumes. Effective groundwater management can manage this supply and demand by utilising the following water opportunities:

- conveyance of water from operation areas with surplus to areas where there is a water deficit;
- storage in suitable disused pits, that are already backfilled or open voids, allowing storage of surplus volumes that could be used during deficit; and
- ASR (aquifer storage and recovery) in dewatered formations, allowing surplus water reinjection for later recovery and operational use.

Significant storage capacity in disused pits is anticipated by 2030 based on the current indicative mine sequence, with discharge to creeks anticipated to be phased out by 2032. As such, a surplus water management strategy is required in which surplus water is initially discharged to Duck Creek (to a maximum wetting front 67 km) and Boolgeeda Creek (to a maximum wetting front 37 km) and/or the NAP until such time as suitable disused pits become available for storage. As pits become available, storage within these pits and ASR will become the preferred surplus water management options to provide future beneficial use.

Water is also required for the proposed MAR (managed aquifer recharge) schemes that are being trialled at Narraminju (Caves Creek) to mitigate potential drawdown of groundwater and potential associated impacts to downgradient groundwater dependent ecosystems along Caves Creek. At closure, continued reinjection of water will be required to ensure no downstream impacts to Caves Creek or Palm Springs occurs as the groundwater table rebounds and to accelerate water level recovery post-mining.

The SGE operational MAR trial commenced in July 2022, investigating multiple recharge methods to inform the proposed MAR scheme. Closure of the SGE MAR trial has not been included in this MCP, however progress of the trial and proposed MAR scheme as well as closure strategies will be included in future revisions.

2.5.5. Other infrastructure

Other infrastructure that is not prescribed above, includes areas where infrastructure has been constructed for mining operation purposes. This includes roads, rail, powerlines and power related infrastructure, communications infrastructure, pipelines, borefields, pump stations, laydowns, wash downs, ANFO facilities, water treatment facilities, power generation and transmission facilities, workshops, laboratories, buildings, plant, conveyors, camps, airstrips, fuel facilities, haul roads and other disturbance areas. Other infrastructure will be decommissioned, and rehabilitation of infrastructure

will occur unless there is a transfer of assets to an agreed third party for post-closure use. Proposed infrastructure areas are shown in Figure 2-4 to Figure 2-6.

3. IDENTIFICATION OF CLOSURE OBLIGATIONS AND COMMITMENTS

The Australian mining industry has a well-established commitment to ensure that mine operations are closed with safe, stable, non-polluting landforms which are sympathetic to the surrounding landscape and that will require minimal (preferably none) ongoing maintenance post closure.

Australian State and territory Government are mostly responsible for the regulation and management of mine closure requirements for the mining industry (ANZMEC and MCA 2000).

This section details the relevant commonwealth, state and local requirements pertaining to the closure of the Brockman Operation.

3.1. Commonwealth

3.1.1. Primary legislation

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) has established a framework for environmental assessment of new proposals and variations to existing projects. Proposals that have the potential to significantly impact on MNES are assessed for approval under this legislation. Issues related to mine closure are considered during the assessment process. Projects that have the potential to impact on MNES are declared a Controlled Action under the EPBC Act and are required to meet conditions of approval as provided in a Decision Notice.

The BSP was referred to the then Commonwealth Department of Agriculture, Water and the Environment (DAWE) under the EPBC Act on the 26 August 2019. On the 31 October 2019 the Minister for the Environment determined that the BSP is a Controlled Action due to potential significant impacts on listed threatened fauna species and therefore will require further assessment and approval under the EPBC Act. On approval, a Decision Notice will be issued which is likely to include conditions to be applied during implementation of the BSP.

3.2. Western Australia

DMIRS is the lead regulator and decision-making authority for mining projects in Western Australia under the Mining Act. DMIRS also has an advisory role in relation to the environmental management aspects of mines which are regulated under State Agreement Acts and the EP Act.

The Department of Water and Environmental Regulation (DWER) is the lead regulator and decision-making authority under the EP Act. The EPA is the Government's chief advisor on environmental issues and is responsible for carrying out environmental impact assessment (EIA) of significant proposals under Part IV of the EP Act.

The Department of Biodiversity, Conservation and Attractions (DBCA) protects and conserves the State's natural environment on behalf of the people of Western Australia under the *Biodiversity Conservation Act 2016* (BC Act).

Department of Jobs, Tourism, Science and Innovation (JTSI) is the lead regulator for all mining and associated activities conducted under Rio Tinto's various State Agreement Acts. The State Agreements set out the obligations of the parties in relation to mining and associated activities, including closure. The State Agreements specifically contemplate the Western Australian Government's entitlements to certain assets at closure.

3.2.1. Primary legislation

State Agreement

A State Agreement is a legal contract between the Western Australian Government and a Proponent of a major project within the boundaries of WA. A State Agreement details the rights, obligations, terms and conditions for development of a specific project. Aspects of the three operations which are located outside the State Agreement tenure are supported by various tenures granted under the Mining Act and

Land Administration Act 1997. The Brockman Syncline is located within an area covered by the State Agreement, *Iron Ore (Hamersley Range) Agreement Act 1963* (WA).

Environmental Protection Act 1986

The EP Act outlines environmental management requirements for mining projects in Western Australia. Under Part IV of the EP Act any proposal that is likely to result in a significant impact to the environment may be referred under Section 38 (s38) to the EPA for assessment. The EPA will make a recommendation to the Environment Minister as to whether the project should be approved for implementation. The EPA requires the provision of an MCP to support the assessment of significant proposals. Following assessment of a proposal under Part IV of the EP Act, the WA Minister for the Environment may issue a Ministerial Statement (MS) approving implementation of the proposal subject to implementation conditions prescribed within the MS.

The existing operations have all been approved under Part IV of the EP Act:

- BS4 is approved under MS 1000 which contains implementation condition 7 relating to rehabilitation and closure. The BS4 2018 MCP was approved by DWER in compliance with MS 1000.
- BS2 is approved under MS 131 and MS 867 which do not does not contain an implementation condition relating to rehabilitation and mine closure. The B2N 2017 MCP was prepared and submitted to JTSI for review and comment.
- The Nammuldi-Silvergrass operation is approved under MS 925 which contains implementation condition 10 relating to closure, decommissioning and rehabilitation. The SGE 2018 MCP was approved by DWER in compliance with MS 925.

The BSP was referred under Part IV of the EP Act in July 2019 and a Public Environmental Review (PER) level of assessment was determined on 2 September 2019. Subject to approval, Rio Tinto is seeking a new consolidated MS with implementation conditions that supersede those currently applicable to the existing operations of MS 131, 867, 925 and 1000. Key environmental objectives and closure outcomes relevant to the existing MS's will be captured in the new MS or as closure outcomes within this MCP.

Mining Act 1978

The Mining Act regulates the terms and conditions upon which exploration and mining for minerals can be undertaken within Western Australia. In 2010, amendments to the Mining Act provided for the requirement of an MCP to be submitted to DMIRS for approval as part of a Mining Proposal and in any other circumstances as outlined in Section 84AA of the Mining Act.

Aboriginal Heritage Legislation

The *Aboriginal Heritage Act 1972* (AH Act) protects all Aboriginal heritage sites in Western Australia, whether or not they are registered with the Department of Planning, Lands and Heritage (DPLH).

Consent is required from the Minister for Aboriginal Affairs under s. 18 of the AH Act for any activity which will adversely impact Aboriginal heritage sites. Authorisation can also be granted under s. 16 to enter, excavate, examine or remove anything on an Aboriginal heritage site (e.g. for archaeological purposes). Sites within the closure boundary are discussed in Section 5.1.2.

The AH Act is to be replaced by the *Aboriginal Cultural Heritage Act 2021* (ACH Act), which received Royal Assent on 22 December 2021, effectively giving Western Australia new Aboriginal heritage legislation. Before the ACH Act is proclaimed (i.e. comes into operation) a transitional period of at least 12 months is currently in effect - during which new ACH Act regulations, statutory guidelines and operational policies are being developed. The transitional period will allow for a new Aboriginal cultural heritage management system to be fully established and to enable affected parties to prepare for the new system.

Native Title

The Commonwealth *Native Title Act 1993* (NT Act) recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters according to their traditional laws and customs. Native Title includes areas where title holders have exclusive rights and interests as well as areas where non-exclusive rights and interests exist. TO rights recognised under the NT Act within non-exclusive areas include, generally, the right to:

- access, remain and move about, and camp and erect shelters and structures for that purpose;
- hunt and fish, gather and use traditional resources, and take and use water;
- engage in cultural activities and transmit knowledge;
- visit, care and protect places of cultural and spiritual importance; and
- conduct ceremonies and rituals.

The Brockman Operation intersects non-exclusive areas of the relevant Native Title determinations.

3.2.2. Primary guidelines

Guidelines for Preparing Mine Closure Plans

DMIRS have developed the industry guidance document *Statutory Guidelines for the Preparation of Mine Closure Plans* (DMIRS 2020a). This guideline was originally released in June 2011, was revised in May 2015 and became a statutory guideline in March 2020.

The guideline adopts the objectives and principles of the Strategic Framework (Section 3.1.2), whilst providing further description of how MCPs in Western Australia can meet the objectives and principles. It also outlines a planning process that aims at ensuring that a mine can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land-uses, without unacceptable liability to the State.

This MCP has been developed to meet the *Statutory Guidelines for the Preparation of Mine Closure Plans* (DMIRS 2020a).

The EPA and DMIRS undertake a parallel assessment of MCPs if the Proposal requires assessment under Part IV of the EP Act.

Other guidelines and industry standards

This MCP has been prepared in consideration of the relevant aspects from the following closure guidelines and industry standards:

- Environmental Objectives Policy for Mining in Western Australia (DMIRS 2020c).
- Guidance – How to prepare a Mine Closure Plan in accordance with Part 1 of Statutory Guidelines for Mine Closure Plans in Western Australia (DMIRS 2020b).
- Guidance Note – Environmental Risk Assessment for Mining Proposals and Mine Closure Plans (DMIRS 2019).
- A Framework for Developing Mine-site Completion Criteria in Western Australia – Western Australian Biodiversity Science Institute (WABSI 2019).
- Mine Closure: Leading Practice Sustainable Development Program for the Mining Industry (DIISR 2016).
- Mine Rehabilitation Handbook (Mineral Council of Australia 1998).
- Mine Closure and Completion (DIISR 2016a).

- Guide to Departmental Requirements for the Management and Closure of Tailings Storage Facilities (Department of Mines and Petroleum, DMP 2015).
- Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure (Australian National Committee on Large Dams, ANCOLD 2019).
- Preventing Acid and Metalliferous Drainage (DIISR 2016b).
- Mine Rehabilitation (DIISR 2016c).
- Integrated Mine Closure: Good Practice Guide (International Council of Mining and Metals, ICMM 2019).
- Guideline for safety bund walls around abandoned open pit mines (Department of Industry and Resources, DOIR 1997).

3.3. Legal Obligations

A legal obligations register relating to rehabilitation and closure for the Brockman Operation is provided as Appendix 3. The register also identifies legislation, standards and guidelines that may not apply to this site specifically, but that may be relevant to closure of mine sites generally.

This register captures legal obligations from the following instruments:

- Hamersley State Agreement;
- Ministerial Statement 131 Brockman No. 2 Detrital Iron Ore Mine (issued 1991);
- Ministerial Statement 867 Brockman 2 Detrital Iron Ore Mine Extension Phase 2B (issued 2011);
- Ministerial Statement 925 Nammuldi-Silvergrass Expansion (issued 2013);
- Ministerial Statement 1000 Brockman Syncline 4 Iron Ore – Revised Proposal (issued 2015);
- relevant Native Vegetation Clearing Permits (NVCP);
- Part V Operating Licence L5258/1991/11 issued for Mount Brockman, Nammuldi and Silvergrass Iron Ore Mines under the EP Act;
- mining leases, general purpose leases and miscellaneous licences issued under the Mining Act pursuant to the Hamersley State Agreement; and
- special leases and easements issued under the *Land Administration Act 1997* pursuant to the Hamersley State Agreement.

This MCP has been prepared to support approval of the BSP and additional obligations may arise through the approval process. Any new obligations will be documented in the next update of this MCP.

The Brockman Operation is located within the boundaries of the recognised native title determinations areas of two Traditional Owner groups of the Pilbara region: the Puutu Kunti Kurrama and Pinikura People; and the Muntulgura Guruma People (Section 3.2.1). Rio Tinto has comprehensive Indigenous Land Use Agreements (ILUAs) with both groups and is committed to consulting with the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People regarding the Brockman Operation and its eventual closure.

4. STAKEHOLDER ENGAGEMENT

4.1. Consultation Program

Rio Tinto recognises that regular and ongoing stakeholder engagement is a key part of mine closure planning as it ensures that the views and expectations of stakeholders are understood, and these are considered and managed during the study and operational phases and through to planning and implementation phase of closure. The ability to build relationships and to work collaboratively and transparently with our host communities is critical to Rio Tinto's long-term success regarding rehabilitation and closure.

Rio Tinto has an ongoing consultation program relating to the Brockman Operation with government agencies (local, State and Commonwealth), non-government organisations, Traditional Owners, and land users potentially impacted by, or interested in, implementation of the Brockman Operation and associated closure strategies. The key stakeholders are listed below in Table 4-1.

Table 4-1: Key stakeholder list

Category	Stakeholder
Traditional Owners	Wintawari Guruma Aboriginal Corporation (WGAC) representing the Muntulgura Guruma People The Puutu Kunti Kurrama and Pinikura Aboriginal Corporation (PKKPAC) representing the Puutu Kunti Kurruma and Pinikura People Robe River Kuruma Aboriginal Corporation (RRKAC) representing the Robe River Kuruma People
Commonwealth Government	Department of Climate Change, Energy, the Environment and Water (previously DAWE) Civil Aviation Safety Authority
State Government	DWER DMIRS JTSI DBCA DPLH Department of Primary Industries and Regional Development (DPIRD) Department of Health (DOH)
Local Government	Shire of Ashburton WA Police – Pilbara Main Roads Western Power/Horizon Pilbara Development Commission WA Country Health Service
Non-government	Fortescue Minerals Group (FMG) and other surrounding companies Conservation Council, Land Care, other environmental groups Tourism Commission WA Pastoral Lands Board State Lands Manager
Community	Cheela Plains Pastoral Station Mount Stuart Pastoral Station Pilbara Aboriginal Businesses
Internal	Rio Tinto employees and contractors

Regular consultation is conducted with a wide range of stakeholders via a variety of forums, for example various State and Local Government agency briefing meetings and Traditional Owner consultation forums established under Indigenous Land Use Agreements. Agenda items regarding closure and related activities are included in these meetings as appropriate.

Given the stage of the Brockman Operation, the current consultation program has typically focused on progressive rehabilitation, consultation with Traditional Owners regarding developments proposed as part of the Brockman Syncline Proposal (Social Surroundings) and technical study updates. The level of closure specific content and detail will increase during the life of operations.

Details of all consultation regarding rehabilitation and closure of the Brockman Operation are captured in the stakeholder consultation register (Appendix 4).

4.2. Closure Stakeholder Engagement Strategy

An overview of the closure stakeholder engagement to be undertaken throughout the life of the Brockman Operation is presented in Table 4-2. The focus of this consultation will be to:

- Provide information to key stakeholders regarding the progress of the operation, progressive rehabilitation, and the closure planning process.
- Identify expectations for, and progress towards agreement on post-mining land use(s) and closure outcomes.
- Establish agreed management actions through the Social and Cultural Heritage Management Plans (SCHMPs), currently being co-prepared with WGAC and PKKPAC, and other management plans to inform operations and ongoing closure planning and consultation.
- Identify the key issues and concerns of key stakeholders regarding the design and management of rehabilitation and closure activities.
- Where practicable, allow for adjustments to the design and/or management of any proposed rehabilitation and closure activities to accommodate concerns or issues raised by key stakeholders.

Table 4-2: Closure stakeholder engagement strategy for key stakeholders

Stakeholder	Engagement Forum and Timing	Focus
JTSI DWER DMIRS	Rio Tinto Closure Regulator Engagement Forum, meetings held three to four times per year. Meetings as required.	Consultation to support three yearly updates, or as required by the MS, to Closure Plans. Agenda may include: • Progressive rehabilitation. • Technical studies updates. • Completion criteria etc.
DBCA DPLH	DBCA have requested targeted consultation to be held when closure planning impacts their areas of responsibilities. Meetings as required.	Targeted closure planning engagement as required.
PKKPAC WGAC RRKAC	Regular ongoing engagement with the Prescribed Body Corporate (PBC) and the Puutu Kunti Kurrama and Pinikura People sub-committee and Heritage and Environment Committee (HEC). Ad hoc to semi-regular board meetings and consultation with Wintawari Guruma WGAC and the Muntulgura Guruma People.	Progressive rehabilitation and updates to technical studies related to closure. Targeted closure planning engagement to commence during Order of magnitude (OoM) closure studies to support and further refine: • Closure strategies and completion criteria. • Post-closure land use. • Business opportunities linked to rehabilitation/closure works.

Stakeholder	Engagement Forum and Timing	Focus
	At least one meeting per year to discuss rehabilitation and closure with Puutu Kunti Kurrama and Pinikura and Muntulgura Guruma. Targeted closure planning engagement to commence 10 years from scheduled mine closure. Regular meetings with Puutu Kunti Kurrama sub-commitee for the Juukan Gorge Remediation Project	• Opportunities to engage Traditional Owner rangers for rehabilitation, closure and monitoring work. • Consultation regarding closure and rehabilitation to support 'social surroundings projects' impact evaluations and inform project design.
Cheela Plains Station Mount Stuart Station	Ad-hoc meetings on an "as needs" basis. Rio Tinto has an existing relationship manager for all relevant 3rd Party stations to ensure matters of mutual interest and impact are discussed in appropriate detail.	Targeted closure planning engagement to commence during OoM closure studies to support further refine of closure strategies and completion criteria.
FMG	Working group for BS1 mining interactions.	Data sharing

Through a range of forums, including those established under the Native Title Agreements (NTA), consultation with each of the Traditional Owner groups in respect of land access; BSP development; heritage surveys; environmental management; and other issues relevant to the Brockman Operation will be undertaken.

These forums and meetings include, but are not limited to:

- Life of Mine Planning (LOMP) meetings which involve face to face meeting to discuss and provide updates to Traditional Owners on exploration, studies/projects, mining, and closure activities. Key topics include management of water and the environment.
- Dedicated Cultural Heritage meetings and board meetings which involve face to face meetings to discuss, in detail, cultural heritage identification, management and approvals.
- Environmental monitoring and management, including on-ground consultation to participate in monitoring and management activities.

Ad hoc meetings: to discuss matters of mutual priority and concern. These meetings often take place 'on-country' with support from internal and external Subject Matter Experts (SMEs), Traditional Owner Elders and Aboriginal Corporation staff.

4.3. Targeted Stakeholder Consultation

Rio Tinto has consulted with key stakeholders regarding rehabilitation and closure associated with the Brockman Operation with details presented in Appendix 4.

Key themes arising from this stakeholder consultation are:

- Rio Tinto has met regularly with the Puuti Kunti Kurruma sub-committee to co-manage the remediation of the Juukan Gorge area at BS4 as well as to seek endorsement for all works carried out at the Juukan Gorge Remediation Project.
- Surface and groundwater management is a key concern for both the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People. In particular, the following has been a key point of consultation:
    - Dewatering of the SGE deposit and consideration of a MAR scheme to prevent potential impacts to Palm Springs;

    - Maintenance of the hydraulic function of the Duck Creek, Boolgeeda Creek and Caves Creek.

- DMIRS is interested in rehabilitation methods and monitoring and refinement of completion criteria.
- Rio Tinto will continue to consult with key stakeholders over the life of the Brockman Operation with rehabilitation and closure remaining an ongoing point of discussion. Cheela Plains Pastoral Station concerns related to the rehabilitation of DP1 at BS4 and specifically the dump's stability and prevention of erosion during intense rainfall events.

Rio Tinto will continue to consult with key stakeholders over the life of the Brockman Operation with rehabilitation and closure remaining an ongoing point of discussion.

5. BASELINE AND CLOSURE DATA AND ANALYSIS

This section provides a summary of relevant baseline and operational data; identifies any closure implications and knowledge gaps. Key baseline data reports are included as Appendices to this MCP and referenced in relevant sections. Rio Tinto will use this information to assist in the refinement of completion criteria and effective mitigation and management of identified risks leading up to and during the closure implementation phase.

Identified closure knowledge gaps are discussed in each section and summarised in Section 5.16.The knowledge gaps are aligned with the Brockman Operation Closure Risk Register (Appendix 5) and associated actions captured in the Brockman Operation Action Register (Appendix 6).

SOCIAL SETTING

5.1. Aboriginal Culture and Heritage

Rio Tinto recognises and respects the significance of Australia's cultural heritage, and the cultural heritage of Aboriginal people who have traditional ownership of, and/or cultural connections to the land on which it operates. Extensive archaeological and ethnographic surveys have been undertaken in the Brockman region, and these surveys have helped to inform the heritage values of the area.

Extensive archaeological and ethnographic surveys have also been undertaken within the closure boundary, along with dedicated Social Surroundings consultation to understand broader social and cultural values. This work has informed Rio Tinto's understanding of the social and cultural values of the area. The ongoing consultation with Traditional Owner groups has also informed the mine layout and design to avoid impacts to significant social and cultural values, sites, and places, as well as identify options to reduce and manage impacts through the implementation, operation, rehabilitation and closure phases of the Brockman Operation. Closure works consider issues such as post closure access requirements to culturally significant sites and appropriate return of any materials salvaged during mining operations.

Consultation with all Traditional Owner groups interested in and affected by the Brockman Operation will be maintained in established forums or through dedicated meetings throughout the life of the operation to ensure that proposed closure strategies address cultural requirements, and to ensure closure outcomes for the site remain appropriate.

5.1.1. Native Title determinations

The Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People are the traditional custodians of the land identified in this MCP (Figure 2-1). The Brockman Operation intersects or is adjacent to the following determined Native Title determination (NTD) areas:

- The Puutu Kunti Kurrama and Pinikura People Native Title determination (WAD126/2005), covering the majority of the BS4 area.
- The Eastern Guruma People Native Title determined claim area (WAD6208/1998) representing the Muntulgura Guruma Traditional Owner group, which includes the eastern portion of the BS4 area and all of the B2N, and SGE areas.
- The Robe River Kuruma People Native Title determination (WAD6090/1998) approximately 20 km west of the closure boundary at SGE.

The Puutu Kunti Kurrama and Pinikura People entered into a Claim Wide Participation Agreement with Rio Tinto in March 2011 and an ILUA was registered with the National Native Title Tribunal in April 2013. The Puutu Kunti Kurrama and Pinikura People are two distinct Groups who each speak for their own Country within the NTD area, as well as collectively over a shared area.

Rio Tinto has negotiated and executed claim-wide land use agreements with the Puutu Kunti Kurrama and Pinikura and Muntulgura Guruma Traditional Owner groups. These Agreements are being subject to a modernisation process, which is ongoing at the time of writing.

Rio Tinto and Muntulgura Guruma representatives signed a Commercial Agreement on 23 March 2001, with a variation to this original Commercial Agreement occurring in August 2008, and an ILUA was signed on 27 November 2002. Following their NTD on 1 March 2007, a Variation Agreement to the Commercial Agreement was signed with Rio Tinto on 19 December 2007.

5.1.2. Ethnographic and archaeological values

Since the 1970s, Rio Tinto and the nominated Traditional Owner representatives have conducted over 300 archaeological and/or ethnographic surveys, that covers approximately 80% of the closure boundary and are within and surrounding the Brockman Operation closure boundary. Surveys are completed to gain a comprehensive understanding of its heritage and cultural values. Further information will be presented in the SCHMPs co-prepared with WGAC and PKKPAC (still in draft at the time of writing). Surveys are also commissioned for other purposes including:

- Inform the Proponent of the location of heritage places so that these may be avoided through project design and re-design where practical.
- Assess the cultural values of heritage places with a view to register them with DPLH in order to gain consent to investigate or disturb sites which Rio Tinto cannot practically avoid and are seeking to disturb.

The Brockman Operation is in a rich natural resource region, resulting in an abundant cultural landscape that reflects a history of social interaction and practice affirmed by the presence of a large number of artefact scatters, rock shelters, scarred trees, rock art and ethnographic sites that directly tie into Aboriginal cultural identity and Lore.

As surveys continue, additional cultural and heritage places are likely to be identified. Archaeological and ethnographic surveys and consultations are ongoing and will continue during the life of mine, which will add to the existing knowledge of heritage and cultural values within the area.

Puutu Kunti Kurrama and Pinikura People

There are a number of heritage places determined to be of high significance to the Puutu Kunti Kurrama and Pinikura People within and adjacent to the Brockman Operation closure boundary. Archaeological and ethnographic heritage surveys within Puutu Kunti Kurrama and Pinikura land have covered approximately 77% of the MCP closure boundary. As at March 2022, surveys had identified at least 160 heritage places of varying significance within the closure boundary and Level 1 archaeological recording (in accordance with the Rio Tinto Heritage Survey Guidelines [Rio Tinto 2022]) have been undertaken on more than 80% of these places. Ethnographic assessment of known heritage places within the closure boundary is currently underway and Rio Tinto is awaiting ethnographic reports, which will inform the ethnographic significance of these places, as well as management recommendations.

There is an expectation from the Puutu Kunti Kurrama and Pinikura People that the heritage places within the closure boundary are viewed as interconnected ‘nodes’ in a cultural landscape rather than as individual places. Archaeological significance typically considers each place in isolation. As such the understanding of the significance of these places is likely to change in response to the ethnographic work. The MCP will be updated every three years or as required by the MS, to ensure the knowledge is captured and closure strategies are adjusted in synergy with the SCHMP.

Key ethnographic and archaeological values and significant site for the Puutu Kunti Kurrama and Pinikura People include:

- Purlykuti Creek, a tributary of the Boolgeeda Creek west of the BS4 mining area, has been identified during ethnographic surveys as being of high significance. The area is a corridor that

has been used by Traditional Owners for generations to reach their significant art and archaeology places to the north and south of Boolgeeda Creek.

- Boolgeeda Creek is a waterway considered to be of high cultural significance that the Puutu Kunti Kurrama and Pinikura People have expressed their desire to register as an ethnographic heritage site.
- Two approximately 46,000-year-old rock shelters Juukan 1 and Juukan 2, within the Juukan Gorge, were discovered in 2003 during survey work of the area. In May 2020 the rock shelters in Juukan Gorge were tragically destroyed by operational blasting. The Juukan Gorge Remediation Project is currently underway to remediate the area and return a sense of place to the Puutu Kunti Kurrama and Pinikura People. The remediation project is discussed further in Section 9.5.
- The range of hills at BS1 is reported to be part of a song line associated with Mt Brockman. Ethnographic work is ongoing at BS1 to understand the complex ethnography for this area
- Five significant site clusters have been identified at BS1 and further consultation with Puutu Kunti Kurrama and Pinikura representatives is required to establish the nature and significance of these sites.

Muntulgura Guruma People

Rio Tinto has commissioned archaeological and ethnographic surveys with the Muntulgura Guruma People within their NTD. The archaeological and ethnographic heritage surveys within Muntulgura Guruma land have covered approximately 68% of the MCP closure boundary. Heritage information can be sensitive and is treated “in confidence” with each Group. The information provided in this section may therefore be non-specific in some cases to protect the sensitivity of the detailed information. In total, 151 heritage surveys on Muntulgura Guruma Country within the closure boundary have been completed as of May 2022.

A heritage dataset is maintained by WGAC, which is derived primarily from the records of mining companies that operate within Muntulgura Guruma Country and from the State’s Register of Aboriginal Sites. Muntulgura Guruma People consider that the approach to collating this dataset views Muntulgura Guruma heritage through a purely archaeological and anthropological lens within the confines of the *Aboriginal Heritage Act 1972 (*currently operating in conjunction with the new *Aboriginal Cultural Heritage Act 2021* [WA]) and are categorised such that sites are not an accurate reflection of how they view and understand their heritage. Similarly, each ‘site’ is often considered as an individual occurrence and does not consider its surrounds and cultural associations. In recent years, WGAC has focussed on collecting information that is more culturally accurate and applying alternative methodologies that are more culturally appropriate.

WGAC has been working with Muntulgura Guruma Elders and Traditional Owners to identify and map the cultural areas within their Country. As a result, WGAC has adopted *cultural catchments*, which are agglomerations of key features and landforms that form a single cultural-geographic assemblage within the broader Eastern Guruma NTD area. Each cultural catchment is centred on a primary waterway and its feeder tributaries, and includes the host of cultural heritage places, land features, localised sub-districts, historic and contemporary associations, objects, sacred sites, environments, biological communities, dreaming narratives and routes that form the constellation of Guruma understanding.

There are 15 cultural catchments, of various size and shape, that comprise Muntulgura Guruma Country. The cultural assemblage of the cultural catchments is considered the cultural values, which are the various connectors that link Muntulgura Guruma People with their Country. The catchments are associated with the main creek system in the vicinity and have been aptly named after.

Four of these catchments are significantly intersected by the closure boundary; Narraminju, Pulykati, Kartajirri, and Maliwartu. The Wakkulinha catchment partially intersects the closure boundary.

- Narraminju Wuntu (Caves Creek) Cultural Catchment Area

This Cultural Catchment Area is 586 km^2 in size and represents 9.5% of the Eastern Guruma NTD area. The main creek within this Cultural Catchment Area is Caves Creek. Along Caves Creek, are various water springs of significance, especially Palm Springs located approximately 20 km west of SGE. Although Palm Springs is outside of the closure boundary, the hydrological and hydrogeological processes that maintains Palm Springs could be influenced by dewatering activities at SGE without implementation of control and mitigation measures.

- Kartajirri Wuntu (Duck Creek) Cultural Catchment Area

  This Cultural Catchment Area is approximately 500 km^2 in size and represents about 8% of the Eastern Guruma NTD area. The main creek through the Cultural Catchment Area is Duck Creek. Along the main creek are five culturally significant waterholes distributed along the main channel and four culturally significant waterholes to the south of the creek system.

- Pulykati Wuntu (Boolgeeda Creek) Cultural Catchment Area

  This Cultural Catchment Area is 233 km^2 in size and represents 4% of the Eastern Guruma NTD area. The main creek through this Cultural Catchment Area is the Boolgeeda Creek. Within this Area are places of importance and significance include Jawunpa (Mt Brockman) site complex, Jawunmullungkanha, Pirtungarramunha, Minha and the rockhole Bulluru (also known as Puluru) as well as Plunge Pool.

- Maliwartu Wuntu (Beasley River) Cultural Catchment Area

  This Cultural Catchment Area is 657 km^2 in size and represents more than 10% of the Eastern Guruma NTD area. The Beasley River is the main water channel through this Cultural Catchment Area.

Robe River Kuruma People

The neighbouring NTD, Robe River Kuruma traditional lands are recognised for the potential indirect environmental impacts on their cultural values arising from activities on the adjoining NTD areas of Muntulgura Guruma and Puutu Kunti Kurrama and Pinikura People.

Rio Tinto have engaged in a consultative process with the Robe River Kuruma People recognising that they have expressed strong views regarding places of importance and the values in this part of the Country. Robe River Kuruma People have also expressed the sentiment that damage to one part of Country, whether in Puutu Kunti Kurrama and Pinikura, Muntulgura Guruma or Robe River Kuruma Country, is detrimental to all three Groups. As such, they wish to work cooperatively with the other groups to protect Country. The traditional meeting place of the three Groups, namely Palm Springs, known as Marlumarlunha to Robe River Kuruma People, is several kilometres upstream of the intersection of Caves Creek and Duck Creek. The Robe River Kuruma People recognise the Muntulgura Guruma People as the Native Title Holders of the land on which this area is, and therefore as the Group with the cultural authority to provide guidance on matters pertaining to Palm Springs.

5.1.3. Management of heritage sites and social and cultural values

Management of identified heritage sites and social and cultural values will be conducted through processes agreed with the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People, as established under the ILUA and strategies incorporated into the respective SCHMPs.

While cultural heritage sites and places will be considered during landform design and planning (which includes rehabilitation designs), there is potential for heritage sites to be impacted because of closure implementation i.e. footprint encroachment, resulting from landforms such as waste rock landforms being reshaped to final design parameters or being located within the Potentially Unstable Pit Edge Zones (PUPEZs) and therefore inaccessible due to being within abandonment bunds.

As options on engineering and rehabilitation designs are narrowed as the site approaches closure, any potential for sites to be impacted will be identified and managed in consultation with the relevant Traditional Owner groups and in accordance with appropriate procedures. Heritage surveys, and any

future assessments or clearances that are required to facilitate closure implementation will be conducted in collaboration with the Traditional Owner groups. Closure planning considers how salvaged artefacts will be managed long term, however the intent for artefact material salvaged has not been determined at this point. Consultation with the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People on the proposed final landforms is ongoing, and engagement will incorporate greater specificity closer to the closure date.

An Integrated Heritage Management Process (IHMP) has been developed to provide an increased level of governance around protection of cultural heritage and decisions made when operating in proximity to heritage sites where there is a risk of impact from mining and closure activities. The IHMP involves systematic identification and risk assessment of all heritage sites that could be impacted by mining and closure activities and controls necessary to avoid and minimise potential disturbance. Where there may be potential for unavoidable direct disturbance, activities cannot proceed unless there is recent Traditional Owner consultation.

All reasonable and practicable measures are taken to prevent harm to cultural heritage sites, including during works associated with rehabilitation and closure. Where this is not possible, steps are taken to minimise or mitigate impacts and ensure required statutory approvals are obtained. Closure works consider issues such as post-closure access requirements to culturally significant sites and appropriate return of any materials salvaged during mining operations. Where possible, heritage sites will be preserved *in situ* and safe access maintained to allow Traditional Owners to conduct cultural activities such as the passing down of cultural knowledge and ‘Care of Country’ to future generations.

Heritage surveys, and any future assessments or clearances that are required to facilitate closure implementation will be conducted in collaboration with the Traditional Owners, in alignment with the respective SCHMP.

5.1.4. Closure access management

Post closure access to culturally significant sites and places and repatriation of any materials salvaged during mining operations need to be considered as part of closure planning. The repatriation of artefacts following closure of the Brockman Operation has not yet been discussed with the Traditional Owners but will be included in ongoing consultation. Whilst this MCP does not include specific strategies for maintaining or restoring cultural values, it does recognise that post-closure access to some sites will be required and that where possible these areas will need to be made safe for this purpose.

Heritage sites and places situated within PUPEZs (i.e., within abandonment bund boundaries) will require management to avoid inadvertent post closure access to unsafe areas. Where sites are unable to be appropriately managed in-situ, further consultation and mitigation will be undertaken with Traditional Owners and the relevant governmental departments.

As part of closure planning, detailed consultation will occur with Traditional Owners for Rio Tinto to understand their priorities, to inform closure options and align and manage closure expectations. Consultation is intended to include:

- the repatriation of salvaged artefacts;
- management and protection of heritage sites during closure implementation;
- how to facilitate meaningful and beneficial post-mining land access and use by Traditional Owners, including the proposed placement of pit abandonment bunds; and
- pursuing meaningful opportunities to include Traditional Owners, Pilbara Aboriginal People and Pilbara Aboriginal Businesses in closure related work.

Specific engagement with each Traditional Owner group will occur to communicate access restrictions to certain areas of the site due to the potential for geotechnical instability associated with pit crests. Site access will be determined in consultation with Traditional Owners and communicated in a post-closure site access plan to ensure that areas of geotechnical instability associated with pit voids are well understood.

These consultations will continue as the site progresses through operations towards closure and be further defined in each iteration of the MCP.

5.1.5. Implications for closure and knowledge gaps

Consultations with the Puutu Kunti Kurrama and Pinikura People, Muntulgura Guruma People and Robe River Kuruma People are ongoing and will be maintained via established forums throughout the life of the Brockman Operation to ensure that proposed closure strategies address cultural requirements and expectations, and to ensure closure outcomes for the Brockman Operation remain appropriate.

Closure implications associated with cultural heritage values at the Brockman Operation that require ongoing focus include:

- Potential for long-term indirect impacts to cultural heritage sites from changes to geotechnical stability, surface water movement and sediment transport are considered during initial mine design siting and development of closure strategies.
- Heritage site exclusion zones to be maintained through the decommissioning, closure and rehabilitation implementation phases.
- Closure strategies to be developed in consultation with Puutu Kunti Kurrama and Pinikura People Muntulgura Guruma People and RRK to fully consider the cultural implications.
- Provision of safe access for the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People to identified sites of cultural heritage significance post-closure.
- Traditional ecological knowledge used to inform rehabilitation outcomes.
- Creek catchment losses and surface water flows to major creeks.
- Visual amenity and sense of place in culturally significant places post closure.

Closure knowledge gaps associated with cultural heritage values, as summarised in Section 5.16, Table 5-20 include:

- Update rehabilitation seed mix to incorporate traditional ecological knowledge in consultation with Traditional Owners.
- Agreement on key heritage locations and access requirements post closure, final site closure outcomes, completion criteria and measurement tools, including visual amenity outcomes
- Strategy for the safe keeping or return of any artefacts or materials salvaged.
- Surface water management through BS1 to reduce catchment loss to Boolgeeda Creek.

5.2. Socio-Economic Aspects

The Brockman Operation is located in the Shire of Ashburton which covers 105,600 km^2 with an estimated population of 13,331 (ABS 2016). The closest regional centre is the Tom Price town, approximately 60 km to the west-north-west.

European settlement dates from the 1860s, with land used mainly for pastoral purposes. Significant development did not occur until the late 1960s, when iron ore deposits were discovered, and offshore gas and oil production commenced. Iron ore mining and oil and gas production are the main industries. Rural land is characterised by open-cut mines, large pastoral leases and cattle stations.

Approximately 1950 people work at the existing Brockman Operations. Most of the Brockman Operation workforce are flown directly from Perth to Boolgeeda Airport at BS4. A small number of employees commute by road from Tom Price. Personnel are housed in a fully serviced accommodation facilities that may be decommissioned as part of closure of the Brockman Operation.

Mining activities are anticipated to continue at a similar rate within the wider Pilbara region after the Project ceases to operate. Thus, regional employment opportunities and mine related services are not

anticipated to be significantly impacted by closure of the mine, however there may be some contraction in the workforce in the local area.

5.2.1. Implications for closure and knowledge gaps

Closure implications associated with the socio-economic setting include:

- Local communities may be impacted by closure of the Brockman Operation, particularly regarding cessation of opportunities for employment and business opportunities.
- Mining activities are anticipated to continue at a similar rate within the wider Pilbara region after mining at the Brockman Operation ceases, however, Rio Tinto will implement strategies to manage any workforce impacts.

Closure knowledge gaps associated with socio-economic impacts, as summarised in Section 5.16, Table 5-20 include:

- Potential social and economic impacts to be considered as closure preparations commence including amenity, loss of employment and business opportunities.

PHYSICAL ENVIRONMENT

5.3. Climate

5.3.1. Local climatic conditions

The Brockman Operation is in the Pilbara region of Western Australia which has an arid climate and experiences regular cyclonic activity during November to March. Characteristic climatic features of the region include seasonally low rainfall with high temperatures, high evaporation rates and high daily temperature range.

The nearest certified meteorological station is Paraburdoo Aero (BOM Station 007185) located approximately 80 km to the south-east of the Project. Climatic data gathered from Station 007185 has been captured since 1974 and is comparable to an automatic weather station located at BS2 (installed in 1998); hence is considered representative of that experienced across the Brockman Operations.

Maximum average temperatures generally occur from November to March with maximum temperatures ranging between 35°C and 41°C and minimum temperatures ranging between 20°C and 26°C. The coolest months occur between June and August when the temperatures reach an average maximum of 25°C and an average minimum of 10°C (refer to Figure 5-1).

Rainfall occurs predominantly in the summer months with the largest events being associated with tropical cyclones bringing heavy rain to inland parts of the Pilbara. Frequent summer thunderstorm activity and occasionally protracted rainfall, when a low-pressure trough descends into the region, are characteristic.

The long-term annual average rainfall for Station 007185 (1974 to 2020) is 323 mm/year (Figure 5-1). Monthly rainfall during December to February ranges from 27-75mm whilst monthly rainfall during September to November ranges between 4-10mm.

The rainfall distribution typically experienced across the Project is bi-modal, peaking in December to February and May to June, resulting from the influence by two main climatic systems:

- the northern rainfall system of tropical origin; and
- the southern winter rainfall associated with low-pressure frontal systems.

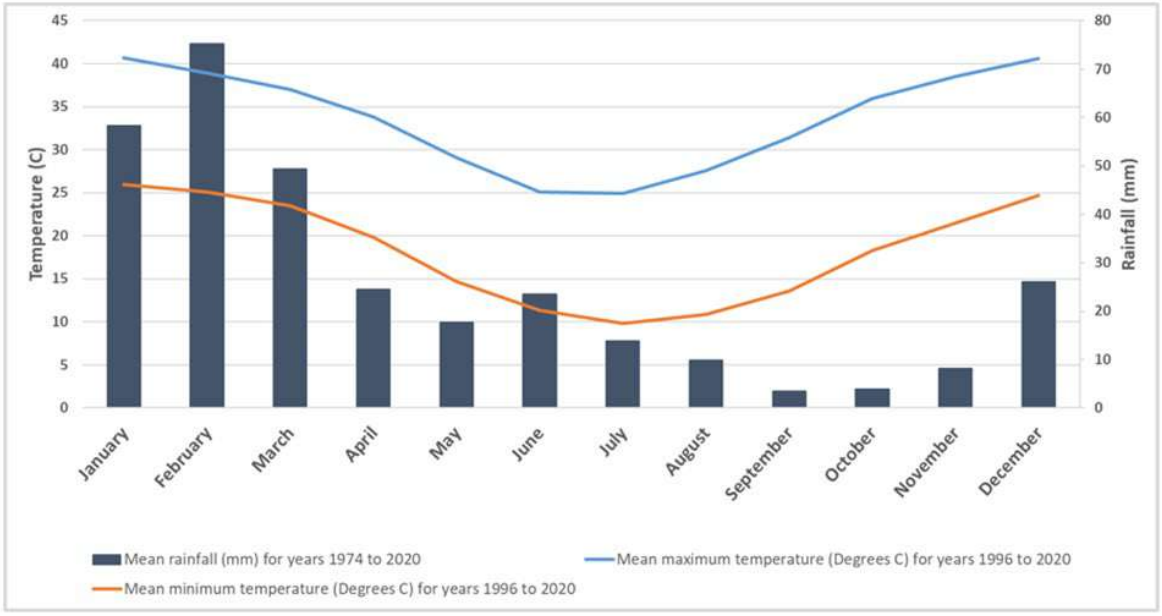


Figure 5-1: Long term average maximum and minimum temperatures for Paraburdoo Aero station 007185

The annual evaporation rate for the region is 3,400mm (BOM 2006) vastly exceeding the annual average rainfall (refer to Figure 5-2). Maximum evaporation rates generally occur in January with approximately 400mm/month anticipated in the seasonal peak. These rates can reduce to approximately 125mm/month in June.

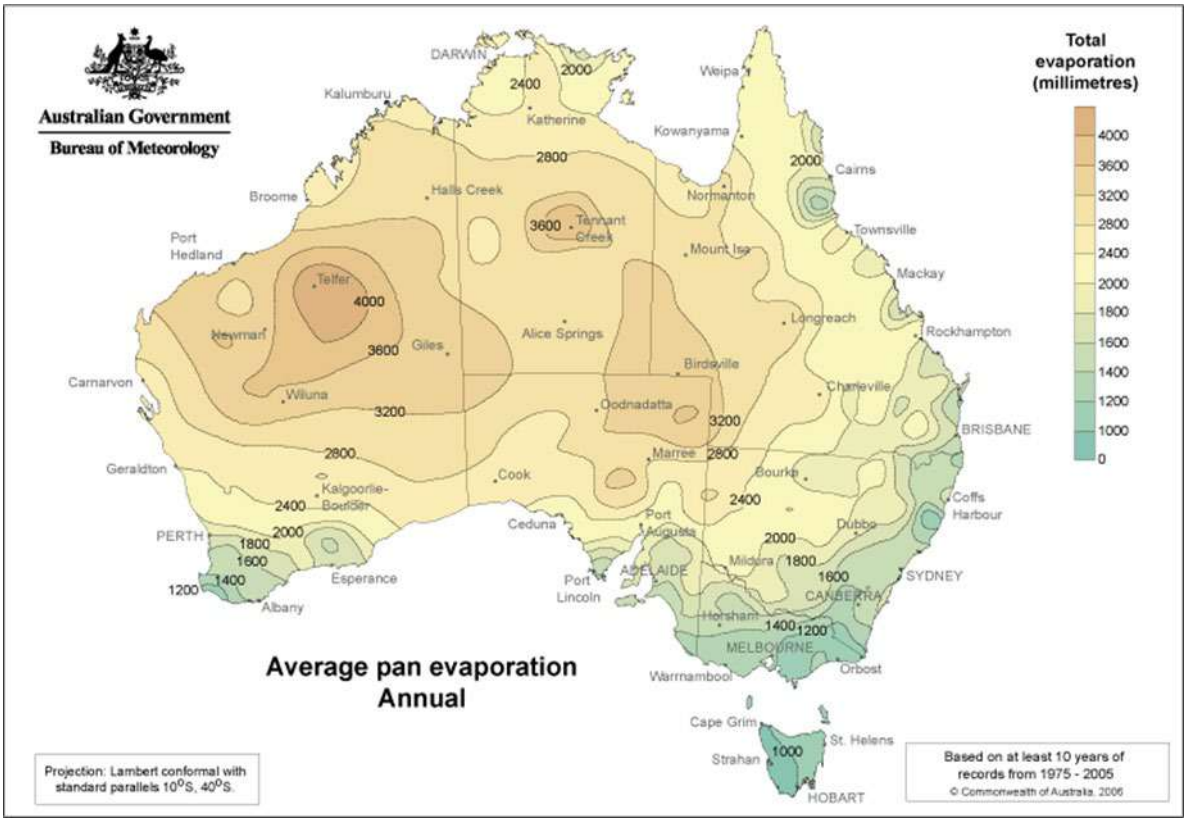


Figure 5-2: Average annual evaporation rates across Australia

(*Source: BOM 2006*)

5.3.2. Climate change

Rio Tinto accepts the Intergovernmental Panel on Climate Change's (IPCC) current view that climate change is unequivocal, human influence is clear and physical impacts are unavoidable (IPCC, 2014). Rio Tinto understands that climate change will amplify existing risks in mining, port and rail operations in the Pilbara region and recognises a responsibility to act by focusing on a reduction in greenhouse gas emissions (particularly with the use of low emissions technology) and increasing resilience to physical climate change impacts.

For the Pilbara region, climate conditions for 2030 and 2050 are forecast by the BOM and Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Watterson et al. 2015) to be:

- hotter (both averages and extremes) and drier (e.g. in 2090 forecast warming of 1.5°C to 3.1°C for medium emission trajectories);
- higher sea levels;
- tropical cyclones may decrease in number, but increase in intensity and duration over the same period; and
- more unpredictable characteristics of other climate-related hazards, including flooding, storm surges and wildfires.

Climate change is a complex issue, with inherent uncertainty about the timing, pace, and severity of possible impacts. Based on climate change projections rainfall reduction will be relatively small in the Pilbara, however, an increase in intensity of extreme rainfall events coupled with the expected rise in

temperatures and potential evaporation may have a large impact on the hydrology of the Pilbara region (Charles *et al.* 2015).

Risks from climate change to the stability of landforms, mobilisation of contaminants and re-vegetation are some of the identified vulnerabilities. The materialisation of these climate projections is likely to make successful rehabilitation in the Pilbara more challenging.

5.3.3. Implications for closure and knowledge gaps

The heavy, intense rainfall experienced in the Pilbara makes rainfall a key climatic factor that influences surface stability in built landforms. Rainfall erosivity (measured in mega joule-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 approximately 1,000-1,600 MJ.mm/ha/hr/yr. 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, average annual erosivity values for Perth are approximately 1000 MJ.mm/ha/hr/yr from an average of 780 mm of rain a year.

Rainfall erosivity is highly variable for each rainfall event. 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. A review of data in the Channar area indicates that the most erosive year recorded was 2007, where 421 mm fell during February, with only a further 283 mm during the rest of that 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. A rapid decline in erosion or sediment yield occurs when annual rain decreases below about 300 mm per year, due to a corresponding decline in rainfall volumes and rainfall erosivity.

This knowledge has informed development of the Rio Tinto Iron Ore (WA) *Landform Design Guidelines* (Rio Tinto 2019a) for achieving stable WRLs, as well as informing the scheduling and implementation of rehabilitation works to enhance rehabilitation success.

Implications of this climatic data to the mine closure includes:

- When annual rainfall increases above 300 mm, vegetation growth increases and becomes increasingly effective in controlling soil erosion.
- Where vegetation cover is low, rainfall erosivity can be sufficiently high to cause erosion.
- Regional evaporation rates exceeding annual rainfall will have a significant impact on surface water and soil cover water balances.
- Optimal timing of rehabilitation works to maximise germination following seeding.
- WRL design to consider the intensity of rainfall events, climatic variation and the potential for extreme rainfall events.

The closure knowledge gaps related to climate changes are evolving as industry studies and adoption of new climate change prediction methods are developed. Closure knowledge gaps may be associated hence with the following modelling:

- Final closure landforms modelling,
- Flood modelling and other surface water assessments
- Groundwater recovery and injection modelling
- Flora and fauna assessments.

5.4. Bioregions, Land Systems and Topography

5.4.1. Bioregions

Bioregions for the Australian content have been created as part of a national classification of ecosystems. There are currently 89 bioregions and 419 sub-regions in Australia. Each region is based on similarities in climate, geology, landform, native vegetation and species information.

The Brockman Operation lies within the Pilbara Craton, a bioregion defined by the Interim Biogeographic Regionalisation for Australia (IBRA). The Pilbara bioregion is further divided into four subregions: Chichester; Fortescue Plains; Hamersley; and Roebourne Plains. The Brockman Operation is situated entirely within the Hamersley (PIL03) subregion.

This subregion consists of mountainous areas of Proterozoic sedimentary ranges with dissecting gorges of basalt, shale and dolerite and plateaus with low Mulga *(Acacia aneura)* woodland over bunch grasses on fine textured soils and Snappy Gum *(Eucalyptus leucophloia)* over *Triodia brizoides* on skeletal sandy soils of the ranges (Kendrick 2001).

5.4.2. Land systems and topography

The Brockman Operation is located within the western end of the Hamersley Ranges, on the southern side of the divide between the Ashburton and Robe Rivers. The Hamersley Ranges escarpment above Caves Creek rises steeply to around 300–400 m from the valley floor. The highest peak associated with the Brockman Operation is Juwunpa (Mount Brockman) (1,127 m), located adjacent to the B2N operation and is a dominant landscape feature.

The Brockman Operation is situated across both limbs of the Brockman Syncline, a prominent geological formation with ridgelines extending either side of Mount Brockman which reach around 300–400 m above the valley floor. These steep areas are characterised by rough, rocky features such as cliffs, gorges, rock outcrops and the Hamersley Range signature ‘Bruno’s Band’ ‘tram tracks’ that typically outcrop horizontally along the slopes. Broad, flat to undulating plains extend from the edges of the steep hills and escarpments throughout the closure boundary.

The BS4 rail loop and associated infrastructure are located on a large floodplain area where elevation can occur up to 150 m above the adjacent valley floors. In the northern portion of the Brockman Operation, the Nammuldi-Silvergrass consists of low undulating hills separated from the steep Brockman Iron Formation escarpments by the valley floors. Caves Creek, Duck Creek and Boolgeeda Creek are the three main watercourses that divide the Brockman Operation closure boundary. Maliwartu Wunti (Beasley River) is east-southeast of the closure boundary and receives flows off the southern limb of the Brockman Syncline landforms.

The Brockman Operation intersects approximately 15 land systems, the description and extent of which are described in the Brockman Operation Closure Biological Knowledge Base (Appendix 7). The Newman and Boolgeeda land systems cover almost two-thirds of the closure boundary. These two land systems are defined by plateaux, ridges and mountains progressing to stony lower slopes and plains.

5.4.3. Implications for closure and knowledge gaps

Closure implications associated with landscape include:

- Final landforms, including heights and slope angles, have been and will be designed to be sympathetic with the aesthetic values of the surrounding landscape.

There are currently no known closure knowledge gaps associated with land systems.

5.5. Soils

5.5.1. Soil characterisation

Topsoil is an important factor in achieving sustainable revegetation outcomes. Characterisation of soils provides an indication of soil properties and their potential impacts on vegetation establishment, growth and landform stability. Appropriate characterisation can also help ensure soils with adverse properties are avoided in rehabilitation.

In the Pilbara, hills and rock ridges have extensive areas without soil cover and soils that do occur are often shallow and skeletal. Rocks of this formation weather very slowly and any soil which does form tends to be transported into the surrounding valleys and plains. The soils on slopes, although having had more time to develop than the soils of the adjacent ridges, are still influenced by the parent rock and may be shallow and stony sands or loams. These soils are generally unfavourable for plant growth due to low moisture holding capacity and poor nutrient status. On pediments, older pediplains and alluvial plains, hard alkaline red loamy soils tend to be dominant and may be considered as the regional mature soil type. The surface of these areas may carry a layer of small gravel derived from the more resistant rocks in the area.

In general, the dominant soil types covering the Brockman Operation area are shallow coherent and porous loamy soils with weak pedologic development. Soils associated with hills and ranges are generally skeletal and stony, with extensive areas without soil cover. The soils on slopes, although having had more time to develop than the soils of the adjacent ridges, are still influenced by the parent rock and may be shallow and stony sands or loams.

Both soil organic carbon (SOC) and nutrient levels vary according to landscape position. The highest levels of organic carbon are found in the hilltop landscape; whilst the nutrient levels were highest in low-lying areas and drainage lines and are typically very low in the higher portions of the landscape (which accounts for most of the BS4 and B2N disturbance footprint and a substantial amount of the SGE footprint). Soils across the Brockman Operation possess low hydraulic conductivity; indicating that they could be naturally susceptible to increased surface run off and surface erosion, but less water availability for plants. Subsoil has physical properties suitable for plant growth and generally has chemical properties amenable to plant growth, although it does lack the nutrient content, organic matter and soil seed bank of topsoil.

A comparison of physical and some chemical properties of typical Pilbara topsoils and topsoils of the Brockman Operation is provided in Table 5-1. Overall, the Brockman Operation soils are consistent with Pilbara soil parameters.

Brockman Syncline 4

The physical and chemical properties of BS4 topsoil are within the range typical of that found elsewhere in the Pilbara (Table 5-1). Soil texture is classified as sandy clay loam with average coarse material content of 70.96% (Outback Ecology, 2014). Soil pH ranged from strongly acidic to slightly acidic (Outback Ecology 2014). Soil salinity is low for sandy loam soils and exhibited an exhibited a low exchangeable Sodium Percentage (ESP), classifying the soils as non-saline and non-sodic (Outback Ecology 2014; Outback Ecology Services 2010).

The SOC is considered low to high and plant-available nutrients were generally classed as ‘low’ for phosphorus and sulphur, and ‘high’ for potassium (Purdie 2001). One transect on the midslope landscape unit was unusual in that it recorded very high salinity, nitrate and plant-available sulphur values. The reason for these elevated levels is unknown, however it is not uncommon for Pilbara soils to have localised spikes in plant-available nutrients (Outback Ecology 2010). These levels of salinity, nitrate N, and plant-available S are unlikely to have any detrimental influence on the growth of local native species.

Brockman 2 – Nammuldi

B2N topsoils possess physical and chemical properties that are within the typical range of topsoils found in the Pilbara (Table 5-1). The soils are generally classified as sandy loam with an average coarse material content of 77.01% (Mattiske Consulting 2009). Soil pH ranged from strongly acidic to slightly acidic in $CaCl_2$, and salinity and ESP values are low making the soils non saline and non-sodic (Mattiske Consulting 2009).

SOC is considered low to high and in some locations exceeded values typical of Pilbara soils (Purdie 2001). Soil analysis showed that levels of Potassium, Calcium, Nitrogen and Zinc were higher on upper slope/hilltop topography (Purdie 2001). Levels of Phosphorous, Magnesium, Sodium, Copper, Iron and Manganese showed no pattern across topographical units. In general, Phosphorus levels were higher than typical Pilbara levels. Conductivity and organic matter composition were highest on upper slope/hilltop topography while pH levels were similar across all topographical units

Silvergrass East

Topsoil parameters measured at SGE area were found to be similar to soils found elsewhere in the Pilbara (Table 5-1). Biota Environmental Sciences (2018) describes the soil texture is comprised of clay loam over clay for the Claypan, and loamy sands / sandy loams over sandy loams / sandy clay loams for the Plains and Hills with a low average coarse material content of 12.25%. Soil pH ranges from strongly acidic to slightly alkaline in $CaCl_2$. Soil salinity and ESP is low and is considered to be non-saline and non-sodic (Biota Environmental Sciences 2018).

The SOC content for the SGE soil samples varied with location in the landscape. Soil SOC is considered to be low to medium levels according to Purdie (2001) and decreased slightly with depth at most sites (Biota Environmental Sciences 2018).

Soil nutrient levels were generally low. Higher levels of organic carbon, sulphur and plant-available ammonium and nitrate were recorded from the Hills sites on average, while higher plant-available potassium and higher levels of exchangeable cations were recorded from the Claypan. In general, the sites with higher SOC had higher ammonium and nitrate levels (Biota Environmental Sciences 2018).

Table 5-1: Comparison between Brockman Operation soils and typical Pilbara soil parameters

Properties		Pilbara Soils[1]	Brockman Syncline 4 Topsoil	Brockman 2/ Nammuldi Topsoil	Silvergrass Topsoil
Sample Depths (cm)		0-20	0-20	0-20	0-20
Physical	Soil texture (<2 mm soil fraction)	Sand clay loam	Sand clay loam	Sandy loam - clay	Sandy clay loam
	Average Coarse material content (%)	0 - 93	70.96	12.25	77.01
Chemical	Soil pH ($CaCl_2$)	4.6 – 8.8	5.0 – 6.4	4.5 – 7.8	4.7 – 6.3
	Salinity (dS/m)	0.007 – 0.233	0.01- 0.962	<0.1 - 1	0.02-0.3
	Organic Carbon (%)	0.07 – 3.74	0.29 – 2.95	0.20 - 2.09	0.62 – 4.6
	Macro-nutrient status	Low	Low	Low	Low-moderate

[1] Values obtained from Outback Ecology Services (2010). *A review of the characteristics of soils and mine wastes and their use in rehabilitation prescriptions in the Pilbara*

Properties		Pilbara Soils[1]	Brockman Syncline 4 Topsoil	Brockman 2/ Nammuldi Topsoil	Silvergrass Topsoil
Sample Depths (cm)		0-20	0-20	0-20	0-20
	Micro-nutrient status	Low - moderate	Low - moderate	Low	Low- moderate
	Nitrate	1 - 57	<1 – 272	<1 - 39	N/A
	Ammonium	1 - 39	<1 - 81	<1 - 7	N/A
	Phosphorus	1 - 20	<2- 8	2 - 25	5 – 50
	Potassium	64 - 536	109 - 598	120 - 580	90 - 365
	Sulphur	1 - 17.7	1.9 – 406.7	<1 – 7.7	N/A
	Cation Exchange Capacity (cmol/kg)	1.9 – 16.8	5.28	7.98	6.66
	Exchangeable Sodium Percentage (%)	0.21 – 6.39	1.90	0.83	1.45
	Total metal concentrations	Low	Low	N/A	Low

5.5.2. Soil inventory

Topsoil recovery in the Pilbara is often restricted due to the nature and terrain of the landscape. The goal of soil management is to maximise the collection of topsoil and subsoil and store in a manner that maximises its viability and productivity for use in rehabilitation. Where practical a minimum of 200 mm of topsoil and 600 mm of subsoil is collected when new areas are disturbed. However, this is not practical in all areas such as rocky ridges where soils are shallow, non-existent or unsafe to access. To account of this, a 30% recovery rate has been applied to all future predicted soil recovery volumes. A review of actual soil recovery rates is planned based on measured volumes of soil recovered relative to the associated disturbance area and will be used to refine the predicted soil balance at closure.

Table 5-2, Table 5-3 and Table 5-4 provide the current and projected soil inventory across the Brockman Operation assuming recovery rates remain consistent over time.

Rehabilitation requirements are calculated based on the closure footprint (excluding pit voids), landform geometry and thickness of topsoil application. For all operations and development areas across the Brockman Operation there is forecast to be sufficient topsoil available for rehabilitation of landforms.

Table 5-2: Predicted LOM soil balance for BS4 (as of February 2022)

	Current balance	Future predicted clearing and recovery	Total at closure
Topsoil volume (m^3)	2,953,377	1,034,624	3,988,001
Subsoil volume (m^3)	3,305,698	1,551,937	4,857,635
Total soil volume (m^3)	6,259,075	2,586,561	8,845,636
Total disturbance area (ha)	3,632	1,724	5,356
Pit areas not rehabilitated (ha)	714	973	1,687
Completed rehabilitation (ha)	500	-	500
Area requiring topsoil (ha)	2,418	751	3,169
Soil volume required 200mm (m^3)	4,836,000	1,502,186	6,338,186
Soil surplus (m^3)	1,423,075	1,084,375	2,507,450
Soil surplus (%)	**129**	**172**	**140**

Table 5-3: Predicted LOM soil balance for Brockman 2 Nammuldi (as of June 2021)

	Current balance	Future predicted clearing and recovery	Total at closure
Topsoil volume (m^3)	3,119,657	1,262,427	4,382,084
Subsoil volume (m^3)	9,466,109	3,787,281	13,253,390
Total soil volume (m^3)	12,585,766	5,049,708	17,635,474
Total disturbance area (ha)	6,846	2,104	8,950
Pit areas not rehabilitated (ha)	1,070	368	1,438
Completed rehabilitation (ha)	331	-	331
Area requiring topsoil (ha)	5,445	1,736	7,181
Soil volume required 200mm (m^3)	10,890,000	3,471,425	14,361,425
Soil surplus (m^3)	1,695,766	1,578,283	3,274,049
Soil surplus (%)	**116**	**145**	**123**

Table 5-4: Predicted LOM soil balance for Silvergrass East (as of June 2021)

	Current balance	Future predicted clearing and recovery	Total at closure
Topsoil volume (m^3)	1,228,828	165,031	1,393,859
Subsoil volume (m^3)	2,034,608	273,247	2,307,855
Total soil volume (m^3)	3,263,436	438,278	3,701,714
Total disturbance area (ha)	1,510	380	1,890
Pit areas not rehabilitated (ha)	150	-	150
Completed rehabilitation (ha)	24	-	24
Area requiring topsoil (ha)	1,336	380	1,716
Soil volume required 200mm (m^3)	2,672,000	760,000	3,432,000
Soil surplus (m^3)	591,436	- 321,722	269,714
Soil surplus (%)	**122**	**58**	**108**

5.5.3. Alternative growth media

In 2010, Rio Tinto commissioned a study into use of mine waste materials as an alternative rehabilitation growth medium (Outback Ecology Services 2010a). The study reviewed soil, tailing and mineral waste characteristics from select Pilbara mining operations, to identify material combinations that may be suitable as a topsoil substitute or supplement in cases where topsoil may be insufficient for rehabilitation requirements. In these cases, topsoil would be applied to high priority areas such as waste landforms first and lower priority areas such as laydown areas may receive alternative growth media. 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 micronutrient concentrations within the range or above the levels measured in benchmark Pilbara topsoil and rehabilitated soils;
- generally, Pilbara mineral wastes were non-saline and non-sodic;
- soil structure of waste materials 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 hard setting; and
- estimated plant available water content of the waste materials ranged from less than 3% to greater than 25%.

In 2016, Rio Tinto commissioned further study into alternative growth mediums (Landloch Pty Ltd 2016). Samples included in the study from Brockman Syncline 4 were deemed as moderately suitable as an alternative growth media. The tested materials were within soil thresholds, aside from permeability and coarse fragments. The samples had low permeability and were deemed likely to runoff rather than infiltrate rainfall, making less water available to plants and the surface more prone to erosion. Some samples were deemed too coarse which indicates rocky materials that often hold little water for plant use; whilst others were not coarse enough, suggesting potential for erosion when used on steeply sloping batters.

Whilst rehabilitation areas have generally performed better with topsoil application, absence of topsoil does not necessarily mean that rehabilitation will fail, or that completion criteria will not be achieved. Trials have been conducted on WRL rehabilitation without topsoil application (for example the Channar 84 East 5 WRL trial) and are performing strongly against most success indicators. Further trials using detrital waste material have begun at Tom Price (MMW4 WRL). Initial observations indicate stability and early growth.

In summary, alternative growth media options are available for consideration in Brockman Operation rehabilitation, should a shortfall of available topsoil and subsoil be encountered. Options for utilising the alternative growth media will be considered as the site comes closer to closure. Opportunities to utilise the growth media in field trials will be considered as part of progressive rehabilitation planning.

5.5.4. Implications for closure and knowledge gaps

Closure implications associated with soils include:

- The predicted soil balance indicates a surplus if all available topsoil and subsoil can be harvested. In the event the predicted volume is not realised, Rio Tinto will consider the requirement suitability of AGM.
- The assumed soil recovery rates are based on historical clearing and may not be realised in future clearing. Soil reconciliations are updated annually to track progress toward estimated volumes of soil required for rehabilitation.

Closure knowledge gaps associated with soils, as summarised in Section 5.16, Table 5-20, include:

- Characterisation of subsoil is limited and will be updated through representative sampling of existing stockpiles.
- Soil characterisation for areas associated with the BSP to ensure it is suitable for rehabilitation activities at closure.
- Review of actual soil recovery rates to date and update of predicted soil available at closure.

5.6. Geology

The Brockman Operation is situated in the centre of the Pilbara Craton, with cratonic basement comprising Archaean granite-greenstone overlain by the Archaean-Proterozoic rocks of the Mt Bruce Supergroup. These rocks can be divided into three stratigraphic groups: the Fortescue, Hamersley and Turee Creek groups, with the Hamersley and Fortescue Groups forming the outcrop across the Brockman Operation.

The Hamersley Group is a sedimentary sequence comprising banded iron formations (BIF), shales and dolomites, with minor felsic volcanic and extensive dolerite dykes and sills. The group contains the Brockman Iron Formation and the Marra Mamba Iron Formation (MMIF), which together host most of the known major iron ore deposits in the Pilbara.

The Boolgeeda Valley is flanked by Brockman Iron Formation ridges to the north and to the south and lies in the centre of the Brockman Syncline. Small outcrops of the Turee Creek Group, underlain by the Boolgeeda Iron Formation, Woongarra Volcanics and Weeli Wolli Formation, occur in the centre of the valley. Basement subcrop is masked by a variable thickness of Cenozoic valley fill and lateritic sediments.

Mineral waste lithologies generated from each deposit at the Brockman Operation as summarised in Table 5-5 for each site.

Table 5-5: Mineral waste geology origin categories across Brockman Syncline and Silvergrass

Lithology	Deposit							
	BS1	BS2	BS3	BS4	Endeavour	BS4MM	Nam	SGE
Detritals	✓	✓	✓	✓	X	✓		✓
Detritals including lignite						✓		
Detritals including lignite and siderite							✓	
Dolerite	✓	✓	✓	✓	✓	✓	✓	✓
Hydrated zone	✓	✓	✓	✓	✓	✓	✓	✓
Joffre	✓	✓	✓	✓	✓		✓	
Whaleback shale	✓	✓	✓	✓	✓		✓	
Dales Gorge	✓	✓	✓	✓	✓		✓	
Footwall zone	✓	✓	✓	✓	✓		✓	
Mount McRae Shale	✓	✓	✓	✓	✓		✓	
Mount Sylvia Formation	✓	✓	✓	✓	✓		✓	
Wittenoom Formation	✓	✓	✓	✓	✓	✓	✓	
Wittenoom Formation (West Angelas Member)						✓	✓	✓
Mt Newman Member						✓	✓	✓
Nammuldi Member						✓	✓	✓
MacLeod Member						✓	✓	✓

5.6.1. BS4 geology

Mineralisation at BS4 occurs along east-west orientated ridges formed by outcropping Brockman Iron Formation and MMIF. These ridgelines form the boundary between the Boolgeeda Creek and Beasley River catchments. The operation at BS4 can be divided in two distinct regions:

- A northerly region of mild deformation with shallow north to north-east trending open folds (Boolgeeda Valley) hosting the BS1 deposits.
- A southerly region of intense deformation, where the more resistant iron formations form prominent ridges and the major iron deposits occur (Southern Strike Valley). This area hosts the BS4 Main, BS4MM, Endeavour, BS4MN and BS3 deposits.

Within the BS4 area, the following deposits are hosted within the Brockman Iron Formation:

- BS1 deposits lie 7.5 km north of BS4, approximately 17 km in length (east - west) and between 600 m to 1,800 m wide.
- BS4 Main deposits, east-west trending over a strike length of 14 km and up to 1.4 km wide.
- Endeavour deposits lie immediately east of BS4 which strike approximately 3.5 km in length (east - west) and between 300 m to 1,000 m wide.
- BS3 deposits lies km northwest of Endeavour, approximately 3.0 km in length (east - west) and between 600 m to 1,800 m wide.

Deposits at BS4 Main, Endeavour, BS3 and BS1 all consist of High Phosphorous Brockman (HPB) iron mineralisation hosted within BIF in the Dales Gorge, Whaleback Shale and Joffre Members of the Brockman Iron Formation. Northwest-southeast trending dolerite dykes that cross these deposits often intrude along these faults, as well as bedding parallel sills. Approximately 75% of mineral resource is above water table across these deposits. A typical geological cross section of the HPB mineralisation is shown in Figure 5-3.

The proposed BS4MM and MN deposits are hosted within the MMIF. These deposits occur over a length of 18.5 km in an east - west direction, with stratigraphy dipping approximately 20° – 50° northward. These deposits are separated from the neighbouring BS4 Main deposit to the north by a minor alluvial filled valley that developed following weathering of the more shale dominated Wittenoom Formation (WF), Mount Sylvia Formation (MTS) and Mount McRae Shale. Mineralisation within the MMIF is mainly restricted to the upper part of the Mount Newman Member, with minor mineralisation within the MacLeod and Nammuldi Members and the overlying West Angelas Member. Minor lignite has been noted in this detrital package. 63% of the mineral resource is below water table (approximately 490 – 505 m above Relative Level [mRL]). A typical geological cross section of the MMIF mineralisation is shown in Figure 5-4.

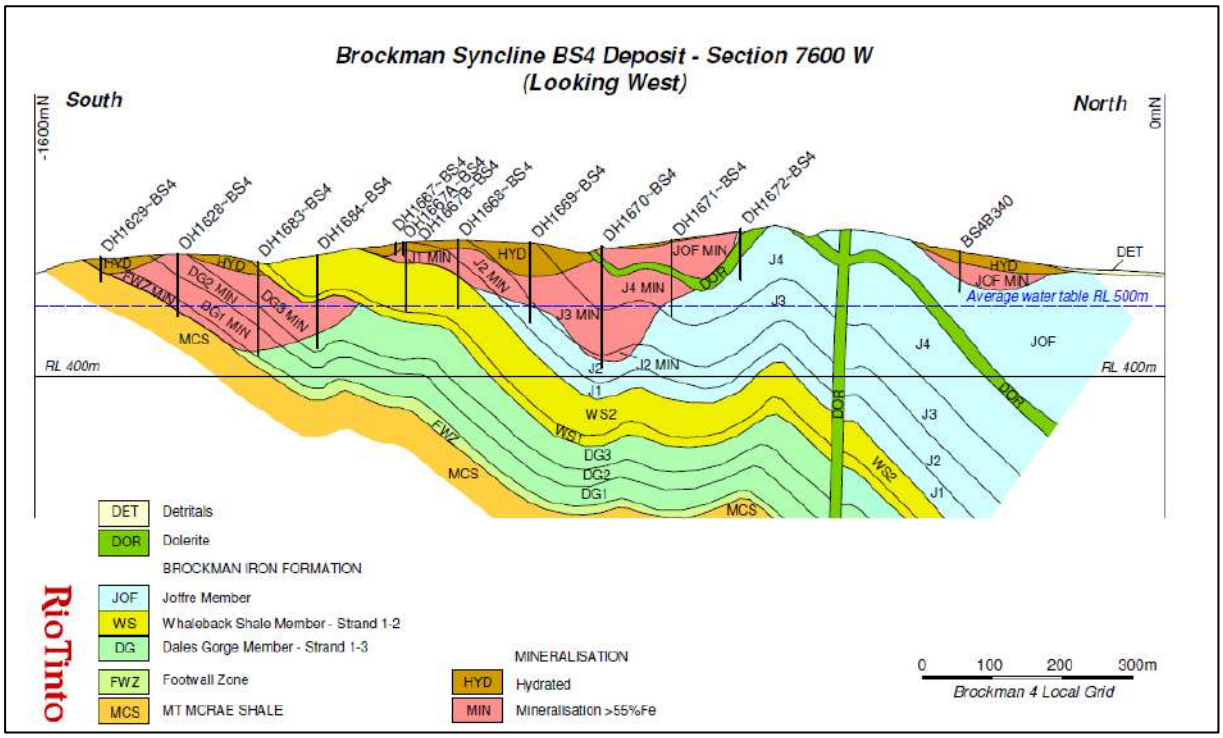


Figure 5-3: Typical geological cross section of the BS4 HPB Deposits (looking west)

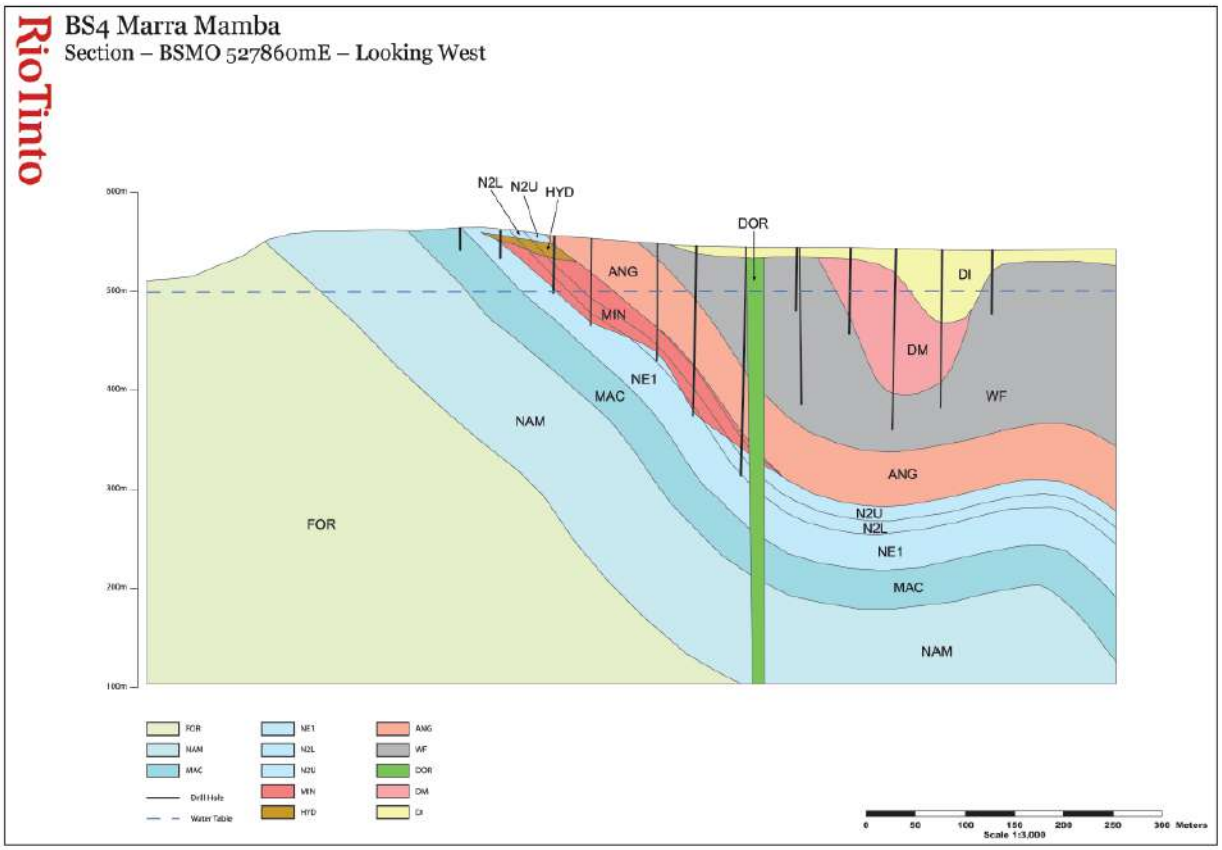


Figure 5-4: Typical geological cross section of the BS4 MMIF deposits (looking west)

5.6.2. B2N geology

The BS2 Main, BS2 Extension and BS2 West deposits (collectively known as Brockman Central deposits) occur along an east-west orientated ridge formed by outcrops of Marra Mamba and Brockman Iron Formations on the northern flank of the Brockman Syncline, which rises over 350 m above the adjacent valley floor. Bedded mineralisation deposits typically extend from outcrop into the valley and are covered by the later Cenozoic detritals/valley fill. The HPB mineralisation is largely restricted to the Dales Gorge Member of the Brockman Iron Formation, with minor mineralisation in the Whaleback Shale and Joffre Members. A typical geological cross section of HPB mineralisation at BS2 is presented in Figure 5-5.

Detrital iron ore deposits at BS2 Main were mined from 1992 – 1998 as Pits 1, 2 and 3.

The Nammuldi deposits are located in the MMIF on the northern flank of the Brockman Syncline, to the north of the Brockman 2 Central deposits. The deposits consist of six lenses from Lens A through to Lens F and extend over a strike distance of 18 km. The majority of the bedded mineralisation occurs within the Mount Newman Member, with minor mineralisation occurring within the upper MacLeod Member and lower West Angela Member of the Wittenoom Formation. Hydration occurs near surface over mineralisation and can be up to 30 m thick, and various amounts of semi-consolidated detrital lenses cover the range front. Detrital accumulations also occur over the MMIF in the west through to the Wittenoom Formation in the east. These accumulations can be up to 150 m deep and comprise layers of colluvial material, unmineralised detritals, calcrete, clay, Red Ochre Detritals (ROD), limonitic clay and manganiferous clay. The water table varies from 574 to 585 mRL, resulting in approximately 90% of mineralisation located below water table.

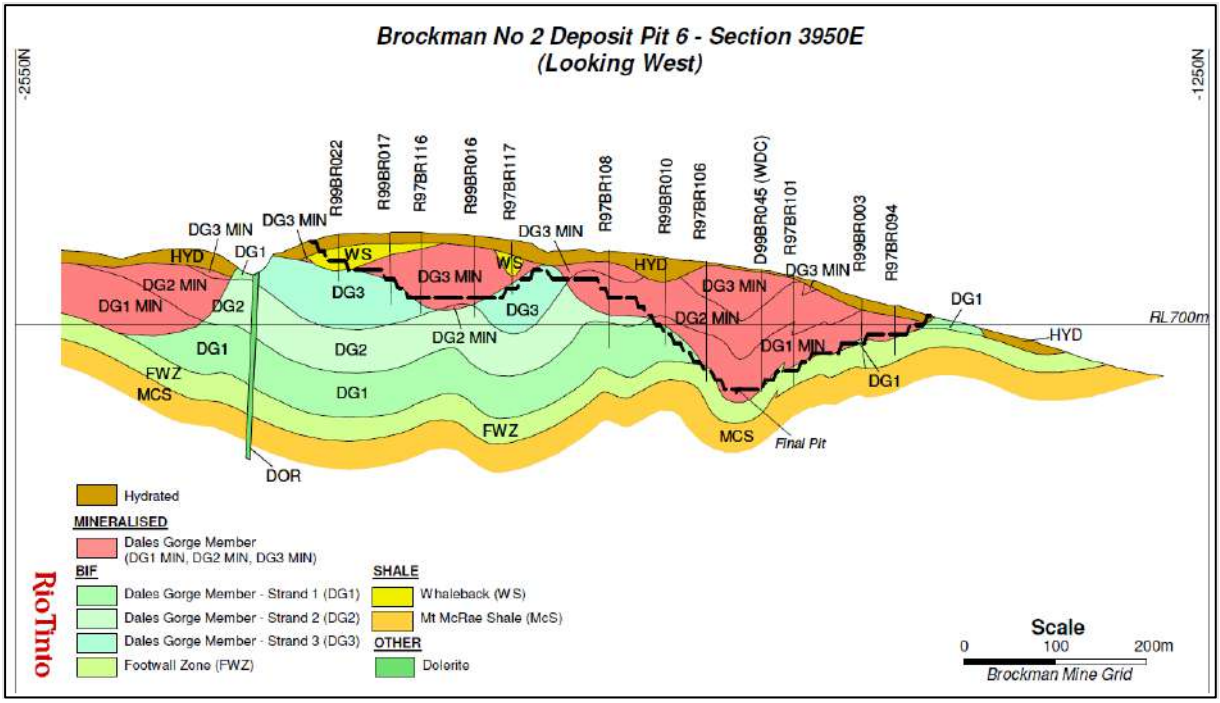


Figure 5-5: Typical geological cross section of a BS2 HPB Deposit (looking west)

The Lens G deposit is the most easterly of the Nammuldi lenses, occurring at the nose of the Brockman Syncline. Mineralisation is constrained to a length of three km and maximum width of 0.8 km, in a northwest striking orientation. High grade hematite-goethite mineralisation occurs generally in the Mount Newman Member of the MMIF, with lower grade mineralisation within the upper MacLeod Member and lower West Angela Member of the WF. Approximately 69% of the mineral resource is below water table.

The BS3 Extension is located to the southwest of Lens G and consists of the Diesel, Sandleford, Monkey, Creekside, Orbe, Lauriston, Brokenwood and MM-J deposits. The south-eastern side of the Brockman Syncline consists of a northeast striking Marra Mamba ridge, separated to the larger Brockman ridge in the northwest by a colluvial valley of between 1.1 km to 2.1 km wide. There are numerous narrow north-west trending dolerite dykes cross the Brockman and MMIF. The Brokenwood, Lauriston and Monkey deposits are mineralised Brockman Formation, mainly confined to the Dales Gorge and Whaleback Shale Members, while the Diesel, Creekside and MM-J deposits are mineralised MMIF. A variable thickness hydrated capping overlies the high-grade mineralisation. The bedded iron formations have been extensively eroded to form the detrital iron deposits at Orbe and Sandleford. Approximately 38% of the BS3 Extension mineral resource is below water table.

5.6.3. SGE geology

The SGE deposit is located on the northern limb of the east – west trending Jeerinah Anticline. The deposit occurs on either end of an embayment within the broader east - west trending ridge line of the MMIF and is over 7 km in strike length (east - west) and between 200 m to 3 km wide. Approximately 65% of the mineral resource is below water table. In the Silvergrass area, the MMIF forms low topographic ridges, which are separated from the high ranges of the Brockman Iron Formation by broad detrital-filled valleys. A typical geological cross section is shown in Figure 5-6.

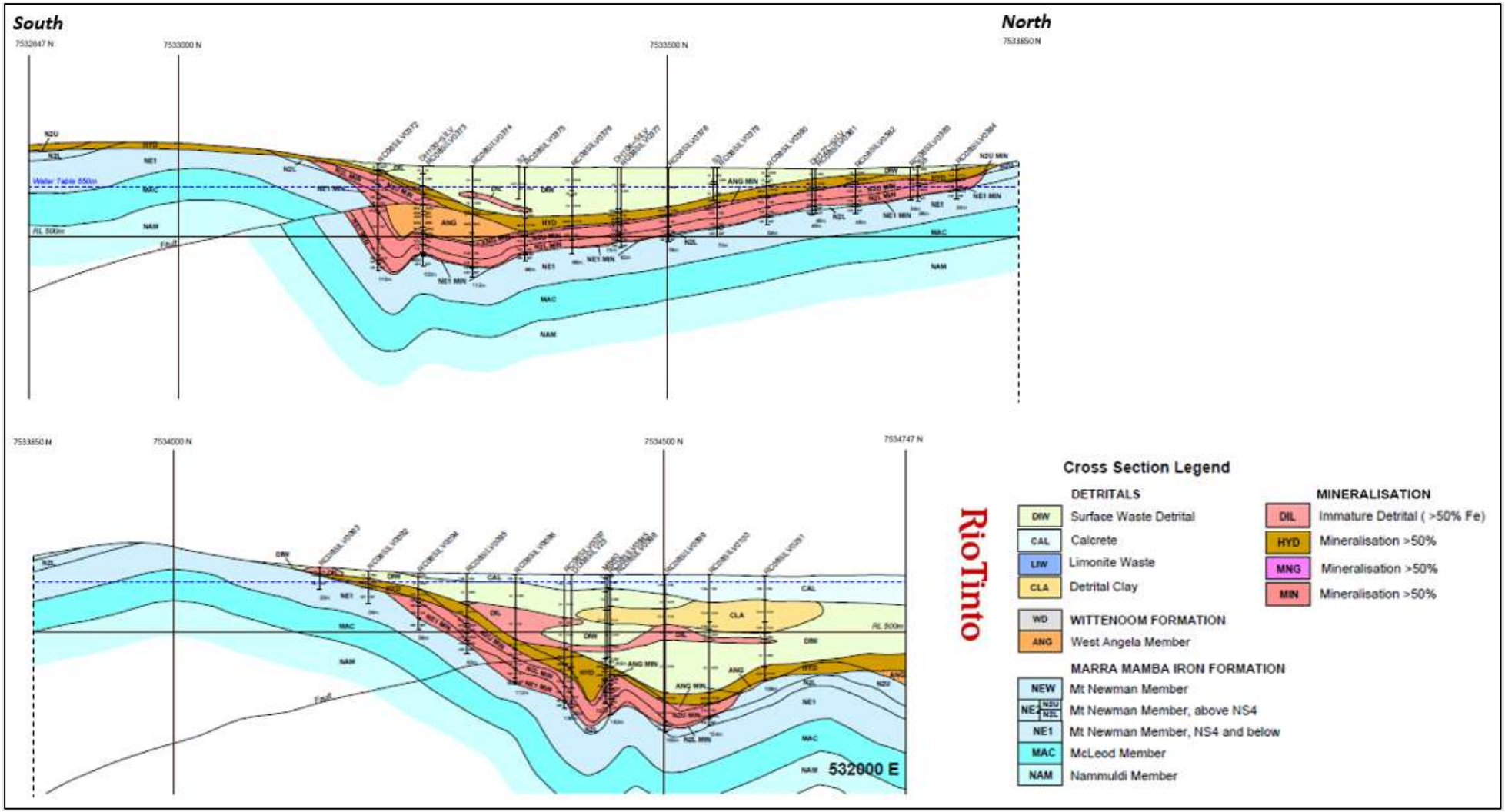


Figure 5-6: Typical geological cross section from the Silvergrass East Deposit (looking west)

5.6.4. Geotechnical stability

Open pits are designed to be stable during the life of the mining operations but may not be stable in the long term as materials weather and erode, leading to instability of sections of the pit walls. The PUPEZs have been identified for all pits at the Brockman Operation based on the angle method described in *Guidelines for safety bund walls around abandoned open pit mines* (DoIR 1997). The PUPEZ has been derived using the conservative assumption that all pit walls comprise weathered rock (i.e. using a 25º angle from the base of the pit [Figure 5-7]).

A 25° line from the pit toe or decoupling berm is projected to the surface topography. Where backfilling occurs, the pit toe may be considered from the surface of the backfilled area. The point at which this projection line intersects the topography back to the pit crest, is termed the PUPEZ. In addition to this, a 10 m offset from the projected PUPEZ is included, plus a 5m abandonment bund base width.

The rehabilitation toe of all WRL rehabilitation designs is required to be outside of the final PUPEZ to ensure the WRL is fundamentally stable. In addition, where there is potential for the PUPEZ to encroach on significant cultural or environmental values, the pit design has been revised to ensure the PUPEZ is outside of the associated Mine Exclusion Zones (MEZ).

Geotechnical evaluations will continue to be undertaken with as pit designs are updated and this will trigger an updated PUPEZ to be developed. Some proposed pit designs for the BSP were conceptual at the time that assessment of the preliminary PUPEZ was undertaken. These will be reviewed continually during the life of mine and the PUPEZ will differ in some areas from those initially defined. A detailed review of final PUPEZs will be undertaken prior to closure to ensure local geological features that may influence the PUPEZ are accounted for.

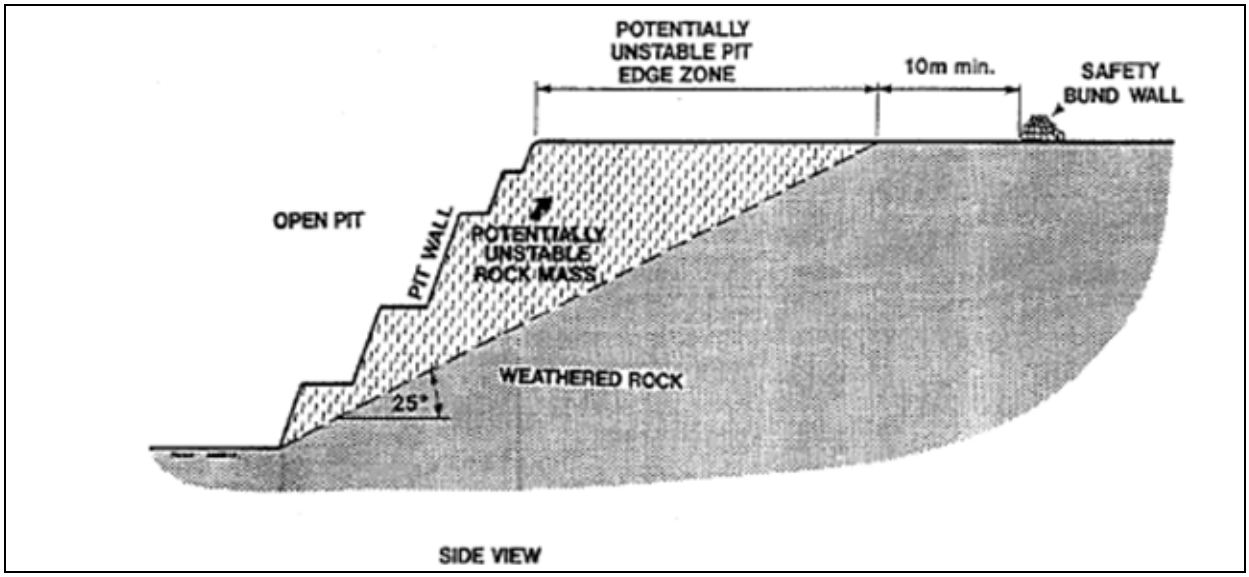


Figure 5-7: Calculation of PUPEZ for pits within weathered rock

(*Source DoIR 1997*)

Pit buttressing and PUPEZ alteration

Pit buttressing is a method of partial backfilling along a final pit wall in order to buttress the in-situ potentially unstable rock mass and offset the PUPEZ area. The resulting buttressed pit wall PUPEZ area is therefore reduced in this area, creating additional stable pit edge area capacity, conceptually displayed in Figure 5-8. This is proposed in areas where the current location of abandonment bunds may encroach on MEZs, be impacted by flood waters or restrict post-mining access.

Areas in which pit buttressing is proposed include:

- at the BS1 deposit to reduce catchment loss to Boolgeeda Creek (refer 5.11.4);
- within the BS4 Main Pit 1 to ensure stability of Juukan Gorge (refer 9.5.2); and

- within the SGE Pit 1 to reduce the likelihood of the Caves Creek flood water interacting with the Pit 1 abandonment bund (refer 5.11.4).

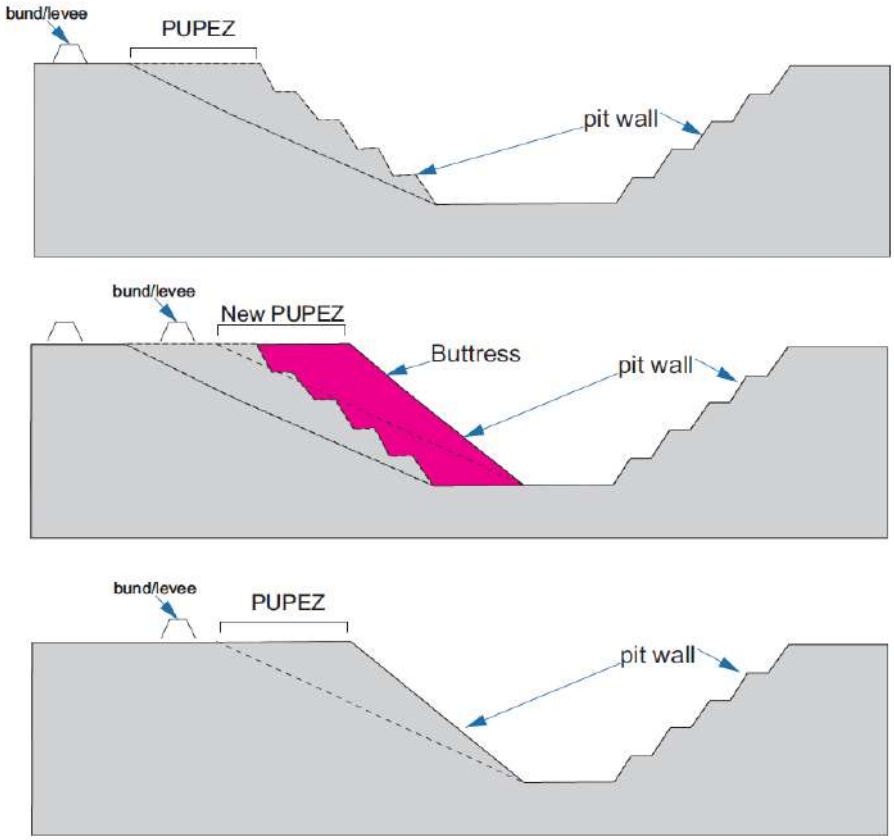


Figure 5-8: Pit buttressing and PUPEZ alteration schematic diagram

5.6.5. Risk of inadvertent public access to pit voids

For most Pilbara operations, the issue of public safety is mainly related to potential for members of the public to inadvertently access pit voids (or areas of potential instability surrounding pits) post closure. Open pits are designed to be stable during the life of the mining operations but may not be stable in the long term as materials weather and erode, leading to instability of sections of the pit walls. These failures would pose significant risks to people if they were to access these areas in vehicles or on foot.

As with waste landforms, designs for restricting public access need to be developed on a case-by-case basis after considering a range of factors such as:

- accessibility of the site (e.g., proximity to towns/major roads/areas of interest);
- nature of the surrounding landscape (e.g., pits abutting steep natural slopes, floodplains, water courses);
- the availability of suitable material to construct structures (e.g., material for abandonment bunds/ rock structures);
- pit geology and geometry (e.g., natural stability of the pit, pit backfill);
- the post closure land use (e.g., pastoral areas may require exclusion of cattle from pit voids); and
- the location of heritage sites (e.g., sites which may require access post closure).

Public access to the Brockman Operations area is limited due to its remoteness. There is only one public road near the project area, the Mt Brockman / Homestead / Silvergrass Road, located to the north of the SGE operation. Traditional Owners will require access to parts of the mining areas post-closure and parts of the area are expected to return to pastoral activities post-closure.

To mitigate the risk of inadvertent public access, the following conceptual measures are proposed:

- rehabilitation of tracks that are not required for monitoring and/or maintenance post-closure;
- rehabilitation of all access roads prior to relinquishment unless agreed with a third party that a road will remain;
- installation of physical barriers (e.g. earthen bunds) where appropriate to prevent access;
- installation of a locked gate on access roads for the duration of the post-closure monitoring and maintenance period; and
- a review of the potential visitors to access the site, and installation of additional control measures, including abandonment bunding around pits, where appropriate.

Abandonment bunds

The *Safety Bund Walls Around Abandoned Open Pit Mines* (DoIR 1997) guidelines require a 5m wide by 2m high abandonment bund be placed around a completed pit outside the zone of instability. The purpose of the guidelines is to reduce the likelihood of inadvertently access to pits. Natural topography more than 35 degrees is considered a suitable natural barrier to preclude inadvertent access; hence abandonment bunds will be designed to intersect with such areas. Where bunds could impact heritage sites then bund designs are amended to avoid sites. Local site drainage and the maintenance of surface flows post-closure has also been considered as part of the abandonment bund designs, in conjunction with development of the backfill strategy.

While a PUPEZ has been calculated for all pit designs, at this stage of closure planning, abandonment bund locations are conceptual due to the likelihood of changes to pit design, WRL rehabilitation footprint, buttressing requirements and backfill heights resulting in a change to the final PUPEZ. A review of the PUPEZ calculated from the current final pit designs and its interaction with WRLs and natural topography has been completed and conceptual abandonment bund locations shown in Figure 5-9 to Figure 5-11.

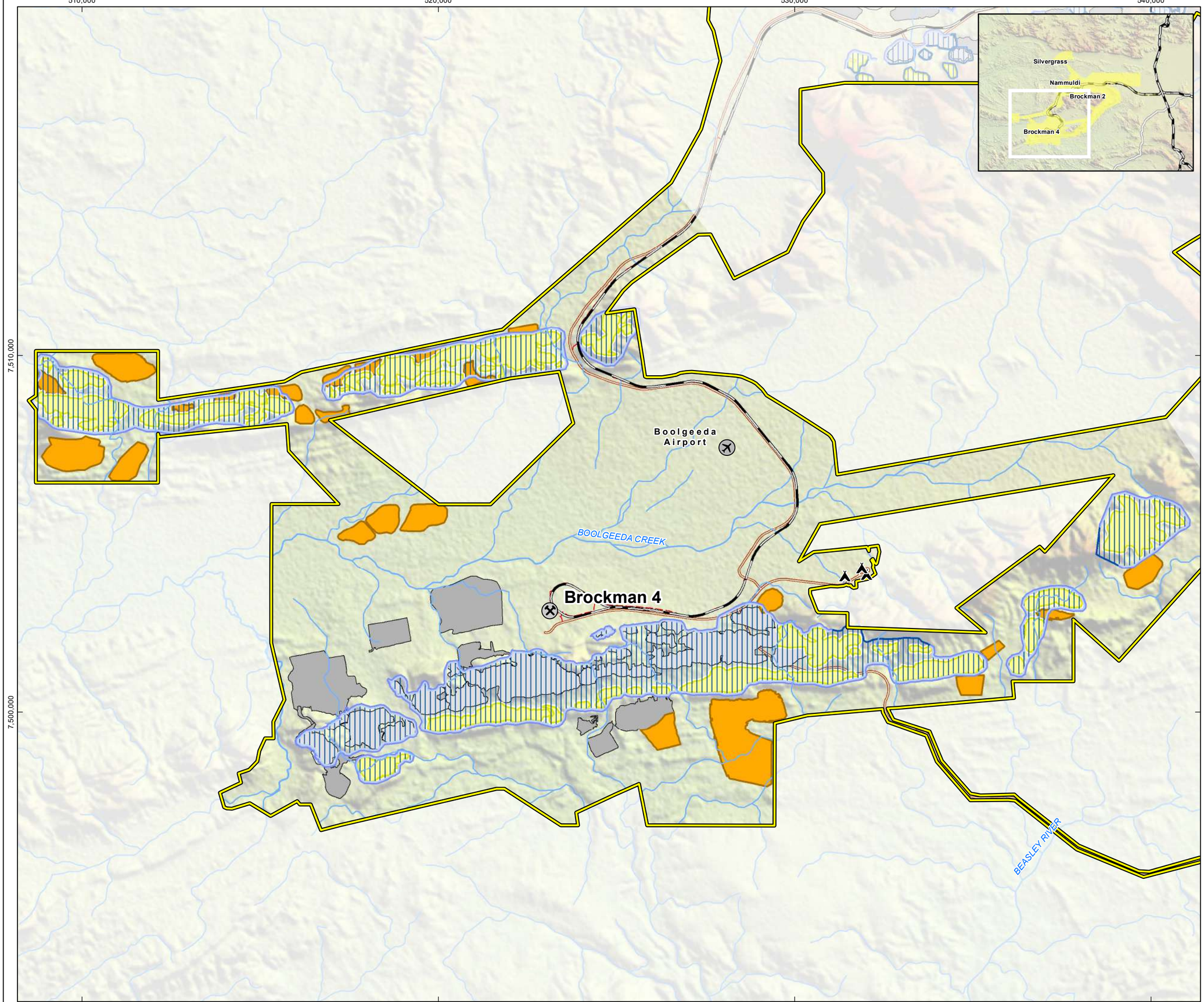
Pit designs at BS1 are conceptual and the PUPEZ and resulting abandonment bund locations are currently outside of the closure boundary. As these designs are refined, the PUPEZ will be constrained by the closure boundary ensuring the abandonment bund can be built within the closure boundary. This may be achieved by changing the pit design or buttressing the pit walls.

RioTinto

Figure 5-9
Brockman 4
Zone of Instability (ZoI) and Abandonment Bund

Drawn: L.Fuentes
Plan: PDE0174411v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A3
GIS.Team@riotinto.com



Legend

- Closure Boundary
- Zone of Instability (ZoI)
- Abandonment Bund

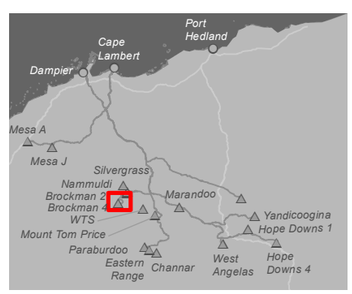
Approved Mine Layout

- Pit
- Waste Rock Landform

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform

- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Major Creek
- Minor Creek
- Conveyor
- Site Access Road
- Rail Access Road



N

0 1 2 3 4 5
Kilometres

Map units in metres

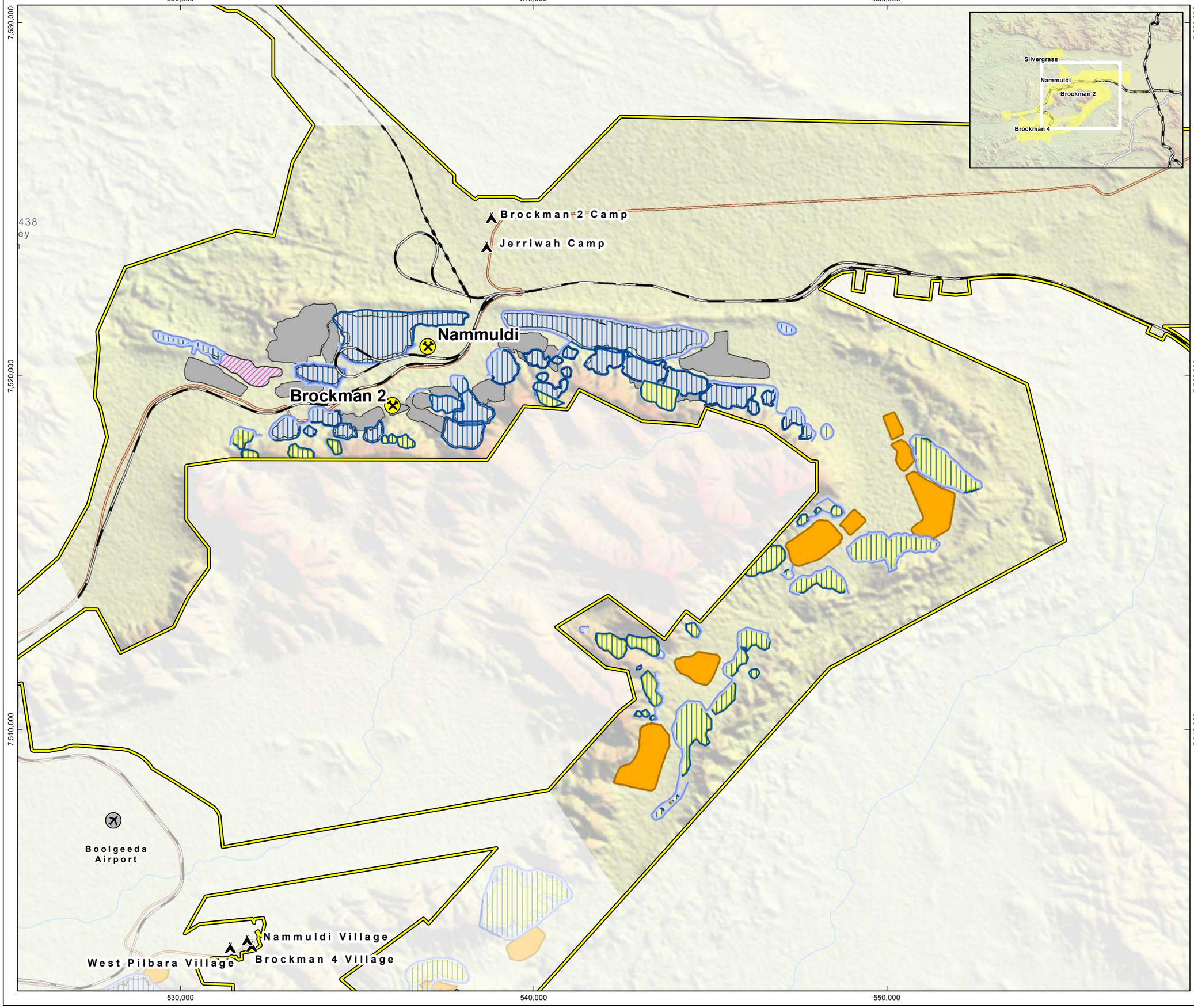
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Figure 5-10
Brockman 2 - Nammuldi Zone of Instability (ZoI) and Abandonment Bund

Drawn: L.Fuentes
Plan: PDE0174411v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A3
GIS.Team@riotinto.com



Legend

- Closure Boundary
- Zone of Instability
- Abandonment Bund

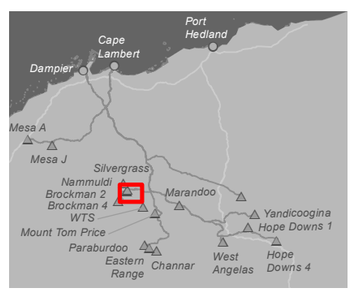
Approved Mine Layout

- Pit Backfilled to Surface
- Proposed Pit Buttress
- Pit
- Waste Rock Landform

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform

- Airport
- Rio Tinto Mine
- Rio Tinto Camp
- Conveyor
- Site Access
- Major Creek



N

0 1 2 3 4 5
Kilometres

Map units in metres

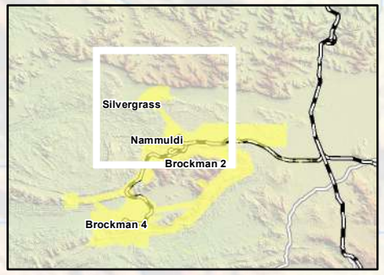
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Figure 5-11
Silvergrass
Zone of Instability (ZoI) and Abandonment Bunds

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Plan: PDE0174411v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A3
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Legend

- Closure Boundary
- Zone of Instability
- Abandonment Bund

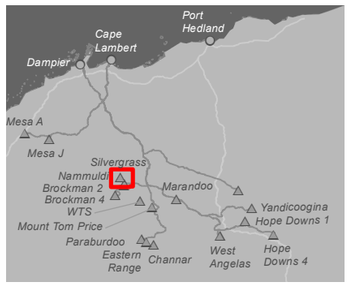
Approved Mine Layout

- Pit Backfilled to Surface
- Proposed Pit Buttress
- Pit
- Waste Rock Landform

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform

- Rio Tinto Mine
- Rio Tinto Camp
- Conveyor
- Minor Road
- Site Access Road
- Rail Access Road
- Major Creek
- Minor Creek



N

0 1 2 3 4 5

Kilometres

Map units in metres

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520,000
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ROBE RIVER
CAVES CREEK
Homestead Silvergrass Road
Mount Brockman Road

Homestead Camp
Brockman 2 Camp
Jerriwah Camp

Silvergrass
Nammuldi
Brockman 2

5.6.6. Implications for closure and knowledge gaps

Rio Tinto has committed to backfilling select current and planned pit voids across the Brockman Operation; however significant voids are expected to remain after closure. Open pits are designed to be stable during the life of the mining operations, but instability of sections of the pit walls will occur post-closure due to erosion; presenting a risk to people if measures to mitigate risk are not implemented.

No rehabilitation of in-pit WRLs or in-pit landbridges is proposed where the waste landform has no potential to impact on the external environment (i.e. any sediment generated will be fully contained within an internally draining pit) and the dump contains only inert material. No re-profiling of pit walls or rehabilitation of pit floors is proposed. Pits not backfilled to surface will not be actively rehabilitated (unless backfilled to within 10 m of the natural surface) and will have abandonment bunds installed around them outside the PUPEZ.

Inadvertent access will be restricted at closure using physical barriers such as abandonment bunds. Strategies for managing safety risks will be developed as the site approaches closure and will consider the need for potential for ongoing public access resulting from a portion of the mining area being underlain by pastoral stations and access requirements of Traditional Owner groups.

Closure implications associated with geotechnical stability include:

- The final rehabilitated toe of all WRL designs will be located outside final PUPEZ.
- Pit designs ensure PUPEZ does not encroach on culturally significant sites and associated post-closure access can be maintained once abandonment bunds have been constructed.
- The abandonment bund is required to be built from competent low erodibility mineral waste which will be stockpiled for construction at closure or constructed during operations where possible.
- Abandonment bund location and construction will consider creek flood inundation zones and surface water flows to ensure long-term post-closure stability.
- Buttressing of Pit 1 at SGE will be undertaken to move the PUPEZ outside of the 1:100 Annual Exceedance Probability (AEP) flood plain to prevent creek capture in the event if pit wall collapse.
- The location of the proposed pit abandonment bunds will be revised and updated in each iteration of the MCP to reflect any changes to the mine plan, understanding of the closure landscape, cultural/heritage sites and post-closure access requirements, and to address any updated flood modelling.

Closure knowledge gaps associated with geotechnical stability, as summarised in Section 5.16 Table 5-20, include:

- Final geotechnical stability review of PUPEZ that considers areas with adverse local structural geology to confirm the PUPEZ and abandonment bund locations.
- Engineered design of abandonment bunds that will act as permanent surface water diversion bunds within flood plains.
- Opportunities to progressively construct abandonment bunds during operations.
- Extent of buttressing of the BS4 Main Pit 1 required to ensure an abandonment bund can be constructed between the Pit 1 PUPEZ and the Juukan Gorge Remediation Project.

5.7. Mineral waste physical characteristics

As described in Section 5.6, the Brockman Operation deposits are geologically hosted within the Hamersley and Fortescue Groups of the Mt Bruce Supergroup. Meta-sedimentary formations of the Hamersley Basin are uniquely consistent in thickness and composition across the entire basin, with characteristics of individual units almost identical regardless of location. For example, the stratigraphic distribution and concentration of sulfides within the lower, middle and upper units of the Mt McRae Shale is consistently demonstrated in outcrop, drillholes and mining operations across the entire Hamersley Basin. As a result, planning for handling, disposal and successful rehabilitation of mineral waste can be anticipated for new deposits based on successful closure outcomes from other Pilbara Iron Ore operations.

Developing a comprehensive understanding of the types and volume of mineral waste material that will be generated/exposed during mining is critical for the effective design, construction and rehabilitation of final landforms. Rio Tinto has a well-developed process for the collection and analysis of this data and this process continues through the life of the mine to inform closure planning. Long-term material behaviour can also be predicted through characterisation of representative waste types and correlation to similar waste materials present at nearby deposits and other sites.

5.7.1. Physical characteristics

The key physical consideration of mineral waste that is applicable to closure landform design is the susceptibility to erosion, which is commonly termed “erodibility”. Erodibility can be defined in different ways depending on the erosion prediction tool; however, Rio Tinto considers erodibility of mineral waste using the following two means:

- erodibility ranking using the Revised Universal Soil Loss Equation (RUSLE), which broadly classifies mineral waste units by erosion risk - low, medium or high; and
- erodibility modelling using the Water Erosion Prediction Project (WEPP) runoff simulation and erosion model to define material-specific landform designs for each mineral waste unit.

In 2021 and 2022 Rio Tint commissioned a large-scale waste characterisation project across its numerous operations within the Pilbara. The physical waste characterisation completed for the Brockman Operations is provided in detail in the following Landloch memorandums:

- Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, BS4 – May 2022 (Appendix 8).
- Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, B2N – May 2022 (Appendix 9).
- Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, Silvergrass – September 2020 (Appendix 10).

5.7.2. Erodibility Ranking

The RUSLE is a measure of long-term annual erosion rates, and as such, the erodibility ranking provides broad guidance to both mine planning and closure planning regarding the placement of mineral waste units and final WRL design. Low erodibility materials, with a higher percent of competent rock, are suitable for placement on the outer surface of the WRL to provide long-term erosion protection. Wastes ranked as medium erodibility can be placed on the outer surface, however, use of these materials requires modified batter shapes (lower lift heights and/or batter angles) to prevent unacceptable erosion. High erodibility waste, where present in large proportions, requires the application of conservative rehabilitation design parameters (low lift heights and/or angles), selective placement within the landform, or capping with an appropriate thickness of a lower erodibility waste to prevent unacceptable erosion.

The RUSLE is calculated using five factors that are multiplied together. Two of these factors - erodibility (K-factor) and cover (C-factor) - are specifically related to the material; the remaining three factors describe rainfall and slope conditions. The K-factor describes the erodibility of the fine fraction (<2 mm

diameter) while the C-factor describes the influence of different surface conditions, such as percentage surface rock cover.

Mineral waste materials that had rock cover levels >70% were ranked as low erodibility and had an erodibility factor (K-factor multiplied by C-factor) of <0.0009. Waste materials with rock cover levels of 30-70% were ranked as medium erodibility and had an erodibility factor ranging from 0.006-0.0009. Waste materials with rock cover levels <30% were ranked as high erodibility and had an erodibility factor >0.006, as summarised in Table 5-6.

Table 5-6: Erodibility classification of mineral waste

Material classification	Rock Cover Level	K factor (fine fraction <2mm erodibility)	Erodibility factor (K factor x C factor)
Low	>70%	High	<0.0009
Medium	30-70%	High	0.0006-0.0009
High	<30%	High	>0.006

Results indicate that all mineral waste units expected to be mined at the Brockman Operation have a K-factor consistent with highly and very highly erodible materials, however, K-factor alone does not explain the observed differences in erosion potential of the mineral waste units produced across the Pilbara mines. When the percentage rock cover was considered using the C-factor, it was shown that rock cover significantly reduced material erodibility and could explain the observed differences in erosion potential.

5.7.3. Erodibility modelling

Although the RUSLE ranking system provides broad guidance, it is not used to define the landform designs that are adopted. This is done through physical measurement of the erodibility parameters that are used in conjunction with site-specific climate data within the WEPP runoff/erosion model. The Rio Tinto Pilbara WEPP model predicts runoff, erosion, and deposition for hillslopes and catchments, using inputs generated from rainfall stimulation plots using waste rock lithologies and a 100-year climate sequence developed from BoM weather stations, from sixteen Rio Tinto Pilbara mines.

The outputs of the WEPP model are compared to acceptable long-term soil erosion rates. Work completed by Landloch Pty Ltd (2018a), on behalf of the Pilbara Rehabilitation Group, established an acceptable long-term erosion rate of 6 t/ha/yr. which is consistent with the rates of soil renewal and naturally occurring erosion, and consistent with a surface with a low tendency for rill and gully erosion.

Based on the existing Pilbara-wide physical waste characterisation database, the predicted volumes and erodibility ranking of expected major mineral waste units at the Brockman Operation are presented in Table 5-7 to Table 5-9. The erodibility ranking for each mineral waste unit has been generated from either from site-specific data or from erodibility test results from nearby sites if site-specific data is not available.

Further work is planned to confirm the site-specific physical characteristics of waste types where from data from nearby sites has been used as well as to compare erodibility of the mineral waste units associated with the BSP once mining commences (Section 5.16).

Table 5-7: Mineral waste units - erodibility ranking and tonnes – BS4 deposits

Mineral waste unit	Erodibility	Total waste (Mt)	Total waste (%)
Dales Gorge	Low	71.26	12.4
Mt Newman Member	Low	28.91	5.0
Joffre	Low	51.56	9.0
Foot Wall Zone	Low	6.80	1.2
Hydrated Zone	Low	39.71	6.9

Mineral waste unit	Erodibility	Total waste (Mt)	Total waste (%)
MacLeod Member	Low	8.20	1.4
Wittenoom Dolomite	Moderate	49.59	8.6
Whaleback Shale	Moderate	50.74	8.8
McRae Shale	Moderate	5.29	0.9
Nammuldi	Moderate	2.04	0.4
Mount Sylvia	Moderate	0.54	0.1
Wittenoom Formation	High	99.08	17.2
Dolerite	High	19.14	3.3
Detritals	High	141.54	24.6
Total		**574.39**	**100%**

Table 5-8: Mineral waste units - erodibility ranking and tonnes – B2N deposits

Mineral waste unit	Erodibility	Total waste (Mt)	Total waste (%)
Dales Gorge	Low	125.60	7.4
Mt Newman Member	Low	97.64	5.7
Joffre	Low	8.66	0.5
Foot Wall Zone	Low	11.76	0.7
Hydrated Zone	Low	38.94	2.3
MacLeod Member	Low	16.34	1.0
Wittenoom Dolomite	Moderate	185.88	10.9
Whaleback Shale	Moderate	92.11	5.4
McRae Shale	Moderate	59.41	3.5
Nammuldi	Moderate	8.34	0.5
Mount Sylvia	Moderate	7.28	0.4
Wittenoom Formation	High	124.92	7.3
Dolerite	High	9.31	0.5
Detritals	High	916.94	53.8
Total		**1,703.15**	**100%**

Table 5-9: Mineral waste units - erodibility ranking and tonnes – SGE

Mineral waste unit	Erodibility	Total waste (Mt)	Total waste (%)
Mt Newman Member	Low	12.34	14.3
Hydrated Zone	Low	0.55	0.6
MacLeod Member	Low	3.65	4.2
Nammuldi	Moderate	15.97	18.5
Wittenoom Formation	High	0.30	0.3
Dolerite	High	0.26	0.3
Detritals	High	53.08	61.6
Total			**100%**

5.7.4. Batter selector tool

Rio Tinto and Landloch Pty Ltd completed an extensive project in 2010-2012 and several subsequent studies since then, to source erodibility data for a range of materials across Rio Tinto's Pilbara mine sites. The establishment of a database defining the erosion characteristics of the predominant mineral waste units has defined stable landform batter geometries used to directly inform WRL design and rehabilitation planning.

The Batter Selector Tool (BST) uses these erosionally stable batter geometries to develop 3D rehabilitation landform designs that considers long-term erosional stability. The batters within the BST are 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 occurrence and development of more significant erosion features, such as gullies. In addition to height, gradient and profile shapes, the BST sets minimum berm widths and backsloping angles that have been developed from WEPP predictions of runoff and erosion to determine the required berm catchment capacities.

The BST provides individual WRL design options that would result in stable slopes that meet the Rio Tinto landform design guidelines, by considering site specific rainfall and the waste types within an individual WRL. Where available, the preliminary closure designs for WRLs across the Brockman Operation developed using the BST are presented in Appendix 2. These designs will be refined and updated as physical characterisation of mineral waste units is updated. All proposed WRLs are still conceptual and therefore do not have rehabilitation designs.

5.7.5. Principles of waste rock landform design

Rio Tinto mineral WRLs are designed, constructed and rehabilitated in accordance with the Rio Tinto *Landform Design Guidelines* (Rio Tinto 2019a). Guidance includes the objective of WRL rehabilitation design to achieve dumps that are:

- safe;
- stable;
- aesthetically compatible with the surrounding landscape;
- vegetated;
- non-polluting;
- compatible with the agreed post-mining land use;
- able to be progressively rehabilitated;
- appropriately located;
- rehabilitated with appropriate surface treatments; and
- considerate of relevant internal and external guidance material.

These guidelines are updated on a regular basis to incorporate learnings from research, studies and rehabilitation implementation projects. The most significant update occurred in 2012 to provide design criteria for WRLs based on the specific waste types present. This was the result of several years of materials testing and landform evolution modelling studies of wastes typically found in the Pilbara, with design recommendations based on the assumption that an average erosion rate of 5/ha/year (with a maximum of 10/ha/year) will be acceptable.

Further studies have since been undertaken on additional waste types, and these have resulted in further minor updates in 2014, 2016 and 2019. A sampling campaign commenced in 2020/21 to further refine material characterisation across Rio Tinto' Pilbara sites. This work will inform closure planning for the Brockman Operation and final WRL designs; any changes to WRL designs will be included in subsequent MCP submissions.

During operations high erodibility material is prioritised to be backfilled to disused pits to avoid the risk of ongoing erosion during closure. When pits are not available or scheduling of waste is not favourable for backfill of pits, high erodibility material will be placed in permanent WRLs. At SGE all waste is anticipated to be backfilled to disused pits, except for the DHW WRL which will be capped with low erodibility material.

Closure landform rehabilitation designs are detailed in Appendix 2 and are based on the site-specific assessments waste material erosion potential (Chapter 5.7.1). A multi-disciplinary pit and WRL design sign-off process is conducted, which considers landform design guidelines and provides rehabilitation designs where appropriate. Performance of rehabilitation designs will be reviewed during the life of the mine. Further work is required to confirm the erosion potential of waste material types expected from proposed deposits, determine dump utilisation in the mine plan, and subsequently to develop rehabilitation designs for proposed WRLs.

During rehabilitation activities, erodible, fibrous and PAF materials are planned to be encapsulated as part of making the site safe and stable. Capping layers are installed as required by Rio Tinto's *Fibrous Material Management Plan 2019* (Rio Tinto 2019b) and *Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan 2021 V7* (SCARD) Management Plan (Appendix 11). Capping is also proposed on some dumps with erodible material, and on WFSF surfaces. Capping is undertaken with inert waste of low or medium erodibility as described in the *Rio Tinto Iron Ore (WA) Landform Design Guidelines* (Rio Tinto 2019a). Where it is not possible to construct the encapsulation with material of low or medium erodibility directly, a sufficient standoff distance shall be allowed such that the rehabilitated slope can be armoured with sufficient thickness (at least 2m) of low or medium erodibility material during rehabilitation.

Studies commissioned by Rio Tinto on the stability of the Tom Price NEBC dump, which has a significant proportion of highly erodible detrital material, indicate that capping with at least 300 mm of BIF-dominated waste would be sufficient to achieve a stable landform (Landloch 2018b). Rio Tinto plans to apply a more conservative 500 mm capping layer of low erodibility material to any dumps with the potential to erode at an unacceptable rate (currently identified as WRLs with >5% high erodibility material on the dump surface).

5.7.6. Rehabilitation materials

Erodible material rock armouring, construction of 'store and release' covers on WRLs containing PAF material and cover of WFSFs are planned to be encapsulated as part of making the site safe, stable and non-polluting. The materials required for encapsulation often require specific characteristics.

PAF encapsulation

Waste rock that is used to construct 'store and release' covers should contain sufficient fine-grained material to have both a high moisture retention capacity and a relatively low permeability (i.e. large boulders should not be placed on the cover). Waste rock composed of well-graded clayey, silty, sandy gravel or clayey silty gravely sand makes the best store and release cover material. Generally, waste rock containing more than 1/3 coarse sand size and finer particles (< 5 mm) will make a suitable cover material. Blocky BIF composed of gravel with very little silt, sand or clay is not ideal for use in cover construction and should be avoided if another more suitable waste type is available. It is likely that a proportion of the high erodibility material at each of the mine areas will serve this purpose.

Calcrete material is currently mined from the Nammuldi pits and may be tipped over in-situ PAF exposures to neutralise the potential for AMD. Work is planned to understand the efficacy of this strategy and stockpiling of calcrete material may be undertaken pending the results (Section 5.16).

Erodible WRL batter rock armour and WFSF capping

Rock armouring of WRLs batters is proposed on some WRLs where high erodibility material is exposed on the WRL exterior. Rock armouring is undertaken by placing a sufficient thickness (0.5 m) of 'normal

waste' of low or medium erodibility over the WRL batter as described in the *Rio Tinto Iron Ore (WA) Landform Design Guidelines* (Rio Tinto 2019a).

The cover design of the WFSFs are typically water shedding or 'store and release', depending on the risk profile. Type of WFSF cover design and volume and type of materials required for construction will be progressed through the WFSF closure investigations.

Rehabilitation material inventory

Suitable low erodibility waste material types for rock armouring of WRLs are present across the Brockman Operation, as summarised in Table 5-7, Table 5-8 and Table 5-9. Stockpiling of competent material has not yet commenced at existing operations, however this is planned to commence to ensure adequate volumes are available at closure. A reconciliation of rehabilitation required at closure is planned to be completed (Section 5.16) to demonstrate sufficient materials will be available at closure.

5.7.7. Implications for closure and knowledge gaps

Waste material mined across the Brockman Syncline display a range of physical characteristics, with a significant proportion, 28% at BS4 and 52% at B2N, expected to be susceptible to erosion. Stable landform batter geometries have been developed based on material specific erodibility testing and are used to directly inform WRL design and rehabilitation planning. Management of highly erodible material is required to prevent unacceptable erosion rates off the WRLs. This includes selective dumping highly erodible material back in-pit or within the centre of a WRL or capping the material with competent waste rock.

Closure knowledge gaps associated with mineral waste characteristics, as summarised in Section 5.16, Table 5-20 include:

- Site-specific physical characterisation of all mineral waste units at the Brockman Operation.
- Rehabilitation designs of WRLs that are still conceptual in design. Removal of all ramps in rehabilitation designs, unless post-closure access is required, as designs are progressed.
- Volume of waste material types required to meet closure commitments and outcomes, including:
    - pit backfill material;
    - competent material for capping of erodible WRLs and construction of abandonment bunds; and
    - suitable material to construct store and release covers on WRLs containing PAF material.

5.8. Mineral waste geochemical characteristics

Rio Tinto has undertaken an extensive program of geochemical testing over several years to understand the potential for acid and metalliferous drainage (AMD) to occur as a result of exposing various waste rock types common to mining operations in the Pilbara. The geochemical characterisation process aims to assess sulfur content as an indicator of acid generation potential, and to undertake static (acid base accounting) and, if appropriate, kinetic testing of materials. This information is applied to the geological block model and subsequent mining model, to ensure materials posing potential geochemical risks are identified prior to mining and managed appropriately. This test work is in accordance with the SCARD Management Plan (Appendix 11).

The most significant geochemical risk in Pilbara iron ore bodies is associated with sulfides, such as pyrite (FeS_2), which can form sulfuric acid when exposed to oxygen and water. The Mt McRae Shale Formation, the geological unit most commonly associated with pyrite and acid mine drainage in the Pilbara, is present at a number of deposits included within this MCP. However, pyrite can also occur in Banded Iron Formations, such as the unmineralised MMIF. Other sulfate minerals, such as alunite and jarosite may also be present and can also pose a geochemical risk, albeit the risk is usually lower due to self-limiting chemical processes.

In addition to a regional AMD risk assessment completed in 2021 (RTIO, 2021) to support the BSP, site specific AMD risk assessments have been completed for the approved Brockman Operation sites taking into account new drillhole data, mine plan and pit shells.

The AMD risk assessments completed for the Brockman Operation are:

- BS4 AMD Risk Assessment Review 2021 (Appendix 12)
- Nammuldi AMD Risk Assessment Review 2021 (Appendix 13)
- BS2 AMD Risk Assessment Review 2021 (Appendix 14)
- Silvergrass East AMD Risk Assessment Review 2021 (Appendix 15)
- Greater Brockman 2021 AMD Risk Assessment to support the BSP (Appendix 16)

The AMD risk assessments aim to assess all waste lithologies present at the site, and analyses have been conducted in accordance with the *Global Acid Rock Drainage* (GARD) *Guide,* developed by the International Network for Acid Protection (INAP 2009). Test work has included Acid Base Accounting (ABA), total sulfur, multi-element analysis to determine chemical enrichment and liquid extract analysis for metals and metalloids and is used in conjunction with mapping of PAF material against the final pit designs and mining models and mapping the position of samples relative to the water table. PAF material volumes anticipated to be mined at each deposit is provided in the relevant AMD risk assessment.

5.8.1. Total sulphur and geochemical characterisation

To determine the risk of AMD, mineral waste is characterised by undertaking a geochemical assessment based on an analysis of total sulfur assay values. Sulfur trigger values are predetermined based on a Pilbara wide study and review of static ABA, mineralogy, and kinetic column leach tests which Rio Tinto has completed to identify the potential for certain rock types to generate acidity (Green and Borden, 2011). The sulfide risk classification definition is provided in Table 5-10.

The analysis of the existing ABA data for high risk rock units (e.g. black Mount McRae Shale Formation) confirms that a sulfur cut-off of 0.1% could be adopted as the boundary value to delineate potential acid forming (PAF) material from inert/non-acid forming (NAF) material. For other rock units such as BIF and detrital rock types, a 0.3% total sulfur concentration may be the most appropriate trigger value (Rio Tinto 2008); the applicability of this higher trigger value is based on low net acid generation derived from sulfate minerals and relatively high acid neutralissing capacity (ANC). Sulfur cut-off levels of both 0.1% and 0.3% are considered for the purpose of this assessment, where a sulfur cut-off of 0.1% may be more relevant to the high risk rock units and a cut-off of 0.3% may be more relevant to lower risk units.

Table 5-10: Sulfide risk classification definition

Waste Type	Definition
Sulfur risk (SR) 1 (Low Risk BS-Oxide)	Oxidised shale which is typically above the water table, contains few intact sulfides, has less than 0.1% total sulfur, and is characterised by red, yellow, orange, and white colours. The potential for reactivity occurs due to the spontaneous oxidation of pyrite and carbon within fresh shale. This reaction has reached equilibrium in oxidised shale, therefore the shale poses little ARD risk and no self-heating risk. This material is classified as non-acid forming by acid base accounting test work.
SR 2 (Moderate Risk BS-Cold)	Non-reactive (cold) black shale which is located below the water table and locally immediately above the water table and has total sulfur concentrations less than 0.1% common. This shale may represent a partially oxidised zone containing material which is neither all black nor the typical oxidised colours. This shale poses a low ARD risk, and low self-heating risk. This material is classified is either non-acid forming or is potentially acid forming with a low capacity by acid base accounting test work.
Sulfur risk 3 (High Risk BS-Hot)	Reactive (hot) black shale which is located below the water table and locally immediately above the water table and has total sulfur concentrations greater than 7% common. This shale may be completely fresh, or represent a partially oxidised zone, and poses both a high ARD risk and self-heating risk.

Waste Type	Definition
Sulfide Risk 4 (BS-Neut, neutralising material)	Material with neutralising potential can be strategically used within waste dump designs. Calcrete within the detritals and dolomite within the Wittenoom Formation has been identified as having neutralising potential.

An analysis of sulfur values in drillhole data (covering drilling from 1968 to 2020) was undertaken to demonstrate representativity of samples across deposits and material types as well as to identify those rock types which require further investigation related to acid-forming potential (and the related impact of metalliferous drainage). Appendix 12 to Appendix 16 provide detailed analysis of the drillhole sulfur assay data collected across the Brockman Operation deposits and specifically within current pit designs.

ABA data compiled from several investigations, including RGS (2021), RTIO (2017), SRK (2015) and SRK (2013) show the majority of samples collected representing the geological formations likely to be encountered during mining are broadly non-acid forming, with only a small portion classified as PAF (Appendix 12 to Appendix 16). Sequences with samples identified as PAF include detritals, Mount McRae Shale and Wittenoom Formation.

The total sulfide risk waste material predicted to be mined is provided in Table 5-11. Note, volumes are based on current geological models and are subject to change.

Table 5-11: Summary of predicted waste material across the Brockman Operation

Deposit	Total tonnages (Mt)		
	SR 1	SR2	SR3
BS4			
BS1	55.7	22.2	0.18
BS4 Main	95	12.5	1.31
BS4 MM	129.3	1.0	0.12
Endeavour & BS3	100.6	5.1	0.96
BS2			
BS2 Main	4.75	0.5	0.0
BS2 Extension	21.63	0.44	0.2
BS3 Extension & Lens G	49.6	0.0	0.0
Nammuldi	164.79	1.83	4.31
SGE			
SGE	476	0.08	0.00

5.8.2. PAF material management

Minor volumes of SR2 and SR3 material is anticipated to be mined across the Brockman Operations (Table 5-11).

Rio Tinto operations in the Pilbara manage and reduce the risk of AMD through implementation of the *Iron Ore (WA) Mineral Waste Management Work Practice* (Rio Tinto 2020a) and the SCARD Management Plan *(*Appendix 11). The management strategy for PAF material is based upon the following principles:

- identification of PAF distribution and character;
- minimising the exposure and mining of PAF to the extent possible;
- identification and special handling of PAF that must be mined;
- in-pit placement of PAF, preferably below the water table in backfilled open pits to limit oxygen contact; and

- encapsulation of PAF inside inert waste rock dumps to limit water contact and allow dumps to be revegetated.

Where practicable, in-pit disposal is the preferred storage option because it:

- is more secure than in above ground waste rock dumps;
- reduces the risk of erosion exposing encapsulated PAF material in the long term;
- inhibits convective oxygen transport because the waste is surrounded by relatively impermeable walls;
- reduces the footprint of mineral waste disposal facilities;
- reduces the volume of inert or net neutralising waste needed to encapsulate the PAF material; and
- may help to prevent the formation of pit lakes if the pit is filled to above the post-mining water table.

Where the storage of PAF waste material in-pits (backfill) is not possible, PAF material will be encapsulated in ex-pit WRL. Waste Rock landforms that contain black shale can potentially generate AMD for long periods of time, hence more stringent design criteria are required for PAF WRLs. The design criteria for WRLs containing PAF material are outlined in the SCARD Management Plan.

Key design features, as shown in (Figure 5-12), include:

- a base layer of inert waste rock to prevent any surface water flooding from contacting PAF material;
- PAF WRLs will be constructed in a series of horizontal layers to minimise PAF exposure and infiltration during construction; and
- a store and release cover will be installed to limit infiltration into the underlying waste rock by maximising the evapotranspiration of incident rainwater.

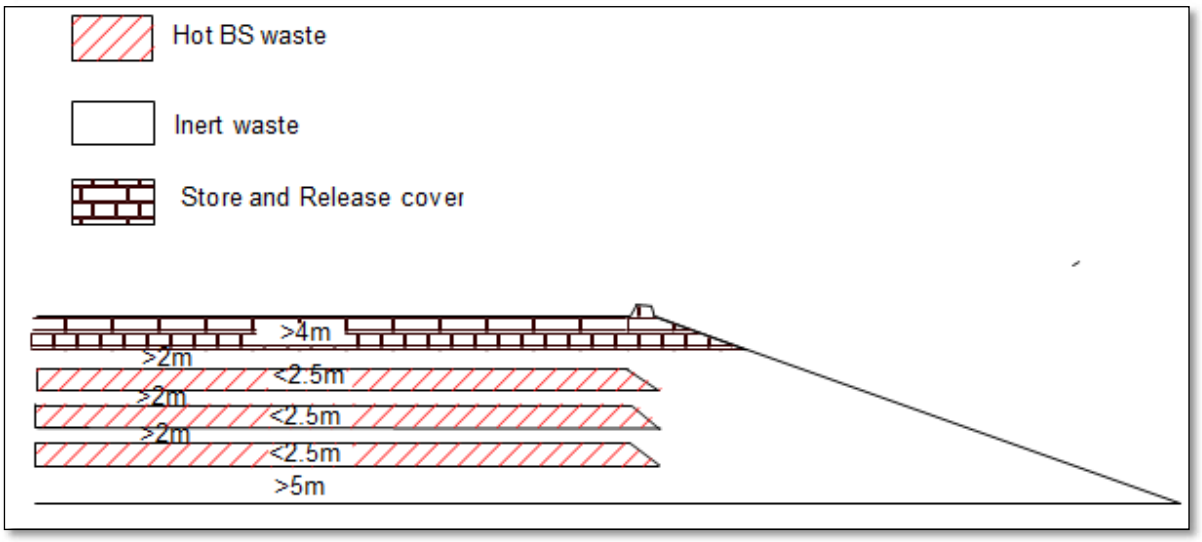


Figure 5-12: Example of WRL design for bs_hot PAF waste encapsulation

(Source: Appendix 11)

Current PAF material storage locations

PAF material has been mined and appropriately encapsulated within WRLs at both B2N and BS4 deposits to date. All PAF material mined at BS4 to date is stored within the DP2 WRL, as per the encapsulation requirements of the SCARD Management Plan. It is anticipated that all PAF material mined from the BS4 Main, MM and Endeavour deposits will be encapsulated within the DP2 WRL.

PAF material mined to date at B2N has been encapsulated within the:

- BS2 Main Pit 1 WRL – This pit is an historical AWT inert detrital pit. Mining of this pit has been completed and the pit has been backfilled to approximately 30 m above the pit crest with a co-disposal mix of inert and PAF material. Known as the Pit 1 WRL, this landform is considered an Elevated Sulfur WRL as per the SCARD Management Plan, requiring at least 1 m of inert material to be placed on the outer surface of the final rehabilitation design surface.
- BS2 Main BS2 Pit – Mining of BS2 pit (a BWT extension of Pits 4 and 6) is authorised by MS 867 which includes the following implementation conditions relevant to PAF management:

9-2	Within two years of the end of productive mining in the BS2 pit, the proponent shall backfill the BS2 pit with inert waste to sufficient depth to ensure that, following mine closure and backfilling, the groundwater water table would permanently remain at least 3 m below the lowest point of the pit floor.
9-3	At the completion of mining of the BS2 pit the proponent shall encapsulate PAF material within a waste material landform consisting of: 1. an inert waste rock layer overlaid on the uppermost PAF layer of a minimum of 2 m; 2. a thick store and release cover of a minimum of 4 metres constructed on top of the 2 m layer of inert waste rock; and 3. topsoil spread of a minimum of 0.3 metres on top of the store and release cover.
9-9	The proponent shall ensure that an adequate capillary break is installed under the waste dump as outlined in Figure 1 to prevent upward movement of groundwater coming into contact with material with potential to produce acid, metalliferous or seleniferous drainage.
9-12	The proponent shall ensure that vegetation species for rehabilitation planting on the store and release cover are to be native to the proposal area with root penetration of less than 5 metres.

  Condition 9-2 has been fulfilled as backfilling of the BS2 pit has been completed to the 600 mRL, approximately 20 m above the pre-mining water level (580 mRL).
- Pit 10 and Lens D (AWT stage of Lens CD pit) backfill – PAF material has been placed within AWT stages of these pit voids. A ‘store and release’ cover will be constructed over this backfill at closure.
- Lens CD and Lens EF2 WRL – PAF material has been encapsulated within these WRLs as per the SCARD Management Plan and will require a ‘store and release’ cover to be constructed at closure.

Future PAF material storage locations

The location and footprint of new PAF material storage areas will be selected to minimise potential long-term environmental impacts and financial liabilities. Selection and design criteria for new PAF material storage areas are detailed in the SCARD Management Plan and must consider the following:

- PAF dump locations should not receive runoff from surrounding areas. WRLs must not be sited in established drainages with significant upstream catchments.
- PAF dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom Formation.
- PAF dumps should not be placed over or adjacent to significant seeps or springs.
- The number of sites containing PAF material, and the footprint of these dumps should be kept to a minimum.
- PAF dumps should be located near sources of clean waste rock for encapsulation.

Approximately 22.2 Mt and 0.18 Mt of SR2 and SR3 material is expected to be mined at BS1, respectively. PAF material will be encapsulated in inert backfill to AWT sections of the West 1 and East 1 pits. When scheduling of PAF material to pit backfill is unfavourable, this material will likely be permanently encapsulated within the BS1 DP10, DP11 and DP13 WRLs as the location of these WRLs

conform to the above criteria. Other BS1 WRLs may be used for encapsulation of PAF material provided they meet the above criteria.

Ongoing geochemical assessment will occur throughout the mine life to ensure that AMD risks are identified early and appropriately managed. During operations and post closure, monitoring will be undertaken to assess for any potential impact to surface and groundwater by AMD. If such impact occurs, appropriate strategies will be developed to monitor and where appropriate, remediate this contamination.

5.8.3. Pit void AMD risk

Final pit void PAF material exposures and geochemical risk

Open pits that contain in-situ PAF exposures in the final pit walls have the potential to generate AMD at closure. Preliminary pit closure geochemical risks have been developed for all pits based on a number of factors including pit depth, final pit wall area and predicted PAF material exposures. Further information on final pit void characteristics and returned groundwater management, including proposed pit void closure outcomes is discussed in Section 5.10.8. The final pit wall PAF exposure areas and mapping for each pit is provided in detail in the AMD Risk Assessments listed above (Appendix 12 to Appendix 16).

Note that the pit shells and modelled PAF exposures will change over time as the geological and mining models are updated. Future mine closure plan updates will include the current modelled final pit exposures and subsequent changes to the pit closure geochemical risk and proposed pit closure strategy. As such, management of PAF material exposures on final pit walls to prevent AMD will continue to be revised as knowledge gaps are addressed (Section 5.16) and will be presented in future revisions of this MCP.

5.8.4. Chemical enrichment

Selected drillholes are regularly analysed for the main chemical element suite of Al, Ca, Fe, Mg, Mn, P, S, Si and Ti as well as As, Ba, Cl, Co, Cr, Cu, Pb, Ni, K, Na, Sr, Sn, V, Zn and Zr. In addition to the full chemical suite, additional elemental abundances in solids are determined for Ag, B, Be, Cd, F, Hg, Mo, Sb, Se, Th and U by either inductively coupled plasma mass spectrometry/atomic emission spectroscopy (ICP-MS/ICP-AES), trace XRF, or by specific ion electrode methods. This test work is completed on a suite of ore and waste samples which are representative of the main lithologies expected to be mined.

Geochemical data suggests several elements, including Fe, As, Sn, Co, Cr, Cu, Mn, Ni, Pb, V and Zn are enriched or elevated in relation to the Global Abundance Indicator (GAI). Given the mineralised nature of the Pilbara, elevated concentrations of metals are not unexpected, and it is considered likely that surrounding receptors have adapted to the naturally elevated concentrations.

5.8.5. Neutral Mine Drainage

The GARD guide identifies neutral mine drainage (NMD) and saline drainage (SD) derived from mine waste as mine water characterised by pH above 6 with a sulphate concentration of 1,000 milligrams per litre (mg/L) (INAP 2014), which is the threshold between NMD and SD (the cut-off between fresh water and slightly saline water of 1,000 mg/L total dissolved soilds (TDS) [USGS, 2014]). Both NMD and SD is therefore unlikely in the absence of elevated sulfur concentrations. Neutral or elevated pH is also a feature of NMD and SD therefore elevated ANC can be used as another indicator of elevated risk of NMD or SD. It should be noted however that high ANC is not a diagnostic feature, as co-disposal of high ANC waste rock with high sulfur waste rock as a management approach can lead to elevated sulfate and/or metal/metalloid concentrations. Therefore, the assessment of NMD and SD should not be limited to materials containing both high sulfur and high ANC.

Additional characterisation work is ongoing within the Brockman region to assess the risk of NMD. Data collected as part of the 2022 investigation identified a leachate pH of between 6.5 – 7.98 of all rock units analysed.

5.8.6. Fibrous minerals

Naturally occurring fibrous minerals can be found in banded iron formations of the Pilbara. At Rio Tinto Pilbara operations, fibrous minerals are generally encountered as thin seams within waste material from the MMIF but have also been encountered in other stratigraphic units such as the Brockman Formation . Riebeckite is the most common mineral associated with fibrous minerals encountered at Brockman Hub. Riebeckite is typically only found in fresh (unweathered) BIF and is not considered to pose a risk to health. Riebeckite is a precursor to crocidolite. Fibrous minerals may also occur as clasts found within overlying alluvium cover. Fibrous minerals pose a risk when fibres of a respirable size become airborne and are inhaled.

Mineral waste characterisation has identified the presence of fibrous minerals in the waste rock across the Brockman Operations.

Fibrous mineral waste will be mined during operations at BS4, B2N, and SGE. This material is expected to be intersected in:

- BS4 Pits 1, 3, 12, 14, 16, 17 and 18;
- BS4 MM pits Q, and R;
- B2 Extension pit 9a;
- Nammuldi Lens A, CD, and G pits; and
- SGE pits 1-3.

Operational fibrous mineral management

All fibrous material encountered during operations is managed as per the Fibrous Mineral Management Plan (FMMP) (Rio Tinto 2019b). Material sourced from a fibrous or designated area is stored preferentially in-pit, but otherwise encapsulated within permanent external WRLs with at least one metre of inert material to prevent fibrous material becoming airborne. In accordance with the mine plan, fibrous material will be encapsulated in cells within the following WRLs at BS4, B2N and SGE, with the exact location and geometry recorded:

- BS4: DP1, DP4, DP5, DP6 and DP8;
- B2N: Pit 6 WRL, Lens AB WRL, Lens EF4 WRL and Lens EF5 WRL; and
- SGE: DHW WRL.

Control measures are employed during operations to reduce the potential health risk posed by exposure to fibrous material in line with internal procedures. These measures include responsibilities for ensuring as-built waste dump designs, which contain fibrous material include 3D plans of the locations and volumes of fibrous material. All fibrous material mined during operations will be encapsulated with at least 1 m of inert material within the above designated WRLs. This encapsulation methodology considers the final rehabilitation design of WRLs encapsulating fibrous materials ensures the minimum 1 m buffer is maintained during earth works to shape the final landform. Where possible, it is preferable for fibrous material dumps to be located in-pit to further reduce the risk of exposure.

The location and footprint should be selected considering the following criteria:

- The location should be such that the waste material should not require re-handling in the future.
- The location should be at a practicable distance from current and future operations such that restricted access can be implemented and allowing for both the short-term control of operations and the long-term recording of the position.

- Ideal sites are areas which are not readily accessible by the public and/or site personnel, and which are not expected to be disturbed in the future.
- The footprint should incorporate lateral containment bunds to prevent potential contaminated sediment run off and further exposure.
- In pit disposal should be considered a priority instead of the construction of above ground waste dumps; the number of sites containing designated hazardous waste and the footprint of the waste dumps should be kept to a minimum.
- The waste dump should be located near sources of inert waste material for the encapsulation process.

Final pit void fibrous mineral exposure management

There is the potential for fibrous minerals to be exposed in the pit walls in the future, although significant quantities are not expected. Post-closure, the pit walls will continue to erode and collapse. Therefore, there is the potential for fibrous minerals to be exposed in the pit walls in the future. These materials may accumulate in talus on the pit walls or could be washed into the base of the pit.

Modelled in-situ fibrous mineral exposures in the final pit wall will be verified in-field as mining progresses. The potential health risks at closure posed by the confirmed presence of in-situ exposures and associated closure strategies to be implemented will be based a pit specific risk assessment. Risk assessments will be completed progressively as exposures are mined. Where the risk is deemed acceptably low, no further measures will be taken. If a potential public exposure risk is identified, control measures will be employed to reduce the risk posed by this material and may include targeted backfill of in-situ exposures

It should also be noted that the likelihood of public exposure to fibrous minerals will be further reduced at the Brockman Operation due to its remote location and the installation of abandonment bunds around nominated fibrous landforms to prevent inadvertent public access.

5.8.7. Implications for closure and knowledge gaps

PAF materials will be mined and exposed at several deposits across the Brockman Operation. If uncontrolled there is the potential for low pH water and solubilised contaminants to enter downstream receiving waters and the groundwater table. Fibrous minerals may also be encountered in small quantities during operations across all deposits. Final pit wall PAF material exposures will continue to be assessed as pit designs are revised throughout the LOM. Closure management measures to reduce the risk of AMD associated with in-situ PAF material exposures on final pit walls, such as backfill or buttress over with NAF material, will be progressed as pit layouts are finalised.

Closure knowledge gaps associated with mineral waste characteristics, as summarised in Section 5.16, Table 5-20include:

- Potential to use SR4 neutralising material, as defined in Table 5-10, to reduce the risk of AMD at closure.
- Opportunities to reduce in-situ PAF exposures on the final Nammuldi Lens CD and Lens EF pit walls.
- Health and safety risk of fibrous mineral exposures on final pit walls.

5.9. Tailings characterisation and storage

5.9.1. Nammuldi wet plant tailings geochemical characteristics

Characterisation testing of the waste fines generated by the B2N wet plant has been undertaken in 2009 (KP 2009), 2010 (Rio Tinto 2010a), 2012 (Rio Tinto 2012a), (KP 2012) and 2019 (KCB 2021). The 2021 KCB assessment reviewed and interpreted all test results to date as part of the proposed in-pit WFSF investigation.

The 2021 KCB report concluded that the waste fine solids are likely to be NAF. It also found the waste fines solids may exceed selected contaminated site assessment criteria with respect to As, Fe, Mn and Sn, however this is only of concern if these elements are leachable which is a low risk given the neutral pH of the supernatant and NAF solids.

Other elements, including Cd, Cr, Cu and Zn produced leachate concentrations higher than background groundwater concentrations.

The slurry supernatant was of neutral pH and contained concentrations of Al, Cd, Cr, Cu, Hg, Mn, Pb, Zn, and possibly Ni higher than background groundwater quality. Supernatant concentrations are significantly higher than deionized and saline leachates. The waste fines liquor / pore water may have elemental concentrations higher than background water quality and therefore seepage from the WFSF may impact the quality of downstream surface/groundwater resources. Actions to better understand the potential for seepage at closure will be completed during the WFSF closure studies.

The deposits BS1 and BS3 are generally enriched in As, Na, Fe, MnO, with K_2O and/or TiO_2. Although identified as enriched, the elements are not necessarily readily mobile upon contact with water. These elements were at, or below, the detection limits of instruments when undergoing solute leach testing, and these results are consistent with work completed on the previously approved deposits.

BS4 low grade pilot plant waste fines

BS4 does not have any large scale WFSFs, present or planned. The Brockman Syncline 4 Low Grade Pilot Plant was run in 2011 and 2012 for the purpose of testing low grade processing. A small waste fines cell approximately 71 x 34 m, with a 4 m embankment height was constructed to store the iron ore tailings from this test work. The iron ore tailings generated from this pilot facility have been flocculated but contain no chemical additives.

5.9.2. Nammuldi ex-pit WFSF

The Nammuldi WFSF is an engineered, valley-fill WFSF and was commissioned in 2014 and is located to the north-west of the Nammuldi mine. It consists of one cell of approximately 230 ha in final waste fines inundation area. Stage 1 of the WFSF was commissioned in 2014 with a 7 m embankment raise, Stage 2, to 582 mRL completed in 2017. This represents the current height of the facility and is forecast to provide storage capacity through to Q2 2023. A final Stage 3 embankment raise to 588 mRL is scheduled to be constructed and commissioned in 2022. This embankment raise will lift the WFSF to the current final approved height of approximately 26 m and is forecast to provide storage capacity through to 2027.

Nammuldi WFSF closure study schedule

The Nammuldi WFSF is classified as having an ‘Extreme’ Dam Failure Consequence Classification hazard rating, in accordance with the Global Industry Standard for Tailings Management (GISTM) using the Maximum Reasonable Consequence approach. Under requirement 5.6 of Principle 5 of the GISTM, all facilities are required to have a pre-feasibility level closure design completed to demonstrate that progressive closure has been considered in the latest design and operational requirements of the facility.

The Tailings Storage Facility Closure Guideline (Rio Tinto 2021b) has been developed to provide a conceptual overview of the requirements and design concepts for the closure WFSFs in the Pilbara. The guideline seeks to integrate closure planning into the development and operational phases of a WFSF, using an iterative risk-based approach and will ensure closure issues and knowledge gaps are understood and addressed effectively during the life of the WFSF. This practice also allows for development designs to be optimised to mitigate closure risks and liabilities.

An Order of Magnitude (OoM) closure study for the Nammuldi WFSF is scheduled to commence in July 2022, with completion expected in Q1 2022. The key objectives are to review the existing knowledge base and identify gaps to be addressed, develop and undertake additional investigations to address the gaps, determine the preferred closure strategy and assess options for closure aligning with this strategy.

The OoM study will focus on a minimum of three options for closure of this facility, with water shedding, cut and cover and rehandling expected to be amongst those considered. Recommendations for closure options to be carried through to prefeasibility study (PFS) phase will arise from this OoM study. Additionally, closure trials will be scoped at the conclusion of this phase, for completion during PFS.

In late Q1 / early Q2 2023 a PFS will then commence to continue the evaluation of a minimum of the two most viable options and is expected to be completed in Q3/Q4 2023. Work will be undertaken to finalise the selection of a preferred closure option, with supporting study and design being undertaken to produce a clear scope to be taken forward to the feasibility study (FS) phase. As part of this, closure trials will be performed to inform the selection.

Nammuldi WFSF closure design

The following conceptual closure design was developed for the Nammuldi WFSF to support the Nammuldi BWT Project Mining Proposal, approval registration ID 38119 (Rio Tinto 2012). At the end of the operation of the facility, the final stage downstream face of the WFSF main embankment will have an overall slope of 1V:3.5H (~16°). This will consist of slopes of 1V:3H (~18°) with 5 m benches at 10 m elevation increments. The adopted downstream profile will be inherently stable under both normal and seismic loading conditions, will provide a stable drainage system, and will allow for re-vegetation.

The downstream construction method limits rehabilitation of the embankment outer slopes until the last three years of the operating life of the facility. The embankment downstream face will be rehabilitated with 200 mm of topsoil where appropriate, which has been stockpiled from initial clearing of the WFSF. It will then be contoured ripped and seeded with native vegetation.

A flood routing assessment was completed for Duck Creek to assess the potential impact on the WFSF downstream toe and haul road using the flood analysis program HEC-RAS. The flood routing assessment was completed for the stream valleys in their original state and once the WFSF has removed the catchment from the reporting to the creek. A 0.01% AEP storm event was used. The modelling indicated that flooding may occur at the downstream toe and that erosion protection is required. This will be installed as soon as the final toe is reached, and suitable rock is available from mining activities.

The proposed capping configuration will be reviewed during operation based on the in-situ waste fine strength and geochemical characteristics. Rehabilitation of the waste fines surface will commence upon termination of deposition into the facility after sufficient time has passed to allow access. The capping will consist of an initial inert waste layer designed to act as a trafficable layer for equipment and also act as a capillary break for the topsoil layer above. This layer will typically be 300 – 600 mm and will be constructed with subsoil removed during initial construction or waste material from nearby stockpiles. A 200 mm soil layer, removed during initial construction, will be the final cap for the facility.

The removal of infrastructure at closure will be staged and will proceed through the following steps:

- The final supernatant pond would progressively evaporate after waste fines deposition has ceased.
- The waste fines surface would be allowed to dry until it has sufficient strength to provide access.
- The waste fines distribution pipelines will be removed from the embankment and southern valleys.
- The decant pump and associated electrical and mechanical infrastructure will be removed.
- The decant tower will be backfilled with coarse rock to the surface of the causeway.
- The final operating spillway would be cut to a lower level to form the closure spillway at the same location. The level will be confirmed based on the beach slope obtained so that the facility will remain predominantly water shedding.
- The underdrainage system would continue to be operated intermittently until the quantity of water reduces. No set duration can be specified, but typically this would be in the order of 6 – 12

months. After the flow reduces, the underdrainage pump will be removed, and the underdrainage riser pipe top will be welded closed.

- The embankment external faces are to be rehabilitated if not already done so as part of the final embankment stage works earlier.
- The cover design placed over the waste fines surface and where practicable topsoil spread.
- The monitoring bores will be continued to be monitored as set out by any permitting requirements.

This arrangement will form a water shedding system which under average and severe rainfall conditions reduces to a practicable minimum the potential for uncontrolled overtopping.

5.9.3. BS4 temporary ex-pit waste fines cell closure strategy

The plant is currently under care and maintenance, and the associated temporary waste fines cell is planned to be rehandled in full as part of the pilot plant decommissioning.

5.9.4. Proposed In-pit WFSFs

The current ex-pit Nammuldi WFSF, including planned embankment lifts, is anticipated to reach capacity in 2027. It is predicted that additional waste fines storage capacity (~83.6Mt) will be required for the remaining LOM. Existing pits Lens A, Pit 8 and Pit 5 at B2N have been identified as suitable permanent storage areas for waste fines. It is intended that Lens A and Pit 8 will provide the primary storage capacity with sequential filling commencing at with Lens A. Pit 5 has been partially backfilled and has significantly less available volume for storage; deposition into this pit has been identified as a contingency option as it is currently disused.

The final voids of the proposed in-pit facilities have the following characteristics:

Table 5-12: Key characteristics of proposed in-pit WFSF voids

Pit	Mining Status		Pit Crest (mRL)		Pit Floor (mRL)	Void Volume (Mm^3)
	Start	Finish	Max	Min		
Lens A	2019	2025	606	582	410	57.9
Pit 8	2014	2025	655	619	460	28.5
Pit 5	<1997	<2002	631	623	580	2.3

Pit scale geology models have been developed for each of the mine voids. Neither Lens A nor Pit 5 are predicted to have PAF material exposures in the final walls. Pit 8 has black McRae Shale (both SR2 and SR3) material exposed in the pit wall, the highest point of which is approximately 570 mRL. The final tailings deposition level is anticipated to be between 600 – 610 mRL which, after settlement, will fully cover the PAF material exposures shown in Figure 5-13 (KCB 2021).

Simplified modelling of sulfate and nitrate concentrations from surface runoff over Pit 8 lithologies has been undertaken to broadly assess the potential for water quality impacts. The modelling indicated that elevated concentrations may occur during early operation (where pit wall exposure is greatest) but these concentrations will reduce as filling of Pit 8 occurs (and the black shale is covered by low-permeability waste fines). The model indicates that the stock water quality criteria, as defined by Australian and New Zealand Environment and Conservation Council (ANZECC) (ANZECC 2000), are not predicted to be exceeded during operations. During the closure phase (modelled to 140 years after end of operation), the ‘no adverse effects level’ of sulfate is exceeded in periods of low pond volume (high evaporation). The mean concentration of sulfate is below the ‘no adverse effects level’ and the ‘potential adverse effects level’ is exceeded at 5% level of occurrence (KCB 2021).

Lens A and Pit 8 are BWT pits, however the recovered groundwater level has been predicted to not reach the mined pit floor. Therefore, the waste fines levels in these pits will be above the recovered groundwater level at closure and will act as seepage outflow until such time the phreatic surface within

the waste fines deposit equilibrates with the surrounding groundwater level. Based on testing results of supernatant water, there is a potential risk associated with seepage to both the groundwater and surface water. The degree of seepage control measures to be adopted into the design will be refined as the in-pit WFSF Project is progressed. In areas modelled to have high velocity surface water flow during flood events, the backfilled area may require rock armouring to prevent scouring of the capping material.

- The proposed Pit 8 WFSF has the potential to affect groundwater quality via seepage, however, there are no identified GDE's in the vicinity of the proposed in-pit WFSFs that could potentially be affected. A minimum of 2 m of inert material will be placed over the tailings material in Pit 8, however there is a very low annualised probability of Pit 8 overtopping due to rainfall runoff inflows and so this pit will likely remain a void at closure.
- The Lens A pit extends across a north-south ephemeral creek line that is currently diverted during operations. To prevent the possibility of overtopping and given this pit will be largely filled with tailings during operations, Lens A will be backfilled to surface, ensuring a minimum of 2m of inert material is placed over all tailings material.

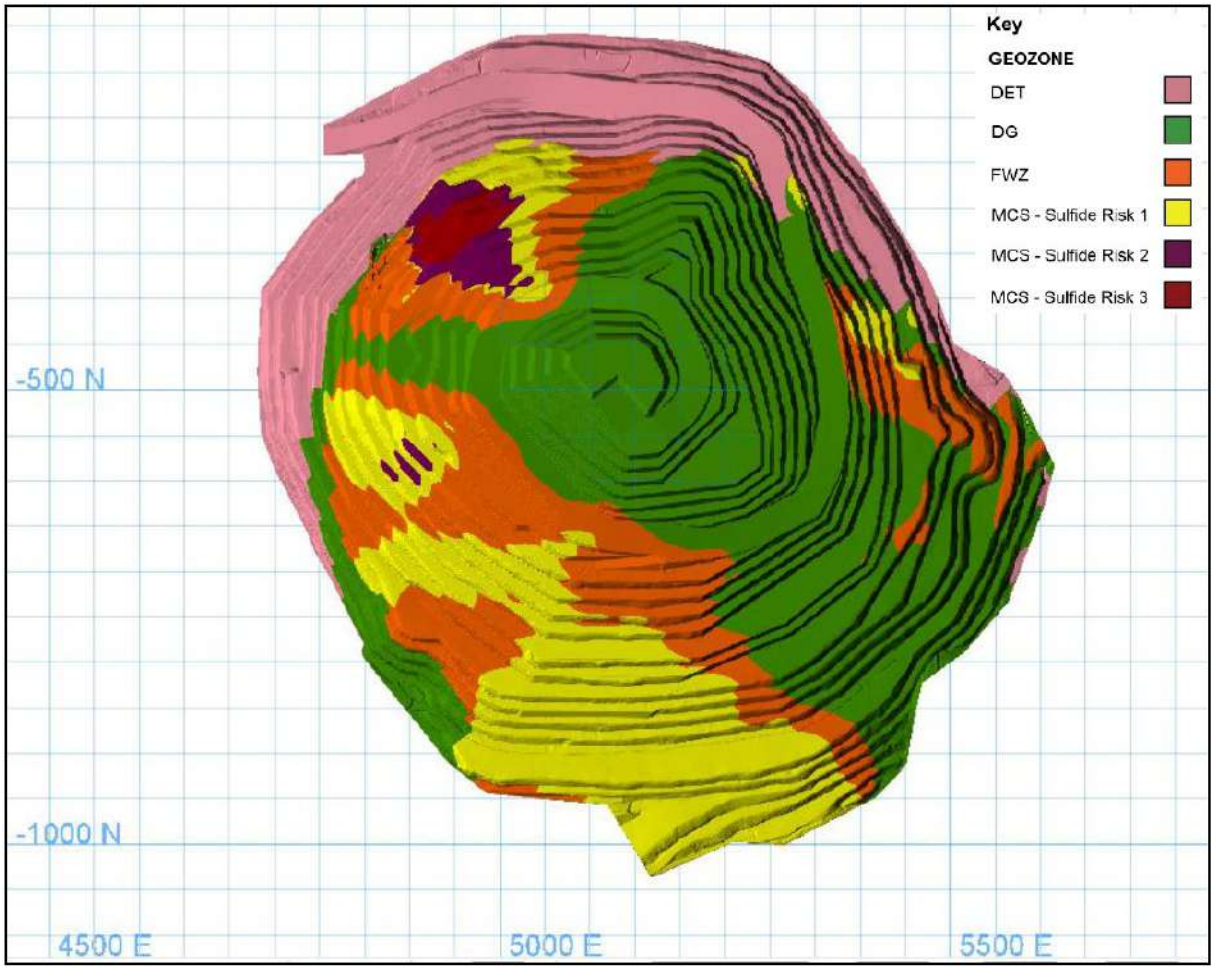


Figure 5-13: Geology unit exposures in the final Pit 8 shell including sulfide risk

5.9.5. Implications for closure and knowledge gaps

While tailings characterisation to date has shown the material to be NAF, leaching with deionized and saline water resulted in a neutral pH with concentrations of some elements higher than background groundwater concentrations. The waste fines liquor and pore water may therefore have elemental concentrations higher than background water quality and seepage from the Nammuldi WFSF may impact the quality of downstream surface/groundwater resources.

The closure designs for the both ex-pit and in-pit WFSF facilities are currently conceptual in nature and will be progressed through OoM to FS prior to implementation of the selected design, as required by the Tailings Storage Facility Closure Guideline (Rio Tinto 2021b).

Closure knowledge gaps associated with tailings characterisation and storage, as summarised in Section 5.16, Table 5-20 include:

- Potential for seepage from ex-pit WFSF at Nammuldi to impact downstream receptors such as the Alluvial aquifer beneath Duck Creek.
- Final closure designs for the WFSFs, in accordance with GISTM.
- Groundwater recovery levels at both ex-pit and in-pit WFSFs.

5.10. Hydrogeology

5.10.1. Conceptual Hydrogeology

Groundwater investigations across the Brockman Operation commenced in the 1970s, with major geological and hydrogeological drilling and testing programmes across B2N and BS4 Main deposits commencing in the 1980s. The current hydrogeological dataset includes groundwater levels, abstraction records, hydrochemical and isotope data and covers the majority of the SGE and Brockman Syncline area and has allowed for the progressive development of the hydrogeological conceptual understanding of the region.

The regional groundwater system across the Brockman Operation can be broadly separated into two hydraulically disconnected systems:

- the Brockman Syncline groundwater system (includes B2N and BS4 deposits); and
- the Caves Creek catchment groundwater system (includes Silvergrass deposit).

Brockman Syncline hydrogeological setting

The conceptual hydrogeological model of the Brockman Syncline region comprises of the following hydrostratigraphic features (Rio Tinto 2022a), Figure 5-14 provides a simplified hydrogeological conceptual section of the Brockman Syncline groundwater system, including boundary formations and key hydraulic features.

- Saturated Alluvials / Detrital:

  Where saturated, Tertiary detrital sediments, may be permeable and host groundwater, with the heterogeneity of these sediments (i.e. pisolites and clays) reflected in variable aquifer properties. Saturated Tertiary sediments may be in hydraulic connection with karstic Wittenoom Formation and mineralised MMIF and create a conduit for groundwater to pass across any basement hydraulic barriers.

- Orebody Aquifers
  - Saturated mineralised zones of basement rock Brockman Iron Formation and MMIF (host orebodies), where the mineralisation process has increased permeability and porosity. Of note is that the MMIF orebodies are often in connection with the Wittenoom Formation and Tertiary detrital aquifers.
  - The orebody aquifers are flanked by low permeability unmineralised banded iron formation of their respective host units; local permeability may be increased where fracturing and faulting occurs.

- Wittenoom, Mount McRae Shale and Mt Silvia Formations
  - Relatively low permeability shales of the Mount McRae Shale and Mount Sylvia Formation acting as an aquitard between the Brockman Iron Formation orebody aquifer and the regional Wittenoom Formation aquifer. However, hydraulic connection between these units is observed where faulting has caused occurred, in particular at BS4.
  - Karstic dolomite of the Wittenoom Formation presents as a regional aquifer system, with development of secondary permeability through dissolution of dolomite within the Paraburdoo Member. Note that primary permeability of units within the Wittenoom Formation (i.e. shale of the Bee Gorge Member, crystalline dolomite of the Paraburdoo Member) is generally low.

- Groundwater hydraulic barriers

  Hydraulic barriers have been identified throughout the Brockman Syncline aquifers, based on changes in groundwater elevations, anomalously steep gradients or response in

monitoring bores to abstraction. The key hydraulic barriers include very low permeability dolerite dykes, which intersect the syncline perpendicular to strike and effectively compartmentalises the aquifers. Additionally, differential groundwater levels have been observed across a major Dolerite Sill that has been observed wrapping around the syncline along strike of the Joffre Member of Brockman Iron Formation. This sill forms a major hydraulic boundary on the inside of the syncline. However, there are a number of locations identified where the sill has been eroded below groundwater level (and infilled with detrital sediments), which will allow hydraulic connection with the formations overlying the Brockman Iron Formation (Figure 5-15).

- Aquifer boundary formations

  Fortescue Group (Jeerinah Formation) underlying the un-mineralised, low permeable MacLeod and Nammuldi Members of the MMIF, is hydraulically disconnected from the above hydrostratigraphy. The prevalence of shale and dolerite within the Fortescue Group is common resulting in hydraulic separation across the Pilbara. Other aquifer boundary formations are unmineralized iron formations (MMIF and Brockman), or formations beneath the Boolgeeda Valley detritals; Weeli Wolli Formation, Wongarra Volcanics and Boolgeeda Formation.

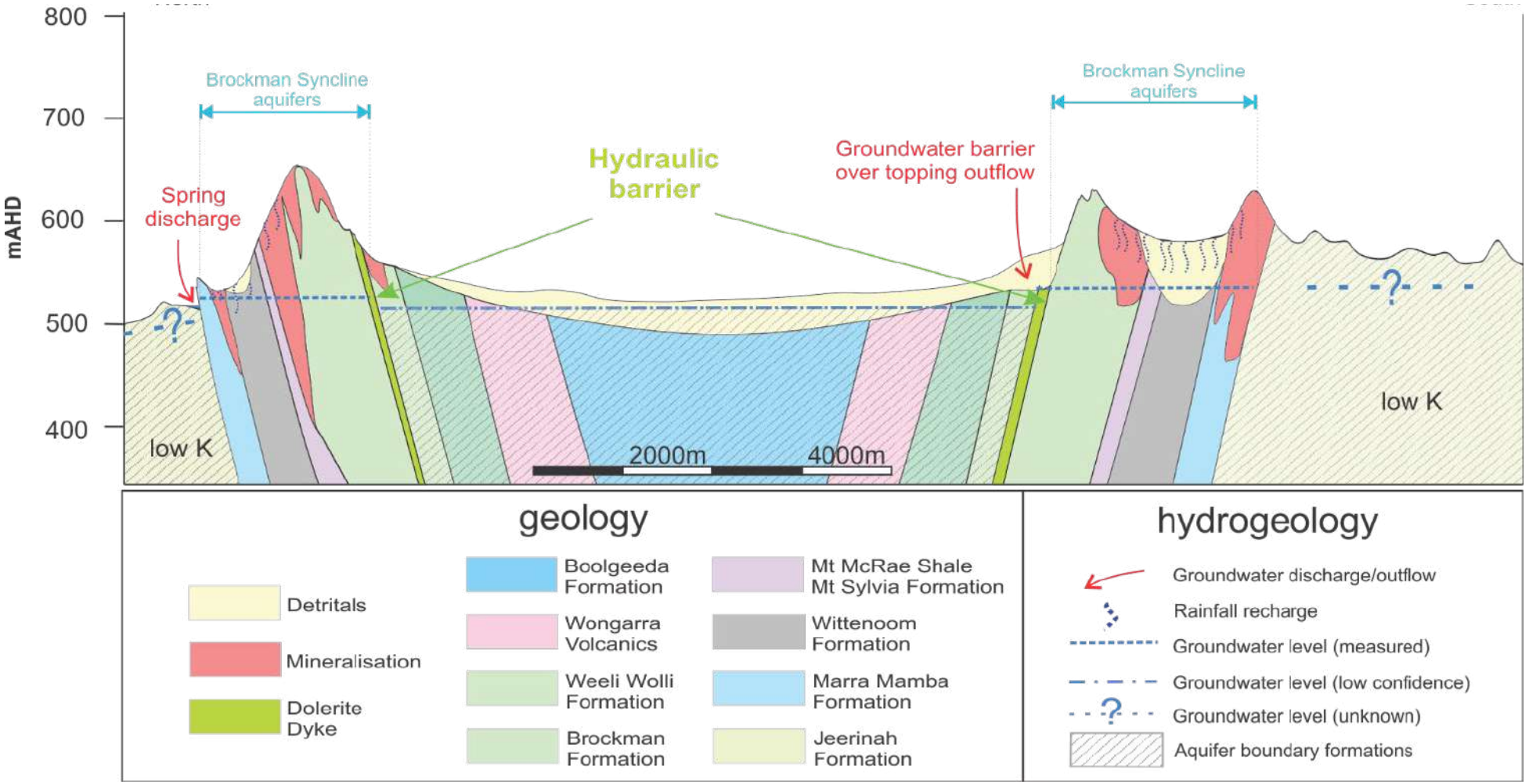


Figure 5-14: Hydrogeological conceptual section of the Brockman Syncline aquifers, boundary formations and key hydraulic features

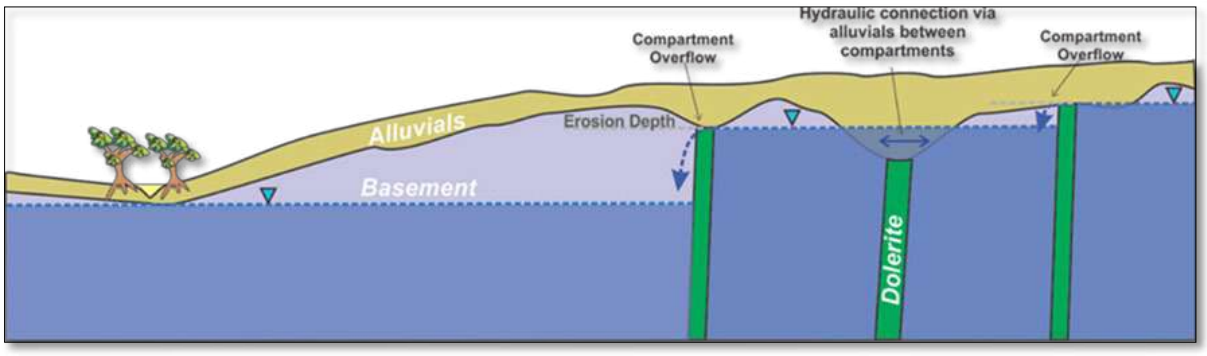


Figure 5-15: Cross section schematic illustrating how groundwater is compartmentalised by dolerite dykes

Caves Creek catchment hydrogeological setting

The SGE deposits are hosted within the MMIF located within the Caves Creek catchment (Figure 5-16). Hydrogeological investigations in the Caves Creek catchment have been undertaken since 1998 and, along with assessment of long-term monitoring data, have contributed to the development of the following conceptual hydrogeological understanding and aquifer system (IGS 2021):

- Shallow aquifers comprised of alluvium colluvium, calcrete / dolocrete, clay and upper detritus layers. Composition is variable; locally associated with the internally draining Themeda grasslands on cracking clays (Hamersley Station) TEC area and downstream towards Palm Springs.
- A deep aquifer comprised of karstic Wittenoom Formation, mineralised MMIF (primarily the Mount Newman Member) and lower Tertiary detrital sediments. This aquifer is bound by low permeability shale of the Mount Sylvia Formation / Mount McRae Shale and unmineralised banded iron formation of the MMIF.
- Aquifer compartmentalisation exists throughout the deep aquifer due to a number of observed and inferred intrusive dykes within the bedrock units only.

These aquifers are poorly connected due to the presence of relatively tight intervening clay layers. However, there are some locations where carbon isotope and bore hydrograph data suggest there are both upward hydraulic gradients between aquifers and evidence of upward flow (IGS 2021). There are also some other locations along Caves Creek where the upper and lower aquifers are connected and modern recharge to the lower aquifers occurs. The deep aquifer terminates against outcropping basement highs toward the western boundary of the catchment, resulting in discharge of groundwater at Palm Springs.

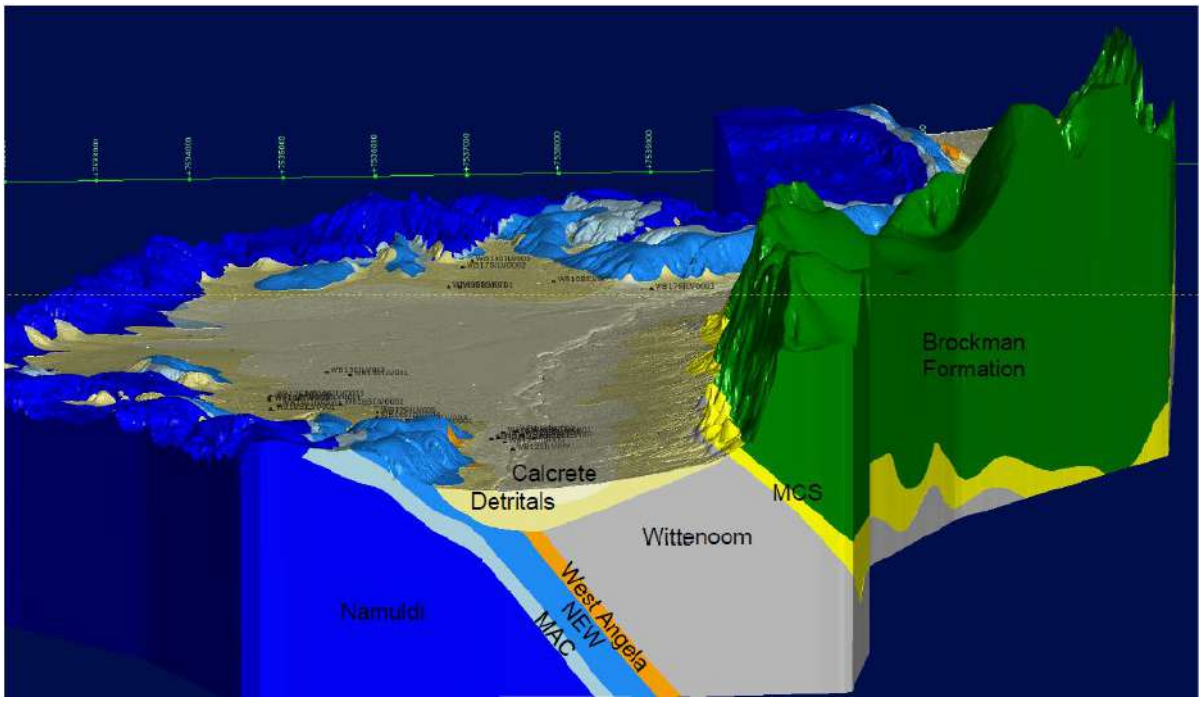


Figure 5-16: Typical hydrogeological cross section of the Caves Creek Catchment – Silvergrass (east) to Palm Springs (west)

5.10.2. Pre-abstraction groundwater levels and flows

Brockman Syncline groundwater levels and flows

The regional hydraulic gradient in the area is generally from a northeast to southwest direction. Pre-abstraction groundwater levels across the Brockman Syncline area range from 593 to 495 mRL. The highest hydraulic head at the Brockman Syncline is measured at the BS3 Extension deposits, where the groundwater level is 593 mRL. The groundwater divide at the BS3 Extension corresponds a high point in the topography, with a ground elevation of ~ 650 mRL, also corresponding to a surface water catchment divide.

From the groundwater divide towards the west, the groundwater levels decrease along the southern limb of the syncline towards the south-west with ground water levels reaching a low of 488 mRL at BS4, 28 km away. On the eastern side of the divide, groundwater level decreases to a flat 586 mRL level at Lens G, located 6 km to the north-east, then continues to decrease to the west in the direction of B2N where groundwater level is 575 mRL at Lens AB. The groundwater level keeps decreasing towards BS1 deposit where a large head step change occurs from 543 to 497 mRL within the deposit, past BS1 levels rise again to 520 mRL. Pre-mining water levels are presented in Figure 5-17. Depth to groundwater is variable due to significant topography variation, the shallowest groundwater is ~20 m below ground level (mbgl) in the BS1 western area.

Regional review of groundwater levels and general groundwater decrease from the groundwater divide suggests a continual hydraulic gradient. However, more detailed assessment of groundwater levels suggest that groundwater is compartmentalised, exhibiting very flat groundwater levels with sudden step changes (up to 50 m) over short distances. The compartmentalisation is a result of numerous NW-SE trending dolerite dykes that crosscut the Hamersley Group hydrostratigraphy (excluding detrital layers). Local dykes crosscut single limbs of the syncline (north or south), where larger regional dykes are observed running across the Boolgeeda Valley, transecting both limbs of the syncline.

There is generally no observed change in groundwater level within each compartment perpendicular to strike within the Hamersley Group formations. If saturated alluvials are present above the bedrock formations, then hydraulic connection through these Tertiary sediments is created between compartments.

Caves Creek catchment groundwater levels and flows

Groundwater levels within the deep aquifer of the Caves Creek catchment range from 552 mRL adjacent to SGE to 498 mRL adjacent to Palm Springs, resulting in a regional westerly pre-mining groundwater flow direction (i.e. following topography). The shallow aquifer groundwater elevation follows a similar trend, with a depth to water, depending on topography and proximity to channel, ranging from 2 to 15 mbgl (2 to 6m within the creek line). Pre-abstraction groundwater levels of the Caves Creek catchment setting are provided in Section 5.10.2.

Different groundwater elevations have been observed through the catchment for adjacent bores installed within the shallow and deep aquifer:

- At SGE, closest to Caves Creek, pre-mining groundwater elevation in the shallow aquifer was ~551.5mRL, compared to ~548.5mRL in the deep aquifer (separated by Tertiary clay), with response to aquifer testing observed in deep bores however not in shallow bores.
- Adjacent to Palm Springs, groundwater elevation within the shallow calcrete is ~496.5mRL, compared to ~498mRL within the deep aquifer. This suggests ~1.5m head different between the shallow and deep, confined aquifer, with a ~6m clay layer separating the two units identified in drill logs. Note that the water level in Palm Springs is commonly 493.5-494mRL, suggesting upward groundwater gradients in the vicinity.

RioTinto

Figure 5-17
Brockman Operation
Pre-abstraction Groundwater Levels of the Brockman Syncline Groundwater System

Drawn: L.Fuentes
Plan: PDE0175861v2
Date: August 2022
Proj: GDA 1994 MGA Zone 50
Scale: 1:150,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Approved Pit
- Proposed Pit

Hydrogeology

- Hydraulic Gradient Direction
- Pre-mining Groundwater Level (mRL)
- GroundwaterDivide
- Hydraulic Barriers
- Hydraulic Barriers Potential
- Major Creek
- Aquifer

- Airport
- Rio Tinto Mine
- Rio Tinto Railway
- Conveyor
- Major Road



N

0 2 4 6 8

Kilometres

Map units in metres

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RioTinto

Figure 5-18
Brockman Operation
Pre-abstraction Groundwater Levels of the Deep Aquifer in the Caves Creek Catchment Area

Drawn: L.Fuentes
Plan: PDE0175861v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:150,000 @A3
GIS.Team@riotinto.com

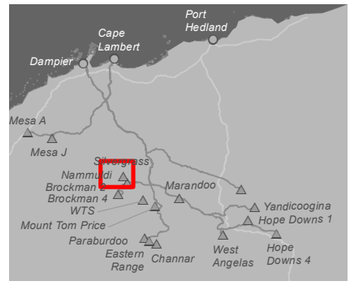
Legend

- Closure Boundary
- Palm Spring Pool System
- Approved Pit
- Proposed Pit

Hydrogeology

- Hydraulic Gradient Direction
- Pre-mining groundwater Level (mRL)
- Hydraulic Barriers
- Hydraulic Barriers Potential
- Major Creek
- Aquifer

- Rio Tinto Mine
- Rio Tinto Railway
- Conveyor
- Major Road



N

0 2 4 6 8

Kilometres

Map units in metres

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5.10.3. Recharge and Discharge

Brockman Syncline recharge and discharge

There is no evidence of groundwater throughflow into the Brockman Syncline aquifer system from the boundary formations, therefore recharge can be assumed to be only due to rainfall. Overland flow around the syncline is minimal and the depth to water is generally >25m, so recharge will predominantly occur diffusely from local rainfall within each compartment's catchment.

Each groundwater compartment (i.e. between cross cutting dolerite dykes that act as barriers) is an isolated aquifer system, within its own recharge and discharge mechanisms. The only hydraulic connection between the aquifer compartments is a result of groundwater overtopping of the hydraulic boundary (Figure 5-15). Groundwater levels in each compartment are reflective of the overtopping elevation, therefore the recharge into the downgradient compartment will equal the volume that overtops from the upgradient compartment. In some locations dykes do not appear to act as barriers, possibly due to faulting or fracturing creating hydraulic connection.

Although the Brockman Syncline aquifers are primarily a closed system, groundwater discharge from the Brockman Syncline aquifer systems does occur in several locations:

- Overtopping of the dolerite sill at BS1, with a groundwater flow direction into the Boolgeeda Valley.
- Groundwater levels near ground surface prior to BS1, where surface drainage cross cuts the syncline, may have outflows into Boolgeeda Valley at this point.
- Groundwater levels diverge at BS4, suggesting groundwater outflow occurs here, it is likely that groundwater discharge occurs into a south trending palaeovalley.
- Groundwater level intersects a topographic low on the southern limb of the Brockman Syncline, allowing groundwater to discharge into the persistent water feature, Plunge Pool.

Caves Creek catchment recharge and discharge

There are two types of rainfall recharge to the Caves Creek groundwater system:

- Diffuse recharge, including recharge to areas of outcropping Wittenoom Formation and Marra Mamba Formation (Mount Newman and MacLeod Members) around the margins of the valley.
- Enhanced recharge infiltration along Caves Creek.

Groundwater level response to rainfall is more notable in the shallow aquifer within the creek line, decreasing moving away from the creek and into deeper lithologies. Hydrograph analyses and carbon isotope data suggest that there are locations along Caves Creek where an upward hydraulic gradient between the deeper Wittenoom / Marra Mamba Formations and the Detrital aquifers exist (IGS 2021). These areas of upward head gradients may also represent areas of potential periodic groundwater baseflow to Caves Creek at some locations. Conceptually, it is understood that the deep aquifer becomes impeded by low permeability MMIF, causing groundwater to express and discharge at surface to form the persistent water feature Palm Springs.

5.10.4. Groundwater chemistry

Brockman Syncline groundwater chemistry

Groundwater sampling for laboratory chemical analysis has been undertaken since the 1990's across the Brockman Syncline, with most of the data collected for the BS4 and B2N mining operations. Groundwater has been sampled from dewatering or supply water bores located within BS1, B2N and BS4 across all hydrostratigraphic units present within the Brockman Syncline.

Groundwater quality in the Brockman Syncline (Table 5-13) is typically fresh with electrical conductivities typically varying between ~500 and ~1,500 µS/cm with samples recorded up to 3,730 µS/cm and pH

values ranging from between 7.2 and 8.4 with a mean of 7.9 (Rio Tinto 2022a). Groundwater quality is generally within ANZECC & ARMCANZ (2000) guidelines for aquatic ecosystems.

Groundwater was also sampled during drilling of monitoring bores, the range in major ions was broader, in particular chloride ranged from 6 to 3,320 mg/L, with a regional average of 189 mg/L. Spatially, chloride concentration is highly variable, with changes in concentration of ~300 mg/L recorded over several hundred meters.

Table 5-13: Summary of physical chemistry and major ion concentrations across Brockman Syncline aquifer

Groundwater sampling Brockman Syncline Aquifer											
Pumping water bores											
Statistic	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Fe mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	pH	EC uS/cm	TDS mg/L
Mean	108	14	74	59	0.1	261	162	189	7.9	1,285	815
Minimum	36	3	24	23	0.0	63	2.0	69	7.2	553	314
Maximum	208	71	383	223	1.9	521	1630	592	8.4	3,730	3,420
Monitoring bores											
Statistic	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	-	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	-	-	-
Mean	95	15	61	52	-	230	111	186	-	-	-
Minimum	6	1	3	2	-	5	1	6	-	-	-
Maximum	1,110	939	560	365	-	610	2,600	3,320	-	-	-

Caves Creek groundwater chemistry

Groundwater in the Caves Creek catchment is generally similar to the Brockman Syncline, with salinity (EC) in bores ranging between 579 to 3300 µS/cm and pH between 6.5 to 9.3 with a mean of 7.9. The alkalinity results from the presence of carbonates in the detritals and Wittenoom Formation.

Chloride concentration in all groundwater sampled ranged from 96 to 610 mg/L and there is a general trend of increasing chloride concentration down gradient within Caves Creek, this trend is more evident within the deeper hydrostratigraphic units increasing from ~ 140 mg/L (at SGE) to ~ 300 mg/L downgradient. Temporal variation in chloride concentration is also observed in the shallow aquifer due to evapotranspiration processes. Water quality sampling results from monitoring undertaken along Caves Creek at Silvergrass and Homestead between 2009-2022 are presented in Table 5-14.

Table 5-14: Summary of physical chemistry and major ion concentrations of the Caves Creek aquifers 2009-2022

Groundwater sampling Caves Creek Aquifer											
Pumping water bores											
Statistic	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Fe mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	pH	EC uS/cm	TDS mg/L
Mean	124	8	59	53	0.2	351	100	176	8.1	1,212	771
Minimum	66.0	4.8	6.3	27.0	0.0	140	2	93.0	7.3	640	390
Maximum	160.0	13.0	79.0	65.5	5.1	470	138	236.0	9.3	1,490	8,000

Monitoring bores											
Statistic	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Fe mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	pH	EC uS/cm	TDS mg/L
Mean	152	13	65	69	0.08	426	131	238	7.7	1390	846
Minimum	56	5	3	17	0.002	190	29	96	6.5	579	361
Maximum	480	23	160	150	2.7	750	459	610	9.1	3300	5,070

Groundwater chemistry comparison

Water quality analyses shows a very similar hydrogeochemical composition between aquifers within the Brockman Syncline and Caves Creek areas. A comparison of the groundwater chemistry similarities using a Stiff-diagram of major ions between Brockman Syncline and Caves Creek aquifers is provided in Figure 5-19. Due to these similarities, there are no anticipated issues related to changes in hydrogeochemical composition of the receiving aquifer, should there be mixing of water types between the two aquifers, as proposed as part of the LOM water strategy (Appendix 17).

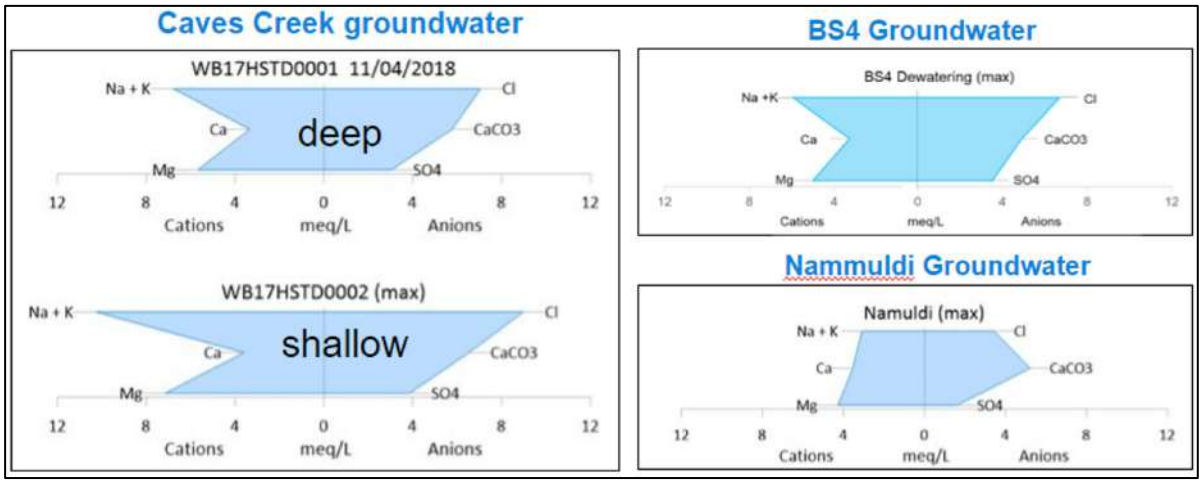


Figure 5-19: Stiff-diagrams showing groundwater chemistry similarities between Brockman Syncline and Caves Creek aquifers

5.10.5. Key Hydrogeological features

Plunge Pool

Plunge Pool is a permanent water body at the base of a small gorge in a sub-catchment of the Beasley River catchment, adjacent and down gradient to the BS3 Extension deposit. Plunge Pool has ecological importance as well as high cultural significance to the Muntulgura Guruma People. A conceptual integrated terrain model (Figure 5-20) of the relationship of Plunge Pool to both surface water and groundwater has been developed based on the monitoring to date and water balance (Rio Tinto 2022b).

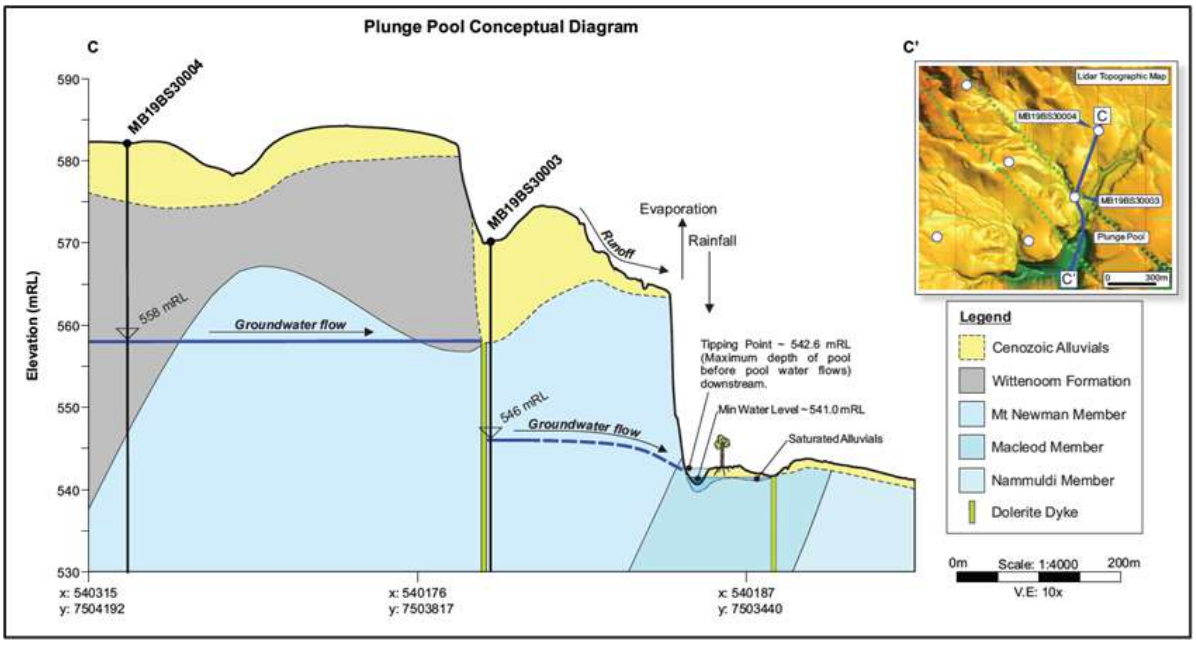


Figure 5-20: Plunge Pool conceptual cross section

The pool is groundwater dependent and topped up by surface water flow from a 21 km^2 sub catchment of the Hardey River regional catchment (Rio Tinto 2021c). It is approximately 20 m by 15 m and 2.5 m deep, as measured in a bathymetry survey undertaken in November 2016 (Rio Tinto 2021c) and surrounded by gorge walls approximately 20 m high. Water depth can reach a maximum level of 2.5 m which is the spilling point of the pool.

Hydrogeological drilling has been undertaken around Plunge Pool to understand its relationship to surrounding aquifers (Rio Tinto 2021c). The measured groundwater levels indicate the aquifers are compartmentalised in this area by the occurrence of dolerite dykes. The water levels decrease in steps from 593 mRL to 546 mRL over an approximate 5 km distance. As illustrated in Figure 5-20, there is a 12 m difference in water levels at two bores upstream of Plunge Pool.

The hydrochemistry of the pool and surrounding groundwater further supports that the pool is groundwater fed, which is topped up by runoff during rainfall events. The electrical conductivity (EC) within the pool immediately increases during high rainfall events as a result of runoff from the local catchment collecting salts prior to flowing into the pool. This peak in EC is then followed by a sudden decrease related to later runoff with a decreased salt load. Overtime, the EC signature of the pool gradually returns to an EC signature similar to adjacent groundwater until the next rainfall event takes place.

The total water storage of the pool is approximately 1,900 kL, with 700 kL assumed to be permanent water sustained by groundwater inflow and 1,200 kL active storage replenished and depleted by rainfall, catchment inflows and evaporation. The pool therefore requires a flow event of 1,900 kL or greater to completely replace the storage.

A high-level hydrological desktop assessment estimates that on average Plunge Pool would receive sufficient runoff volume to fill the pool seven times per annum under undeveloped conditions (Rio Tinto 2021c). At closure, it is anticipated that the contributing catchment to Plunge Pool would reduce by 66% to 7 km^2. With the reduced catchment area, it is estimated that Plunge Pool would fill and spill on average four times per year.

Palm Springs

Palm Springs are permanent groundwater dependent pools within the Caves Creek hydrogeological setting, east and downstream of the SGE deposits. Investigations have been undertaken since 2009 to characterise the mode of occurrence of Palm Springs, including bathymetry and water level

measurements (including of adjacent shallow and deep monitoring bores), groundwater chemistry sampling (including for isotopes and other hydrochemical tracers) and regional geological mapping.

Groundwater levels in the aquifer are sufficiently above the bed level at Palm Springs that discharges occur from the groundwater to sustain permanent pools in Palm Springs. It is evident that groundwater is the primary driver in the system at Palm Springs and that surface water events are sporadic, typically occurring between one to three times per wet season. This would imply that the current vegetation at Palm Springs is being sustained by groundwater.

As discussed in Section 5.10.3, it is understood that groundwater flow from the Caves Creek deep aquifer becomes impeded by low permeability MMIF, causing groundwater to express and discharge at surface (Figure 5-21). Current information suggests that the Palm Springs pools are surrounded by calcrete / dolocrete deposits, which exist in the subsurface throughout the length of Caves Creek. The dolocrete forms where carbonate rich groundwater has previously expressed at surface (Rio Tinto 2019c).

Comparison of water levels between the pools and monitoring bores installed nearby in the shallow and deep aquifer suggest an upward gradient between the deep aquifer, shallow aquifer, and the pools, with a clay layer identified during drilling separating the deep and shallow aquifers. Structural controls may also contribute to pools development. It is likely that there are other sources (shallow aquifer, surface runoff) that contribute to the pools' water balance. Surface water expression from the pools continues downstream, through a series of permanent and semi-permanent water features which support riparian vegetation (IGS 2021).

The main pool at Palm Springs is located within an extensive expanse of calcrete / dolocrete. Bathymetry surveys at the main pool at Palm Springs suggests a maximum depth of ~4.5m, with volume estimated to be between 2,300 m^2/d and 3,100 m^2/d (Rio Tinto 2019c).

The minimum recorded water level of Palm Springs recorded was 493.5 mRL (February 2017), whilst the maximum water level (outside of peak rainfall and flood events) was 493.9 mRL (October 2013). During flood events the maximum water level of Palm Springs recorded was 496 mRL (January 2013), coinciding with Tropical Cyclone Peta (Rio Tinto 2019c).

Due to the assumed connectivity of the shallow and deep aquifer at Caves Creek (Figure 5-21), groundwater abstraction at SGE has the potential to impact both Caves Creek and the downstream Palm Springs. The proposed Caves Creek MAR scheme may be required to continue into closure to mitigate impacts as the groundwater levels rebound to pre-mining levels (Section 5.10.8). Implementation of any MAR schemes during operations or closure will be dependent on the MAR trial evaluation to determine design effectiveness for drawdown mitigation and management with ongoing consultation with regulatory agencies and the Muntulgura Guruma People.

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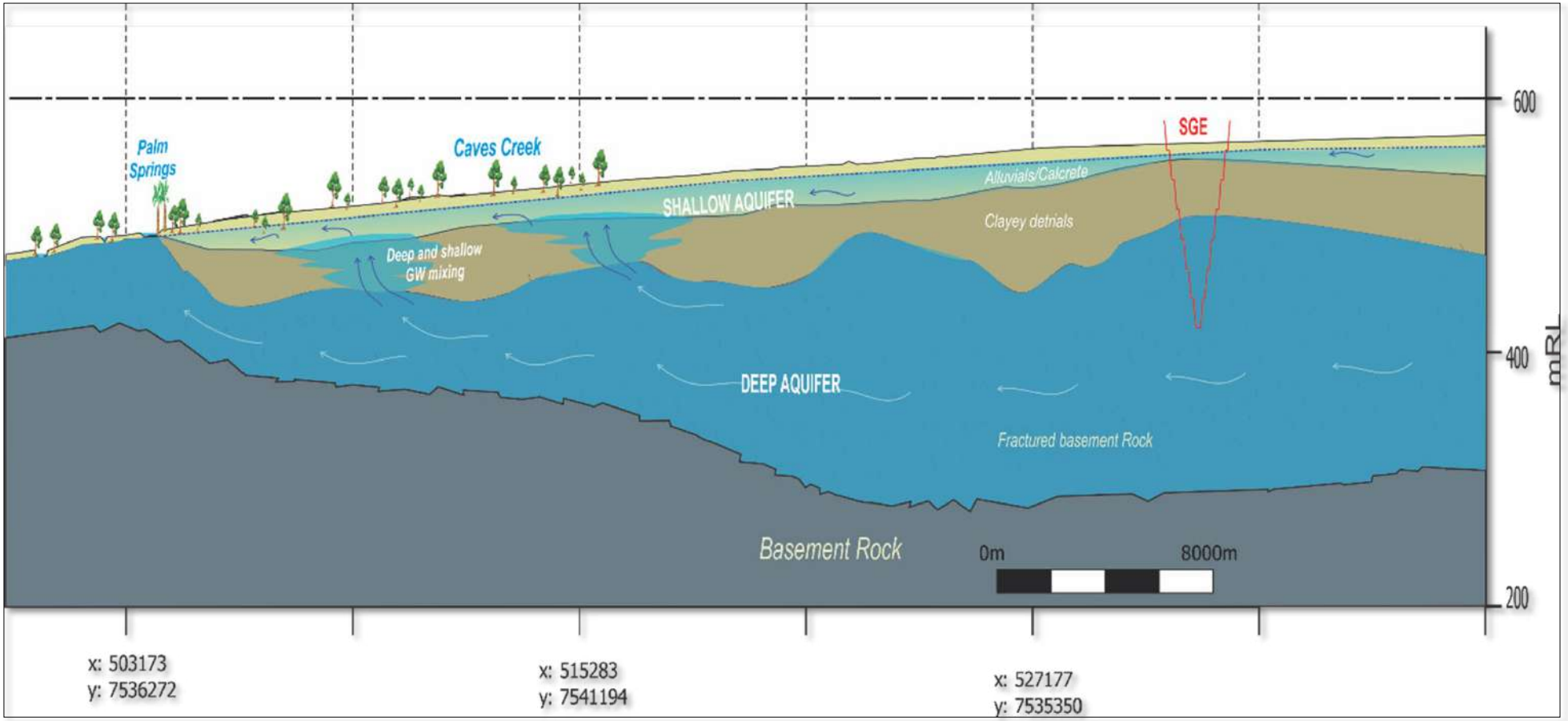


Figure 5-21: Conceptual Caves Creek catchment aquifer interactions – Silvergrass (east) to Palm Springs (west)

5.10.6. Groundwater dependent ecosystems

Hydrogeological features and shallow aquifers support various groundwater dependent ecosystems (GDE) such as aquatic fauna, subterranean fauna, and vegetation. Other groundwater dependent ecosystems are also associated with riparian environments along creeks and river channels and are discussed in subsequent sections of this MCP. GDE's are typically associated with shallow alluvial aquifers particularly along Caves Creek, Boolgeeda Creek and Duck Creek. Groundwater supports semi-permanent pools and other GDEs along Caves Creek and Duck Creek and are sources of respite for fauna in the area, in dry no-flow conditions.

The depth to groundwater within the closure boundary is generally well beyond the rooting depth of vegetation (approximately 20 mbgl), limiting the potential for groundwater dependence to low-lying areas. A GDE assessment was conducted to identify areas of vegetation that are potentially groundwater dependent (Biologic 2021a) within an area of interest developed for the GDE study where aquifers may be connected or are close to those being dewatered. This area was deliberately larger than the closure boundary so that any changes to the BSP and groundwater model would not result in gaps in the GDE study.

The likely groundwater dependence of the 54 potential GDE features was assessed and refined:

- Initially using regional hydrogeological information
- Refined using biological survey data and ground truthing at ten sites
- Further refined using project hydrogeological data and pre-mining groundwater levels
- Aerial photo interpretation.

Generally, groundwater levels deeper than 15 m were considered too deep for vegetation to access and were excluded as potential GDE; except where *Eucalyptus camaldulensis* was identified from aerial imagery as this species can sometimes access groundwater beyond 20 m (Biologic 2021a).

The process identified 28 features in the broad hydrological development zone with some potential for groundwater dependence:

- two features were of potential 'high' dependence;
- nine features were of 'moderate' dependence although some features rely on perched groundwater or other water sources; and
- seventeen features were of 'low' dependence and are not discussed further.

The 11 GDE features of moderate to high potential groundwater dependence are described further in Appendix 7.

Other potential GDE identified from the Bureau of Meteorology (BOM) GDE Atlas database, are not well understood for how likely they are groundwater dependent. These potential GDEs have been indicated on Figure 5-22 and Figure 5-23 in the modelling section below.

Those ecosystems that are dependent on aquifers immediately within BWT pit footprint, will be impacted by BWT mining activities as orebody aquifer depletion will reduce habitat availability due to dewatering. Level of impacts will vary depending on abundance and distribution of species populations, remaining aquifer storage and hydraulic connectivity between habitats and other hydrological interactions. Groundwater management strategies to maintain subterranean habitat in immediate BWT mining areas has not been proposed at closure. Drawdown propagation beyond BWT pit areas has the potential to impact surrounding GDEs, particularly along creek lines in hydraulic connection to orebody aquifers, such as Caves Creek (refer to Section 5.10.8).

Further details of groundwater dependent flora and vegetation and subterranean fauna can be found in Sections 5.14 to Section 5.15 and Appendix 7.

5.10.7. Groundwater modelling

Brockman Syncline drawdown and recovery modelling

Groundwater modelling has been developed from the increasing knowledge of the hydrogeological conceptualisation through monitoring and hydrogeological investigations across the Brockman Syncline. Groundwater modelling has been completed for the Brockman Syncline groundwater system to assess the extent of groundwater drawdown during operations, as well as the potential cumulative impacts due to other groundwater users such as neighbouring FMG and post-closure recovery (RPS 2021).

The model shows that as mining progresses, the dewatering of open cut pits (including the adjacent FMG operations) will result in a cone of depression and cause groundwater to flow towards the pits. Due to the variation in timing of completion of mining within the various pits across the Brockman Syncline, the drawdown in the location of several of the shallower pits continues to develop below the pit floor over time as the cone of depression induced from the larger, deeper pits continues to propagate. Drawdown is restricted from developing to a regional extent as a result of low permeability barriers in the form of dykes and aquitard units, as well as internal low permeability units. Figure 5-22 outlines the groundwater drawdown expected at the end of mining operations (approximately 2050).

Groundwater recovery levels were modelled (RPS 2021) for 300 years post-mining (approximately 2350) (Figure 5-23). The recovered groundwater levels of all BWT pits are not expected to recover to pre-mining groundwater levels over this modelled timeframe due to the very low rate of recharge within the Brockman Syncline. This low rate of recharge is a result of the low rainfall and lack of through-flow from neighbouring aquifers (due to compartmentalised nature of the Brockman Syncline) and means that the time taken for backfilled pits to reach post-mining groundwater equilibrium levels is expected to be intergenerational (several hundreds of years).

Post-closure recovery was simulated (RPS 2021) using the proposed pit closure strategies developed for the Brockman Operation. The groundwater model therefore assumes all but 11 of the BWT pits (Table 2-1) will be backfilled to prevent a permanent pit lake:

- BS4MM Q, O1, O2 and O3 pits;
- BS4MN N1, N2 and M2 pits; and
- Nammuldi Lens B, Lens CD, Lens EF and Lens G pits.

Seven of these 11 BWT pits are expected to form pit lakes, see Table 5-15. Given the low level of predicted lake recovery and excess evaporation, it is likely that the pit lake voids will continue acting as groundwater sinks (RPS 2021), resulting in a hydraulic gradient toward these pits. These pit lakes are discussed further within this Section of the MCP.

BWT pit voids that are backfilled to above the recovered groundwater table will remain as dry voids with potential for ephemeral ponding. Groundwater in the vicinity of these pits will recover faster due to limited evaporation.

The predicted drawdown at several GDE's that occur within the Brockman Syncline have also been modelled, the primary GDE of concern is Plunge Pool within the Brockman Syncline aquifer. Several other potential GDE's identified from the BOM Atlas database are indicated on the drawdown Figure 5-22 and Figure 5-23, one of which is located south of the Maybelline Deposit and east of BS2, though groundwater dependence is not well understood at these locations.

The dykes that compartmentalise Plunge Pool are thought to be impermeable, and drawdown is not expected at Plunge Pool. However, in order to run the numerical groundwater model a permeability must be assigned, therefore the groundwater modelling simulated dyke permeability of $1x10^{-7}$ m/day to consider potential drawdown impacts from lowered groundwater levels in upgradient compartments to consider appropriate groundwater management options (Section 5.10.8). The modelled drawdown, with low permeability dykes at Plunge Pool, was predicted to be 0.1m by the end of 2050 and long-term simulated drawdown by 2350 to be 0.8m in Plunge Pool compartment (RPS, 2021). The presence of

water at Plunge pool is not expected to be impacted given the dyke permeability and depth of Plunge Pool (2.5m). However, it remains possible that Dyke permeabilities could vary in time and be affected by fracturing, weathering and other geological complexities that cannot be quantified by field testing. Uncertainty analysis was completed to assess potential drawdown for other dyke permeability ranges and finds the degree of drawdown is dependent on the degree of permeability.

For other potential GDE's identified in the BOM GDE Atlas database, the recent modelling (RPS 2021) suggests that longer term (i.e. by 2350) propagation of the cone of depression away from the mining areas if pits remain as open voids; results in a 10-20m lowering of the groundwater table in the vicinity of the potential GDE located south of the Maybelline Deposit, however the mode of occurrence is believed to supported by a perched aquifer 50m above regional groundwater level.

Caves Creek catchment drawdown modelling

Groundwater modelling was initially developed in 2015 to support assessment of SGE below water table mining and since then several revisions of the groundwater model has occurred as hydrogeological understanding has improved based on operational monitoring. The latest iteration of the Caves Creek groundwater modelling was updated in 2020 for the 2021 SGE LOM plan to predict drawdown in the aquifer underlying Caves Creek towards Palm Springs in the west that are associated with dewatering at SGE (Appendix 17).

The preliminary groundwater modelling results indicate:

- An average recharge rate of around 10 ML/d through MAR is needed in the Homestead area from 2023 to 2050 in order to prevent current drawdown impacts propagating further down Caves Creek and likely impacting Palm Springs.
- To avoid impact to Palm Spring post-closure, modelling indicates an estimated 230GL is required to return groundwater levels in the mining area to the pre-mining baseline condition, which under natural recharge processes will take over 150 years to achieve.
- To mitigate drawdown propagating towards Palm Springs and along Caves Creek beyond operations, and to reduce the natural water level recovery timeframe, MAR will be required to continue into closure.

A MAR trial has commenced in July 2022 to determine an appropriate design for an operational MAR scheme that will successfully mitigate groundwater drawdown propagation impacts from occurring to Palm Springs. The MAR trial and subsequent evaluation will determine future work required for an operational and closure MAR scheme.

The proposed MAR scheme will aim to reduce the natural water level recovery timing and accelerate rates of recovery to achieve pre-mining conditions in the Caves Creek Aquifer system sooner than the natural rate predicted of >150 years post-mining. The accelerated recovery will depend on the scale of the scheme and aquifer injection strategy applied, depending on deep and/or shallow aquifer response and analysis.

The LOM water balance, including source and volume of water required to maintain the SGE MAR at closure will be refined based on outcomes of the MAR trial investigations and availability of surplus water through the implementation of the proposed water management strategy discussed in Section 2.5.4. The water source for injection into the Caves Creek aquifer system during closure is proposed to be from surplus water stored during operations in disused pits and/or ASR, and, if required, other water sources that are compatible with the Caves Creek cultural and environmental values.

The volume of operational surplus water stored during the Brockman Operation is subject to disused pit availability and other water storage suitability criteria such as geochemical characteristics and will be developed and progressively refined as operational storage strategies are defined and implemented. As discussed in Section 5.10.4, the groundwater chemistry of the Caves Creek and Brockman Syncline aquifers are similar, and no issues related to changes in the hydrogeochemical composition of the Caves Creek aquifer are anticipated from transfer of surplus water stored from the Brockman Syncline aquifer.

The forecast water balance of the caves creek aquifer system indicates that an alternative water source may be required to maintain the SGE MAR until closure outcomes are met. Rio Tinto will identify potential alternative water sources and undertake Traditional Owner consultation to ensure the water source is culturally appropriate prior to seeking the appropriate regulatory approvals if additional water sources are required.

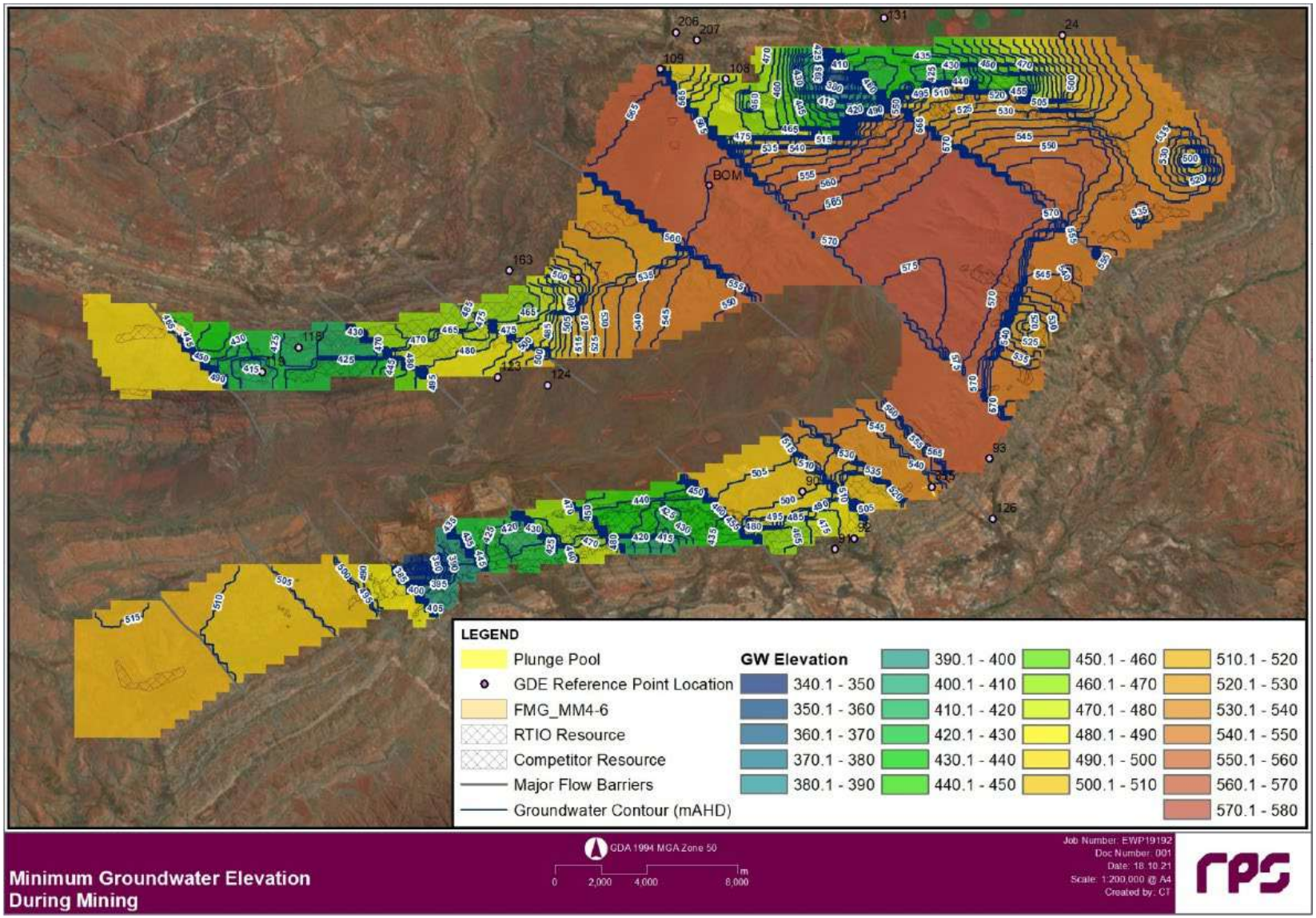


Figure 5-22: Minimum predicted groundwater level during mining (to 2050) (includes assumed FMG dewatering)

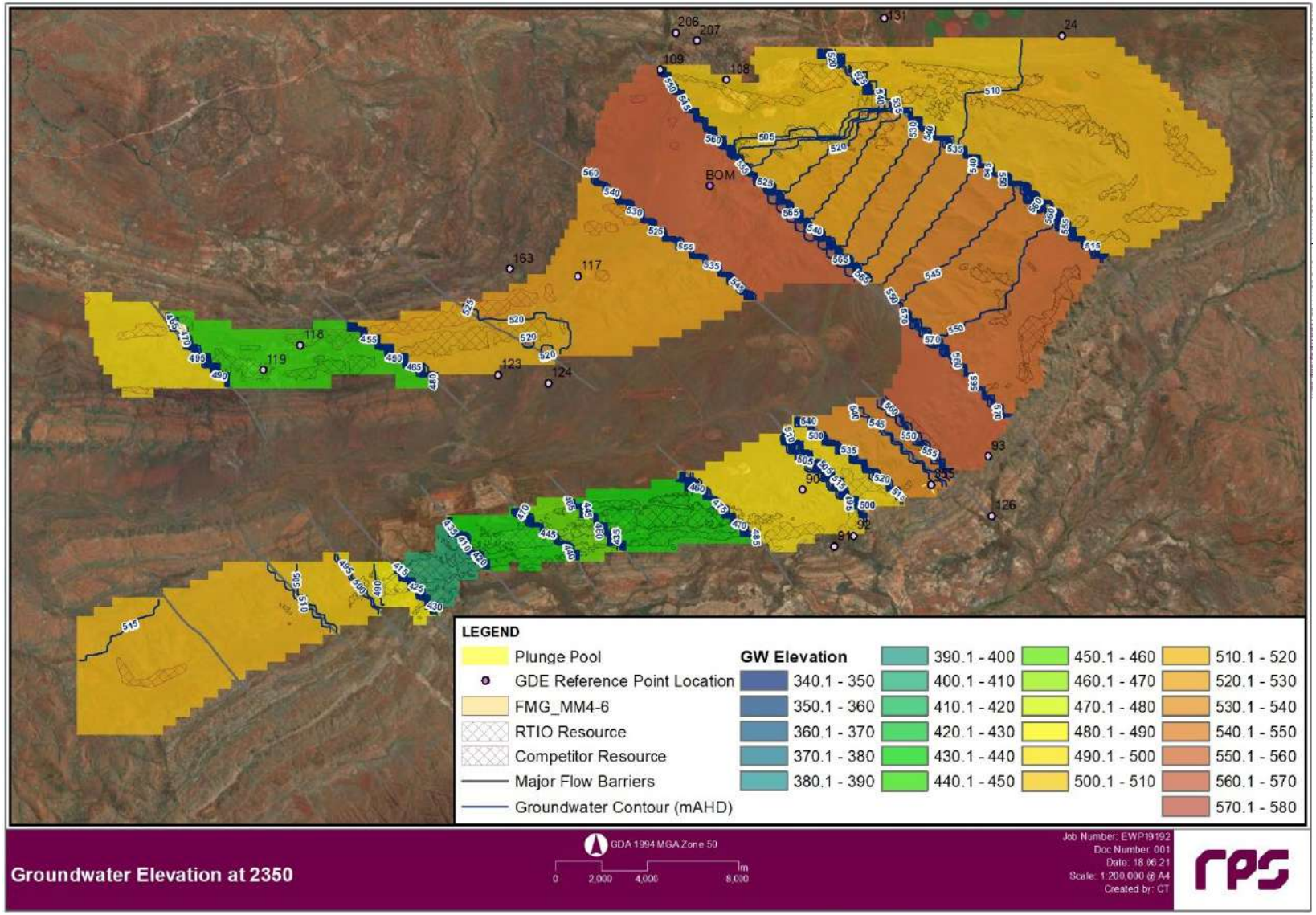


Figure 5-23: Recovered groundwater level at 2350 – 300 years post mining (includes assumed FMG dewatering)

Brockman Syncline aquifer pit lake modelling

The post-closure groundwater recovery levels modelled using the above BWT pit closure strategy was limited to groundwater inflow rates. The groundwater levels shown in Figure 5-23 are representative of the groundwater recovery levels within the pit footprint post-mining, however, does not provide an accurate equilibrium water levels for modelled pit lakes (RPS 2021).

To predict the likely equilibrium pit lake levels in voids within which groundwater is predicted to return above the pit floor, an additional water balance assessment was completed that included other expected water inflows and outflows to the pit lake system (Appendix 18). Pit lake evolution modelling was undertaken to determine the following:

- pit lake equilibrium depth;
- time to reach recovered equilibrium depth;
- Total Dissolved Solids (TDS) evolution over 300 years; and
- change in the above due to climate variability.

A stage/volume/area relationship was used to determine the lake stage and surface area in each pit, using a daily timestep to calculate the change in lake volume after accounting for inflows and outflows at that timestep. Daily rainfall and evaporation values were obtained from SILO data for a central location at the Brockman Syncline aquifer area over the period 1960 to 2019, with the sequence repeated to fill a time series for 300 years. Direct rainfall and evaporation to/from the lake are a function of the lake surface area at a given timestep, increasing as the lake area increases; while the rate of groundwater inflow and volume of pit wall runoff are a function of the lake stage, both decreasing as the lake stage increases.

Inflows included direct precipitation onto the lake surface, runoff from pit walls above the pit lake surface and groundwater inflow from the regional groundwater aquifers. Potential seepage from a WFSF or other water source is not included as a potential input volume, nor surface water inflow from any catchment area outside of the closure bunding (which is planned to fully encircle the pit rims), nor any interflow from groundwater that may occur after large rainfall events through shallow alluvial sediments. The only outflow considered is the evaporation from the lake surface, assuming that the pit lakes remain as a groundwater sink.

Based on a combination of the groundwater modelling and the analytical water balance method, permanent pit lakes are predicted to form in the following seven BWT pits[1]:

- BS4MM O1 pit
- BS4MN N1, N2 and M2 pits; and
- Nammuldi Lens CD, Lens EF and Lens G pits

Equilibrium levels and long-term TDS values predicted for the pit lakes are presented in Table 5-15. It is assumed all seven pit lakes will act as sinks due to the low recharge rates and due to the compartmentalised Brockman Syncline aquifer system (see Section 5.10.3). However, if significant recharge occurs through high permeability channel sediments or major surface runoff events occur (e.g. a major cyclone event) there is potential for the short-term level in pit voids to exceed that of the surrounding groundwater, whereby pits may become localised through-flow systems within the groundwater compartment.

The groundwater level is not predicted to recover to the base of the Endeavour pit 1, BS4MM Q, O2, and O3 pits nor the Nammuldi Lens B pit due to drawdown from deeper pits. Rainfall may pond for a

[1] The closure strategy for pit lakes to form within the Nammuldi Lens CD and Lens EF pits is approved under MS 925. The proposed closure strategy for pit lakes to form within the BS4MM O1, BS4MN N1, N2 and M2 and Nammuldi Lens G pits are new pit lakes within the BSP.

short duration at the base of these pits and ultimately infiltrate into the unsaturated zone below the pit or evaporate. It is unlikely that any long-term connection with groundwater will form at these pits.

Due to the elevated sulfur concentrations within rock formations that will be present in the final walls of both the Lens CD and Lens EF pits, there is the possibility that water quality of the pit lakes will be impacted by AMD. Preliminary Pit Lake Assessments have been conducted for both Lens CD and EF (Appendix 19 and Appendix 20 respectively) using the internal Acid and Metalliferous Pit Lake (AMPL) Risk Assessment tool. The outcomes of these preliminary risk assessments show a moderate overall risk for both backfill and no backfill scenarios of both pits and suggests further investigation is required to understand the risks and mitigation measures associated with a pit lake in these pits.

Due to the moderate preliminary geochemical risk assigned to the Lens CD and Lens EF pits, geochemical pit lake evolution modelling is currently being undertaken to understand the potential for poor quality pit lake water to form. Based on the results of this modelling, a Source-Pathway-Receptor (SPR) will be developed to understand the potential risk to downgradient receptors.

Table 5-15: Pit lake evolution of BWT pits where groundwater recovers above the pit floor

Pit	Approximate lake formation time (years)	Modelled equilibrium level (mRL)	Current planned pit depth (mRL)	Modelled pit lake depth (m)	TDS at 300 years post closure	NTD area
BS4						
BSMM – O1	20	428	400	28	16,940	PKKP and EG
BSMN – M2	5	484	470	14	59,765	EG
BSMN – N1	5	482	470	12	82,112	EG
BSMN – N2	20	481	460	21	29,903	EG
Nammuldi						
Lens CD	50	442	360	82	7,461	EG
Lens EF	45	492	465	27	11,062	EG
Lens G	60	503	480	23	24,279	EG

5.10.8. Groundwater management

BWT pit void management

The closure strategy for BWT pits is based on a risk-based approach to retaining pit lakes at closure which considers recovered groundwater levels, AMD risk (Section 5.8.3), flow through of the system and sensitive receptors in proximity to the pit. Backfill has been allocated for pits with moderate to high geochemical closure risk and/or through-flow are presented, where sensitive receptors have been identified, or if any combination of these factors are confirmed.

The proposed mine void closure outcomes for the Brockman Operation pits are therefore developed on a case-by-case basis and are dependent on the anticipated hydrogeological and geochemical behaviour of the pit. Extensive backfilling of pits is not practical for many of the pits due to the size of the final void, insufficient backfill material availability and high-cost implications as well as sequencing constraints related to the groundwater level often preventing progressive backfill during operations. Therefore, selective partial backfill of pits is the preferred closure strategy for those pits with potential risk of environmental impact due to down-gradient sensitive receptors or beneficial groundwater use. As hydrogeological modelling is refined, backfill levels and volume and source of material will be presented in future versions of this MCP.

Where practical, mineral waste is used to progressively backfill pits rather than create external WRLs. However, this will not be viable for all pits, particularly those which are scheduled to remain active until the end of the mine life. In some instances, opportunistic backfill will be undertaken where it makes

operational sense from a haul optimisation perspective. This may result in some pits for which backfill is not required being partially backfilled or backfilled to surface (for example B2N pit 1).

Apart from Lens CD and EF, all pits with a moderate to high closure geochemical risk are proposed to be partially backfilled to prevent a permanent pit lake forming and therefore reduce the risk of potential groundwater contamination arising from PAF exposures on final pit walls. Due to the size of the Lens CD and Lens EF pits and the preliminary assessment of the pit closure geochemical risk, further investigation and modelling of the pit lake water evolution at closure is warranted. Where PAF exposures are anticipated above the backfill level required to prevent a permanent pit lake, these exposures will be verified during mining operations and backfill heights will be reviewed if AMD risk is present.

BWT and AWT pit characteristics and proposed pit void closure outcomes are indicated in Table 5-16 to Table 5-18, including pits proposed to be partially backfilled or buttressed and where pit lakes are predicted to form. As mentioned in Section 5.10.7, pit lakes are expected to form in seven of the 88 voids at closure.

Categories of proposed pit void closure outcomes are as follows:

- open void (AWT pit or BWT mining groundwater levels not predicted to recover post mining above the final pit floor)
- partially backfilled to prevent formation of a permanent pit lake (backfilled to equilibrium recovered water level that is above the final pit floor but below the pre-mining water level)
- partially backfilled to above the pre-mining water level (to achieve compliance within MS 1000 and MS 925 to backfill for BS4 and SGE respectively to above pre-mining level irrespective of equilibrium recovered water level)
- open void - pit lake (groundwater sink, no hydraulic connection to GDEs)

Due to the compartmentalised nature of the Brockman Syncline aquifer, it is assumed there will be limited to no groundwater throughflow between compartments and all pit lakes formed will act as terminal groundwater sinks and are not expected to have a degrading effect on regional groundwater quality or an impact on any downstream receptors (environmental/cultural). Pit lake water quality evolution modelling is underway for Lens CD and EF to assess the impact of the modelled PAF material exposures anticipated to be left on the final pit wall. The results of this modelling will inform the requirement for further work such as a source-pathway-receptor model to assess potential for AMD and impacts to the downgradient environment. Monitoring will be conducted on pit lake chemical balance to ensure actual water quality aligns with the predicted water quality to confirm confidence in the long-term model projections and closure outcomes.

Table 5-16: Brockman Syncline 4 pit characteristics and proposed void closure outcome

**italics reflects completed scope*

Pit	Preliminary Closure Geochemical risk	AWT/ BWT	Pre-mining water level (mRL)	Pit crest (mRL)	Proposed pit depth (mRL)	Upper PAF material exposure (mRL)	Upper fibre exposure (mRL)	Proposed void closure outcome
BS1								
E1	Moderate	BWT	550	638	470	556	-	Open void – partial backfill to prevent a permanent pit lake Proposed buttressing to reduce catchment loss to Boolgeeda Creek
E2	Moderate	BWT	550	686	465	-	-	Open void – partial backfill to prevent a permanent pit lake
E3	Moderate	AWT	550	786	570	-	-	Open void
W1	Moderate	BWT	500	647	440	525	-	Open void – partial backfill to prevent a permanent pit lake Proposed buttressing to reduce catchment loss to Boolgeeda Creek
W2	Moderate	BWT	500	746	410	526	-	Open void – partial backfill to prevent a permanent pit lake
BS4 Main								
1	Low	AWT	490	620	490	-	510	Open void To be buttressed on eastern end to ensure PUPEZ does not encroach on Juukan Gorge Remediation Project
2	Low	BWT	490	630	330	-	-	Open void – partial backfill to above pre-mining water table
3	High	BWT	495	670	430	533	610	Open void – partial backfill to above pre-mining water table
4	Low	BWT	500	640	470	-	-	Open void – partial backfill to above pre-mining water table
5	High	BWT	488	540	410	500	-	Open void – partial backfill to above pre-mining water table
6	Low	BWT	494	570	450	452	-	Open void – partial backfill to above pre-mining water table
7	Moderate	BWT	495	600	454	500	-	Open void – partial backfill to above pre-mining water table
8	Low	AWT	495	620	540	533	-	Open void
9	Low	AWT	500	620	530	-	-	Open void
10	Low	BWT	488	580	480	-	-	Open void – partial backfill to above pre-mining water table
11	Low	BWT	502	580	425	-	-	Open void – partial backfill to above pre-mining water table
12	Low	BWT	502	550	550	-	480	Open void – partial backfill to above pre-mining water table
13	Low	AWT	500	650	610	-	-	Open void
14	Low	AWT	524	620	530	-	540	Open void

Pit	Preliminary Closure Geochemical risk	AWT/ BWT	Pre-mining water level (mRL)	Pit crest (mRL)	Proposed pit depth (mRL)	Upper PAF material exposure (mRL)	Upper fibre exposure (mRL)	Proposed void closure outcome
15	Low	BWT	524	590	520	-	-	Open void – partial backfill to above pre-mining water table
16	Low	BWT	524	590	500	-	510	Open void – partial backfill to above pre-mining water table
17	Low	BWT	525	670	434	-	490	Open void – partial backfill to above pre-mining water table
18	High	BWT	495	610	404	516	540	Open void – partial backfill to above pre-mining water table
19	Low	AWT	500	630	505	-	-	Open void
BS3								
S1	Low	AWT	550	800	560	537	-	Open void
S2	Low	AWT	550	800	560	-	-	Open void
BS4 MM								
O1	Low	BWT	500	570	400	-	555	Open void – pit lake
O2	Low	BWT	500	570	510	-	-	Open void – groundwater level not anticipated to return to above pit floor
O3	Low	BWT	495	520	510	-	-	Open void – groundwater level not anticipated to return to above pit floor
Q	Low	BWT	495	580	410	-	480	Open void – groundwater level not anticipated to return to above pit floor
R	Moderate	BWT	490	530	400	432	535	Open void – partial backfill to prevent a permanent pit lake
Endeavour								
Endeavour 1	Low	BWT	490		460	539	-	Open void – groundwater level not anticipated to return to above pit floor
Endeavour 2	Low	AWT	490		550	-	-	Open void
BS4 MN								
M1	Low	AWT	520	640	520	-	-	Open void
M2	Low	BWT	500	590	470	-	-	Open void – pit lake
N1	Low	BWT	500	560	470	-	-	Open void – pit lake
N2	Low	BWT	500	570	460	-	-	Open void – pit lake

Table 5-17: Brockman Syncline 2 Nammuldi pit characteristics and proposed void closure outcome

**italics reflects completed scope*

Pit	Preliminary Closure Geochemical risk	AWT/ BWT	Pre-mining water level (mRL)	Pit crest (mRL)	Proposed pit depth (mRL)	Upper PAF material exposure (mRL)	Upper fibre exposure (mRL)	Proposed void closure outcome
BS2 Main								
1	Low	AWT	576	660	580	-	-	Open void
2	Low	AWT	575	630	610	-	-	Open void
3	Low	AWT	577	660	580	-	-	Open void
BS2 (4/6)	Moderate	BWT	580	700	550	-	-	Open void – *Partial backfill completed to 600 mRL to prevent pit lake*
5	Low	AWT	580	623	580	-	-	Open void - Proposed contingency WFSF *Partially backfilled*
6X	Low	AWT	580	900	610	-	-	Open void
7	Low	AWT	577	920	680	-	-	Open void
BS2 West								
1a	Low	AWT	575	820	730	-	-	Open void
1d	Low	AWT	575	880	710	-	-	Open void
2b	Low	AWT	575	900	600	-	-	Open void
3a	Low	AWT	575	760	600	-	-	Open void
3b	Low	AWT	575	760	600	-	-	Open void
BS2 Extension								
8	Moderate	BWT	580	655	460	570	-	Open pit – proposed in-pit WFSF Tailings and capping level anticipated to fully cover PAF exposures.
9a	Low	AWT	580	890	595	-	810	Open void
9c	Low	AWT	580	TBC	TBC	-	-	Open void
10	Low	BWT	585	820	570	-	-	Open void - partial backfill to prevent a permanent pit lake
11	Low	BWT	586	690	570	-	-	Open void - partial backfill to prevent a permanent pit lake
12	Low	BWT	586	690	580	-	-	Open void - partial backfill to prevent a permanent pit lake
13	Low	BWT	586	730	575	-	-	Open void - partial backfill to prevent a permanent pit lake

Pit	Preliminary Closure Geochemical risk	AWT/ BWT	Pre-mining water level (mRL)	Pit crest (mRL)	Proposed pit depth (mRL)	Upper PAF material exposure (mRL)	Upper fibre exposure (mRL)	Proposed void closure outcome
14a	Low	AWT	586	730	600	-	-	Open void
14b	Low	AWT	586	700	600	-	-	Open void
14c	Low	AWT	586	650	620	-	-	Open void
South East	Low	AWT	586	TBC	TBC	-	-	Open void
Nammuldi								
Lens A	Low	BWT	575	606	410	-	510	Proposed WFSF – tailings deposition and subsequent backfill and capping to natural surface.
Lens B	Low	BWT	575	620	510	-	-	Open void – groundwater level not anticipated to return to above pit floor
Lens CD	Moderate	BWT	575	600	360	531	540	Open void – pit lake
Lens EF	Moderate	BWT	585	660	465	525	-	Open void – pit lake
LF5	Low	AWT	585	640	590	-	-	Open void *Backfill completed to 630 mRL*
Lens G	Low	BWT	586	700	480	-	540	Open void – pit lake
BS3 Extension								
Diesel	Low	BWT	587	680	520	-	-	Open void – partial backfill to prevent a permanent pit lake
Sandleford 1	Low	AWT	587	700	620	-	-	Open void
Sandleford 2	Low	AWT	587	700	620	-	-	Open void
Sandleford 3	Low	AWT	587	700	620	-	-	Open void
Monkey 1	Low	AWT	587	665	630	-	-	Open void
Monkey 2	Low	AWT	587	635	620	-	-	Open void
Monkey 3	Low	AWT	587	630	610	-	-	Open void
Creekside 1	Low	AWT	593	650	610	-	-	Open void
Creekside 2	Low	BWT	593	680	520	-	-	Open void – partial backfill to prevent a permanent pit lake
Orbe 1	Low	AWT	587	780	600	-	-	Open void
Orbe 2	Low	AWT	587	780	600	-	-	Open void

Pit	Preliminary Closure Geochemical risk	AWT/ BWT	Pre-mining water level (mRL)	Pit crest (mRL)	Proposed pit depth (mRL)	Upper PAF material exposure (mRL)	Upper fibre exposure (mRL)	Proposed void closure outcome
Lauriston	Low	AWT	593	680	610	-	-	Open void
Brokenwood	Low	AWT	593	830	690	-	-	Open void
MM-J-1	Low	BWT	585	680	580	-	TBC	Open void – partial backfill to prevent a permanent pit lake
MM-J-2	Low	AWT	585	630	590	-	TBC	Open void
MM-J-3	Low	BWT	585	620	580	-	TBC	Open void – partial backfill to prevent a permanent pit lake

Table 5-18: Silvergrass East pit characteristics and proposed void closure outcome

Pit	Preliminary Closure Geochemical risk	AWT/ BWT	Pre-mining water level (mRL)	Pit crest (mRL)	Proposed pit depth (mRL)	Upper PAF material exposure (mRL)	Upper fibre exposure (mRL)	Proposed void closure outcome
1	Low	BWT	551	630	450	-	630	Open void – partial backfill to above pre-mining water table Proposed to be buttressed to prevent Caves Creek surface water flow pit capture in 1:10,000 AEP flood plain
2	Low	BWT	549	630	405	-	600	Open void – partial backfill to above pre-mining water table
3	Low	BWT	546	600	485	-	520	Open void – partial backfill to above pre-mining water table
5	Low	BWT	546	570	440	-	-	Open void – partial backfill to above pre-mining water table
7	Low	AWT	546	605	570	-	-	Backfill to surface
8	Low	BWT	546	570	535	-	-	Backfill to surface

In-pit water storage

In-pit storage, ASR and water conveyance between hubs are proposed options for helping manage surplus and deficit predictions, both spatially and temporally. Operational water demands are expected to exceed supply as BWT pits are dewatered and mining in these pits are completed. Surplus water must be stored during operations prior to the deficit being realised, for future beneficial use and to reduce and cease surplus water discharge along creeks. The water deficit is due to the supply of water being insufficient to meet the forecasted water use during operations for mining as well as the proposed MAR closure requirements to accelerate water level recovery at the end of mining.

Further investigations are required to refine in-pit water storage strategies that utilise disused pits (backfilled or open pit voids) for surplus water banking, for future water use requirements. Across B2N there are some pits that have been identified as potentially viable for water storage but they require further validation. Disused pits are not available until 2025 and backfill strategies and scheduling needs to be considered for in-pit storage strategies.

The Brockman Syncline aquifer provides an ideal setting for storage of groundwater due to compartmentalisation arising from the dolerite intrusions which act as hydraulic barriers and effectively creating discrete ‘buckets’. ASR is proposed to recharge the Brockman Syncline aquifer with surplus water for later recovery (re-abstraction) for beneficial use if there is a water deficit during operations or at closure. Previously dewatered pit voids will be preferred as the groundwater storage potential is greater. Pits may be backfilled prior to recharge; this has advantages of reducing evaporation, however total storage capacity would be reduced.

In addition to mine planning and engineering constraints and consultation with and feedback from Traditional Owners, the following hydrogeological and environmental criteria will need to be assessed to determine the suitability of the nominated disused mine pits to be used for water storage:

- Pit wall PAF material exposure risks, water quality modelling and management strategy of hydro -geochemical evolution of pit lake water due to evapo-concentration potentially by backfilling to prevent a pit lake.
- There will be no significant change to the quality of the receiving groundwater system, i.e., water transfer will only occur between aquifers with comparable water quality.
- Pit storage will not cause groundwater mounding in areas with a shallow watertable.
- Pit storage will not result in water seeping out of pit walls on down-gradient slopes.
- Infrastructure required to support pit storage (i.e., pipelines) are within approved clearing limits and minimise clearing of vegetation with elevated significance.
- Assess recirculation of groundwater potential to active dewatering areas by targeting formations that are hydraulically disconnected from current BWT operations.
- Geotechnical assessment undertaken to assure pit is suitable for water storage and not scheduled for progressive backfill during operations.
- Pit storage will not result in overtopping of the mine pit.

Post-mining water usage from in-pit storage strategies may be required for proposed closure MAR schemes or accelerated groundwater level recovery.

Hydrogeological features

Plunge Pool is a culturally and environmentally important pool in the BS3 mining area that is groundwater dependent. No dewatering or BWT mining will occur within the BS3 mining area to ensure groundwater levels in the Plunge Pool compartment are not impacted by drawdown. Plunge Pool is understood to be separated from all BWT mining by dolerite dykes but additional measures, such as further reducing or ceasing BWT mining further upgradient of the pool are proposed if hydraulic

conductivity is later determined between dykes to ensure there will be no change in groundwater levels in pool compartment.

Depletion of groundwater levels in Brockman Syncline aquifer compartments upgradient of Plunge Pool at the BWT MMJ and Creekside deposits has the potential to reduce compartment groundwater overtopping to downgradient compartments connected to the Plunge Pool compartment. This will be mitigated by backfilling these pits to above the water table recovery level post mining. With the proposed mitigation, groundwater levels at Plunge Pool are not expected to be impacted by mining, ensuring that the minimum water level of the pool are not affected.

Hydrological interactions with the Plunge Pool are not expected to change the groundwater flows to the pool, however mining of upgradient deposits is modelled to result in the removal of 66% of the Plunge Pool catchment, reducing the catchment area from 21km^2 to 7 km^2. Even with this impact, the remaining catchment is expected to maintain filling and flushing of the pool at a similar, but slightly reduced frequency to the existing baseline. The potential for increased sediment load will be managed through the installation of surface water management infrastructures such as leaky weir sediment traps at key locations within the catchment. On this basis, Plunge Pool will continue to be a permanent pool and environmental values supported by the pool are not expected to be significantly impacted.

While Palm Springs is outside of the closure boundary, drawdown at SGE may have indirect impacts to the hydrogeological feature and associated ecosystem. Proposed mitigation measures of potential drawdown at Palm Springs are discussed below.

SGE Managed Aquifer Recharge

Condition 6 of MS 925 requires that the Nammuldi-Silvergrass operation does not cause long-term impacts to the health and abundance of groundwater-dependent vegetation communities in the Duck and Caves Creeks because of dewatering and discharge.

Modelling of dewatering at SGE suggests that drawdown in the Caves Creek aquifers could propagate to Palm Springs unless mitigated (Section 5.10.6). A MAR trial, using various injection and infiltration bore designs to demonstrate the ability to successfully mitigate groundwater drawdown impacts from occurring in the Caves Creek aquifer system is underway and learnings will inform future work regarding options for an operational and closure MAR scheme.

As discussed in Section 5.10.7, the LOM water balance will be refined based on outcomes of the MAR trial and implementation of the operational water management strategy. Should an alternative water source be required to maintain the SGE MAR scheme through closure, consultation with Traditional Owners will be undertaken to ensure identified water source options are culturally acceptable

5.10.9. Implications for closure and knowledge gaps

The groundwater levels of many of the BWT pits within Brockman Syncline are not expected to recover to pre-mining water levels, due to the highly compartmentalised nature of the hydrogeology and very slow rates of groundwater recharge predicted. Where water levels recover above the pit floor, partial pit backfilling will occur to avoid the formation of permanent pit lakes, except for seven BWT pits which are predicted to form pit lakes. It is assumed all pit lakes will act as terminal groundwater sinks and therefore no regional impact to groundwater quality or impacts to downstream sensitive environmental/cultural receptors are anticipated.

Groundwater levels are not predicted to change at Plunge Pool due to the separation of the Plunge Pool compartment from BWT mining areas by dolerite dykes. Dewatering of the Brockman Syncline compartments upgradient of Plunge Pool at the MMJ and Creekside deposits has the potential to reduce compartment groundwater overtopping to downgradient compartments connected to the Plunge Pool. This will be mitigated by backfilling these pits to above the water table recovery level post mining. Reduction in the surface water catchments will also be reduced but it is not anticipated to affect the groundwater levels but will reduce the surface water frequency and time to take to fill and flush Plunge Pool. Plunge Pool and mitigation measures are proposed in Section 5.10.8.

The proposed SGE Closure MAR Scheme for drawdown mitigation of Caves Creek and Palm Springs is dependent on the evaluation of the MAR trial in progress during drafting of this report and implementation of an Operational MAR Scheme. Trials and evaluations will determine the future work requirements to determine the quality, quantity, recharge sources and MAR scheme locations at SGE for closure implications. Outcomes from this ongoing work will inform proactive consultation with Muntulgura Guruma representatives and regulatory stakeholders and future revisions of this MCP. Support from Traditional Owner groups will also be sought through the engagement process for use of operationally stored surplus water or other culturally acceptable water sources to be used for a closure MAR scheme.

Closure knowledge gaps associated with the hydrogeology of the Brockman Syncline and the Caves Creek catchment areas, as summarised in Section 5.16, Table 5-20 include:

- Pit scale hydrogeological modelling to predict recovered equilibrium groundwater levels of BWT pits not proposed to form pit lakes at closure to inform backfill requirements to prevent a permanent pit lake.
- The water quality modelling of the proposed Lens CD and EF pit lake that considers geochemical interactions with the final pit walls to ensure the proposed pit lake strategy meets proposed closure outcomes.
- The potential for density driven pit lake water outflow to the surrounding aquifer from proposed pit lakes due to high salinity pit lake water quality forming.
- The water balance at closure that considers surplus water (quality and quantity) stored during operations and potential requirement for additional water source/s to meet the proposed environmental and cultural outcomes.

5.11. Hydrology

The Pilbara region is generally characterised as a water scarce environment with:

- highly variable, seasonal runoff; and
- evaporative demand exceeding rainfall by an order of magnitude.

Water and water systems in the Pilbara hold high significance for indigenous peoples (Rumley and Barber 2004). A report commissioned by Rio Tinto in 2011 (Barber and Jackson 2011) explains *'In Indigenous belief systems water is perceived as an elemental part of the broader cultural landscape, held and managed under customary systems of lore. Water 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'*.

Understanding water and drainage systems is an ongoing focus for Rio Tinto. Outcomes from this ongoing work will inform closure planning and future revisions of this MCP.

5.11.1. Regional hydrology

The Brockman deposits are distributed across two regional sub-catchments of the Ashburton River catchment, Duck Creek and Hardey River sub-catchments, as depicted in Figure 5-24.

Duck Creek Catchment

Duck Creek, including its major tributaries of Boolgeeda Creek and Caves Creek, has a total catchment area of approximately 6,400 km^2 and drains from east to west through the high relief areas of the Hamersley Ranges and onto more gently sloping areas before discharging into the Ashburton River.

Duck Creek is ephemeral; however, permanent and semi-permanent pools occur in the lower reaches where bedrock structures reach near-surface and impede groundwater flow or against cliffs where high flow events have scoured deep pools. These pools play an important role in the creek's ecosystem by

supporting a diverse range of aquatic fauna, terrestrial fauna and social surroundings. Ephemeral pools also form along Duck Creek following significant wet season rainfall, establishing connectivity between the more persistent waterholes (WRM 2020).

The Boolgeeda Creek sub-catchment within the Duck Creek catchment is approximately 1,600 km^2 in size. Boolgeeda Creek drains in a westerly to south-westerly direction from the mountain ranges of Mount Brockman and the Hamersley Range; joining Duck Creek at Lawloit Range. As a result, the catchment is relatively steep and therefore it is expected that a relatively high proportion of rainfall will be converted into runoff. Purlykuti Creek is a tributary of Boolgeeda Creek; the confluence of the two systems occurs to the north-west of the BS4. A low number of semi-permanent and permanent water features along Boolgeeda Creek indicates that it is a relatively dry system typical of the ephemeral creeks in the Pilbara. Pool features are likely to be transient and dependent on rainfall, surface water and shallow alluvial interflow rather than groundwater (Rio Tinto 2014).

The Caves Creek sub-catchment within the Duck Creek catchment covers an area of approximately 1,917 km^2. The headwaters of Caves Creek are located to the east of SGE, encompassing the large flat floodplain of Wackilina and Barnett Creeks. These creeks flow with a gentle gradient over wide, flat plains, producing a meandering channel, which can alter its course following large flood events. The low flow drainage channel in Caves Creek is poorly defined with minor braiding in some reaches and significant in-channel vegetation comprising Eucalyptus camaldulensis (River Red Gum) and Eucalyptus victrix (Coolibah).

Hardey River Catchment

The Hardey River reaches its confluence point with the Ashburton River approximately 100 km west of the closure boundary at Hardey Junction. The Hardey River catchment area is approximately 6,300 km^2.

The Beasley River sub-catchment, within the major sub-catchment of the Hardey River, covers an area of approximately 2,058 km^2. The Beasley River drains from northeast to southwest through the Hamersley Ranges and discharging into the Hardey River. Three significant pools exist within the Beasley River sub-catchment, Plunge Pool, Kurwillinha Pool and Ridge Pool.

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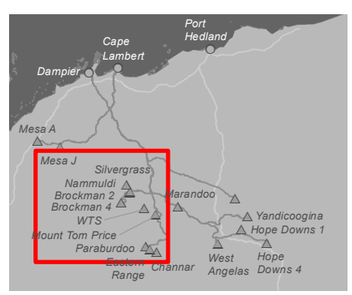
Figure 5-24
Brockman Operation
Regional Surface Hydrology

Drawn: L.Fuentes
Plan: PDE0172864v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:650,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Approved Conceptual
- Duck Creek
- Hardey River
- Major Creek
- Rio Tinto Mine
- Rio Tinto Railway
- Conveyor
- Major Road



N

0 6 12 18 24 30

Kilometres

Map units in metres

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5.11.2. Local hydrology

Brockman Syncline 4

The BS4 operation is located on the catchment divide between the Boolgeeda Creek and Beasley River sub-catchments. There are no major river systems passing directly through or located within the BS4 mining areas (Figure 5-25). The BS1 deposit is located in the Boolgeeda Creek sub-catchment, with minor ephemeral tributaries running through the BS1 area. The BS4MM, Endeavour and BS3 deposits are located within the Beasley River catchment (Figure 5-25). As discussed in Section 2.5.4, surplus water from BS4 is currently discharged to Boolgeeda Creek, with an approved 37 km wetting front.

Four pools are located in proximity to BS4 deposits; Kurwillinha Pool, Ridge Pool, Snake Pool and Plunge Pool. Kurwillinha Pool, Snake Pool and Ridge Pool are above regional groundwater levels and considered to be surface water (rainfall) driven, ephemeral pools. Plunge Pool is understood to be surface expression of groundwater which is periodically topped up and flushed by rainfall and streamflow events (discussed further in Section 5.10.5).

Brockman Syncline 2 – Nammuldi

B2N is largely within the Duck Creek catchment, situated in a valley north of the catchment divide between Duck Creek and Boolgeeda Creek. The valley drains from the east to the west to a central location where flows head north to Duck Creek (Figure 5-25). The majority of the BS3 Extension deposit is located in the Beasley River catchment, with the exception of a small portion of the Brokenwood area, which is located in the Boolgeeda Creek catchment (Figure 5-25). Lens G is situated in an internally draining basin located in the upper catchment of the Beasley River, immediately east of the Nammuldi mine. The basin captures local runoff and is subject to flooding after large rainfall events.

As discussed in Section 2.5.4, surplus water from B2N is discharged to Duck Creek with a proposed wetting front of up to 67 km downstream of the discharge point.

Silvergrass East

The SGE deposit is located entirely within the Caves Creek catchment (Figure 5-25). The Caves Creek floodplain in this area is well defined and is considered a conveyance driven system with little storage capacity. Most creeks and their tributaries within the catchment area of interest are ephemeral, where flow (rainfall excess) only occurs as a direct response to rainfall.

Palm Springs is a permanent expression of groundwater located approximately 30 km downstream (west) of the SGE deposit and within Caves Creek, outside of the closure boundary. Surface water flows infrequently contribute to Palm Springs and it is concluded that the Spring is not primarily supported by surface water (discussed further in Section 5.10.5).

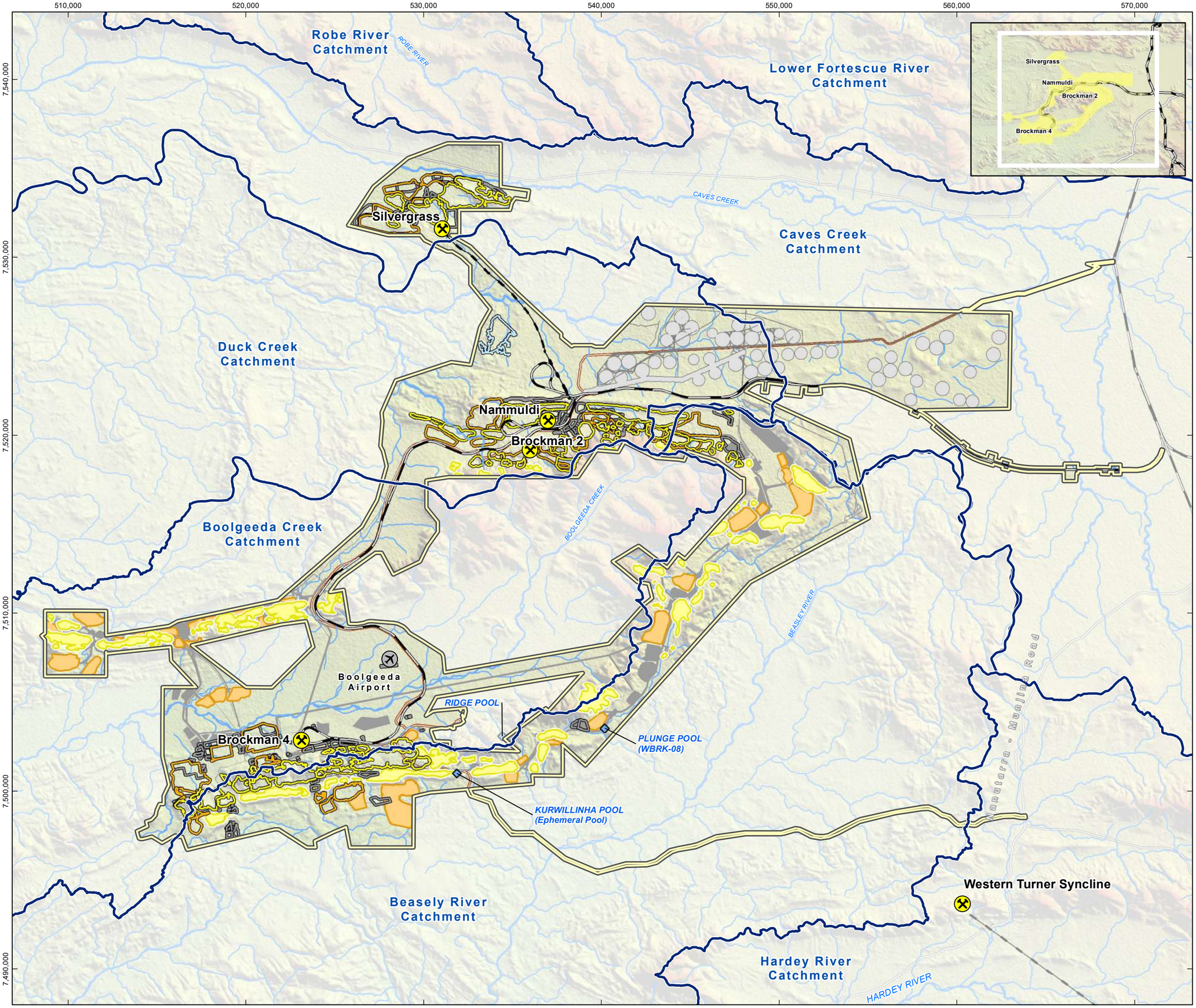
During operations at SGE, a temporary levee will be constructed adjacent to Pit 1 to provide flood protection. The proposed Pit 1 does not intercept the main creek line, but it is situated within the 1 in 100 AEP floodplain. The levee would prevent in-pit flooding during operations and allow flow from Caves Creek to continue flowing downstream, maintaining downstream flow connectivity. At closure, the surface water levee will be removed and rehabilitated, and Pit 1 will be buttressed to prevent creek capture. The Caves Creek flow volume past SGE is therefore not anticipated to be impacted during the operation or at closure.

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Figure 5-25
Brockman Operation
Surface Hydrology
Overview

Drawn: L.Fuentes
Plan: PDE0172864v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:200,000 @A3
GIS.Team@riotinto.com



Legend

- Closure Boundary
- Catchment
- Major Creek
- Minor Creek
- Water Feature - Pool

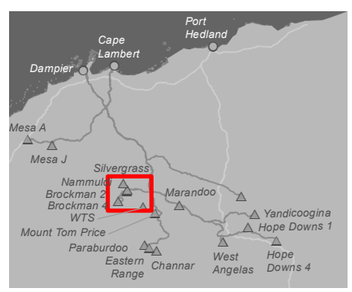
Approved Mine Layout

- Pit
- Waste Rock Landform
- Infrastructure
- Nammuldi WFSF
- Nammuldi Agricultural Project

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform
- Infrastructure

- Airport
- Mine
- Rio Tinto Railway
- Conveyor
- Major Road
- Minor Road
- Site Access



N

0 2 4 6 8 10
Kilometres

Map units in metres

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5.11.3. Surface water pools

Plunge Pool and Palm Springs are both permanent surface water pools that are groundwater dependent and as such are described in Section 5.10.5.

Kurwillinha Pool

Kurwillinha Pool is a small ephemeral pool located at the upper end of a small gorge within the boundaries of the BS4MM deposit (Figure 5-25). The gorge is within the low permeability Marra Mamba Iron Formation, with overlying colluvium along the base. The pool has a 0.72 km^2 catchment located within the Beasley River catchment that drains from north to south. The elevation of the pool is approximately 555 mRL which is more than 50 m higher than the pre-mining groundwater table in the area. Therefore, the pool is not dependent on the regional aquifer and is most likely fed by surface water that collects at the head of the gorge after rainfall events.

The water in Kurwillinha Pool was observed to diminish between October 2016 and December 2016 until it was completely dry. The pool measured approximately 4 m by 1.5 m and 0.2 m deep in October 2016, equating to a volume of 1.2 m^3 at that time. Analysis of available LiDAR topographic data indicates that the volume of the pool when full could be as little as 6.6 m^3 (Rio Tinto 2021d).

The proposed footprint of the Endeavour deposit has the potential to reduce the contributing catchment of Kurwillinha Pool to two thirds of its current area. Hydrological assessment has shown that, given the small volume of runoff required to fill the pool and that the rainfall in the region is concentrated to only a few months of the year, the frequency of full water level recovery and the persistency of Kurwillinha Pool is unlikely to be impacted by the proposed reduction in contributing catchment area (Rio Tinto 2021d). The pool should be filled and overtopped at a frequency similar to that of the pre-mining condition. It is estimated that the reduction in peak surface water flows to Kurwillinha Pool would be approximately 51% and 52% for 1 in 100 and 1 in 10,000 AEP events respectively, with the loss of two thirds of its original catchment area (Appendix 21).

Endeavour pits are not proposed to be backfilled and abandonment bunding conceptual design refinement for further modelling will progress as pit designs are subject to change throughout the operation to confirm closure strategies and monitoring requirements.

Snake Pool

Snake Pool is a surface water dependent, ephemeral pool that fills up after a rainfall events and remains filled only a few days before drying up. It is a small scour hole at the outlet of a small rocky ravine located in the Juukan Gorge. It considered to be culturally significant to the Puutu Kunti Kurrama People. Surface water monitoring is being conducted to better understand the frequency of occurrence and drying period after rainfall events.

Ridge Pool

No mining is proposed for the Ridge Pool catchment and no impact post-mining is expected. It lies just outside of the closure boundary and is not anticipated to require closure monitoring.

Ridge pool is in a gully high in the Brockman Iron Formation ridge, in the vicinity of the BS3 and BS4 mining areas (Figure 5-25). The pool measured approximately 4 m by 8 m and 1 m deep in 2016 and is at an elevation of 670 mRL, approximately 160 m higher than the pre-mining groundwater level (510 mRL). The pool therefore functions independently of the regional Brockman Syncline aquifer.

The pool has a surface water catchment of approximately 0.5 km^2 and is most likely fed by surface water which collects after rainfall events in a hollow in the low permeability Dales Gorge Member of the Brockman Iron Formation. The water in the pool is protected from evaporation by an overhanging rock shelf.

5.11.4. Alteration of hydrology and flow of surface waters

Creek catchment hydrology alterations will occur as a result of permanent minor reductions in creek catchments due to permanent pit void footprints remaining post-closure, changes in catchment surface water flow pathways due to closure landforms and other surface water management options (abandonment bunds etc) where hydrological management is not implemented to reinstate catchment losses. Catchment reductions resulting in reduced surface water flows are still anticipated to sustain natural ecosystems, including riparian vegetation.

Artificially modified creek ecosystems are expected to form within the surface water discharge wetting front zones along Duck Creek and Boolgeeda Creek due to prolonged periods of surface water discharge. This may alter riparian ecosystem dependence on perennial surface water flows from mining surplus discharge operations and potentially be impacted by cessation of discharge activities.

While the cessation of discharge activities will not directly modify the natural hydrological function and surface water flow regimes post-closure, the riparian ecosystems are expected to return to ephemeral systems. Riparian vegetation and fauna associated with riparian and surface water regimes are discussed in later sections (5.14 and 5.15) of this MCP.

Boolgeeda Creek catchment losses may also be impacted by third-party activities such as FMG Flying Fish deposit mining adjacent to the BS1 deposit area. Cumulative reductions in Boolgeeda creek catchments are being considered for impacts to surface water flows to Boolgeeda Creek and hydrological and hydrogeological functions. It also considers the expressed desires of the PKKP People that surface water flows should be maintained to Boolgeeda Creek. Buttressing of two tributaries (BS1C and BS1Ee) within the BS1 deposit area is proposed to reduce some of the catchment losses to Boolgeeda Catchment.

At closure there is expected to be a permanent reduction in catchment area and annual flow along the Boolgeeda Creek, Duck Creek (upstream of Caves Creek confluence), and Beasley River. The impacts are expected to be most prominent locally and will decrease with further distance away from mining activities and areas of sub-catchment loss (Rio Tinto 2021d).

Closure landform flood modelling

Constructed landforms need to consider the surrounding hydrology of the area, as they can have an impact on catchments both upstream and downstream of their location. WRLs can act as a diversion or dam for upstream surface water, reducing flow to the downstream catchment. Likewise, these landforms can erode with surface water flow, destabilising the landform and impacting the downstream environment with sediment. Similarly, pit voids can capture and cut off downstream flows.

Landform design and location guidelines have been well adopted when completing new designs. All WRLs are generally built outside the 1:100 AEP floodplain, consider material characterisation in their design parameters, and post rehabilitation will include surface water management structures such as diversions, bunds and surface water retention cells.

Hydraulic modelling of the closure landforms has been completed across the Brockman Operation using the TUFLOW hydrodynamic modelling software. Several discrete TUFLOW models have been created across the Brockman Operation, incorporating all approved and proposed mining activities to ensure modelled catchment flow regime is reflective of the post-mining development and surfaces. Where possible, model boundaries have aligned with natural surface water divides so as to ensure the model domain includes all relevant contributing catchments. Figure 5-26 displays the model extents for each area across the Brockman Operation.

Floodplain modelling is used to consider closure scenario design flood flows for very rare to extreme flood events across the Brockman mining area (1:100 to 1:10,000 AEP). The modelling uses both the current final operational surface, prior to closure implementation, as well as rehabilitation designs where available, to indicate where closure surface water management will be required. Due to their conceptual nature, not all WRLs have rehabilitation and therefore have operational ramps incorporated into the

design. All WRL rehabilitation designs will be developed or updated to remove operational ramps unless post-closure access is required.

The flood modelling does not include abandonment bund designs as these and conceptual and subject to change, therefore the modelling does not reflect the final pit void surface water capture risk post closure. The position and design of abandonment bunds will be informed by the iterative flood modelling completed. All open voids will have abandonment bunds constructed outside of the PUPEZ and will require flood modelling assessments to ensure appropriate engineered designs if interaction with flood waters is expected.

The modelling indicates that in certain areas of the mine, pits will intercept flood waters, and landforms will impede flows, at both 1:1,000 and 1:10,000 AEP events. A summary of specific site landform key risks and concerns is below and detailed in closure surface water flood modelling assessment (Appendix 21).

A BS4 closure surface water assessment includes approved and proposed pits in the BS4 catchment area, capturing the closure landforms and strategies for BS4 Main pits and proposed BWT BS4 MM Pits. All other BS4 proposed pits and landforms have been assessed in the BSP closure surface water assessment discussed below.

Key surface water risks at closure in the BS4 catchment modelling assessment include:

- DP4 intersects the Boolgeeda Creek floodplain, flow velocities in a 1 in 10,000 AEP event would be up to 3 m/s with depths of 3 m.
- Ponding depths to the north of DP8 in a 1 in 10,000 AEP event are greater than 5 m.
- DP9 intercepts multiple tributaries and has extensive ponding depths up to 6 m to the east of the dump, flow velocities are also greater than 3 m/s in a 1 in 10,000 AEP event.
- High flow velocities over pit crests (Pits 3, 4, 6, 17, R, O2 and Q) have been modelled, however abandonment bunds were not included in this model, which could significantly alter the hydraulic model results.

B2N closure surface water assessment includes approved and proposed pits in the BS2N catchment area and captures the closure landforms and strategies for pits. Key surface water risks at closure in the B2N catchment modelling assessment include:

- The Lens A Waste Dump intersects a tributary causing ponding to the south of the dump that then flows around the dump.
- Flow velocities in some toe areas of Lens A and Lens B waste dumps are greater than 2 m/s.

SGE Closure Surface Water Assessment (Appendix 21) was completed for the approved pits in the SGE catchment area and captures the closure landforms and strategies for SGE. Key surface water risks at closure in the SGE catchment modelling assessment include:

- Ponding is expected on the eastern side of Pit 1 during incidental rainfall events.
- For events rarer than the 1 in 100 AEP, flooding of Pit 1 is expected as flood water heights exceed the backfilled level.
- Flow velocities exceeding 2.5 m/s were predicted at the crest of Pit 1 on the east side for the very rare and extreme events (1 in 1,000 and 1 in 10,000 AEP).

BSP closure surface water assessment was completed for the proposed pits and includes the proposed closure landforms and strategies for BS1, Endeavour, BS4 MN, BS3, BS3 Extension and Lens G deposits. Key surface water risks at closure in these catchment models is listed.

- BS1 - flow velocities are greater than 2 m/s around DP01, DP08. Overtopping predicted for Pit West 1 and West 2b.
- BS3 – flow velocities at BS3-DP1 and MM-J DP1. High velocity flow over pit crest of Pit MM-J3.

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Figure 5-26
Brockman Operation
Closure Landform
Flood Modelling Extent

Drawn: L.Fuentes
Plan: PDE0190358v1
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:210,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary

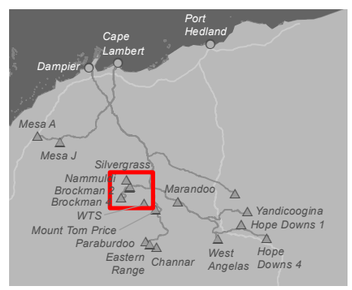
Drainage Lines

- Major
- Minor

Flood Modelling Areas

- B2N
- BS4
- BSP
- SGE
- Boolgeda Creek

- Rio Tinto
- Rio Tinto
- Conveyor
- Major Road



N

0 2 4 6 8 10

Kilometres

Map units in metres

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Cessation of surplus water discharge during operations

During the LOM of the Brockman Operation, surplus dewatering water is directed to a number of destinations. The overarching strategy for surplus water management (as discussed in Section 2.5.4) considers controlled discharge to Duck Creek and Boolgeeda Creek as the least favourable option.

Discharge into Boolgeeda Creek is managed by a Monitoring and Management Plan (MMP) (Rio Tinto 2014) in compliance with MS 1000. Approval to discharge to Boolgeeda Creek is limited by a maximum wetting front of 37km from the discharge point under natural flow conditions. Discharged water was modelled to be contained within the low flow channels and overtopping of the creek banks in dry conditions is not anticipated (Rio Tinto 2019d).

Discharge to Duck Creek is managed by an Environmental Management Plan (EMP) (RTIO 2022c) in compliance with MS 925. The anticipated volume of surplus water discharge to Duck Creek is significantly smaller than the volume that would be generated by the catchment during flood events. Based on model results, discharged water is contained within the low flow channels and overtopping of the creek banks in dry conditions is not anticipated (Rio Tinto, 2021e).

The respective Monitoring and Management Plans detail the monitoring and trigger levels for riparian vegetation health and abundance, to ensure discharge does not cause long-term impacts to the environmental and conservation values of the Boolgeeda and Duck Creek systems. Water discharged from operational areas will meet site-specific requirements, developed in accordance with the ANZECC & ARMCANZ (2000) guidelines for determining water quality trigger levels. Extensive baseline mapping of the riparian areas (approximately 46km of Boolgeeda Creek downstream of the approved discharge point and approximately 67km of Duck Creek) has been conducted to establish baseline data. The condition of both creeks will continue to be monitored during management of cessation of surface water discharge and for a period after cessation of discharge to ensure hydraulic function of the Creeks is retained.

As mining activities draw to a close or as disused pits become available for storage, the volume of surface water discharged into the two creek systems will gradually taper then cease, returning the impacted reach of the creek to its pre-existing ephemeral regime. After cessation of dewatering discharge, riparian vegetation is expected to gradually revert to condition similar to the pre-mining condition (e.g. structural composition, functional behaviour, habitat elements and recruitment dynamics). Noting an augmented system is anticipated to develop during discharge period, which may result in a modification of the riparian conditions and hence returning the augmented system to an ephemeral state will involve reduction of discharge over a period to allow this transition and adaption.

5.11.5. Closure surface water quality management

Construction and operation of the mine areas has the potential to contaminate surface water through various sources that present possible challenges (such as erosion, contamination, AMD and surplus discharge) for closure and rehabilitation of the site.

The risk of surface water contamination from release of AMD will be minimised through implementation of measures detailed in the SCARD Management Plan. Key measures include:

- Constructing bunding to reduce surface runoff flowing over exposed PAF material and material and material with enriched elements in the pit face.
- Storing waste material in appropriately designed WRLs according to expected erosivity.

Pit voids will create a series of internally draining areas, capturing incident rainfall over pits and remnant catchment areas. The use of toe bunds at the base of WRLs and contouring of disturbed land are expected to be sufficient to manage surface water flows appropriately, to achieve acceptable surface water quality standards outside the pit voids. The application of standard rehabilitation practices to all WRLs is expected to minimise erosion and thereby minimise the transport of sediment and dissolved salts (including metalliferous salts) into the environment. This will also consider surface water flushing

events and sedimentation changes with various mine design options that may interact with surface water pools (such as Plunge Pool). Contamination of surface water due to mining operations is unlikely to present a significant environmental risk for closure given the management measures to be implemented.

Surplus water discharged to Duck and Boolgeeda Creek is sourced from groundwater and is fresh with a neutral pH. The surface discharge to Duck Creek may have temporary impacts to water quality of pools within the wetting front. Along Boolgeeda Creek, there are no semi-permanent pools within the wetting front.

The existing approved EMPs (Rio Tinto 2014, Rio Tinto 2022c), include consideration of the following in relation to water quality and the objective that no long-term impacts occur:

- quality of water being discharged;
- prevention of erosion at the discharge location and downstream reaches;
- minimise eutrophication and algal growth in downstream pools; and
- avoid carbonate precipitation and deposition in downstream reaches.

At the cessation of surplus discharge activities, Rio Tinto will consider the EMP discharge management plan baseline information and the augmented hydrological system to develop a monitoring program appropriate for achieving the closure outcomes in consultation with Traditional Owner groups. It is anticipated that discharge will create an augmented system in response to surplus water and as discharge is reduced, there is likely to be decline in vegetation as the system returns to an ephemeral pre-mining state.

5.11.6. Implications for closure and knowledge gaps

Closure implications associated with surface water include:

- Flood modelling indicates that some areas of the pits in each deposit will intercept surface flows under flood conditions, as well as landforms impeding flows, even at 1:100 AEP.
- Topsoil stockpile areas will be placed outside the 1:100 AEP flood inundation zone.
- Creek system health may be impacted as operational surplus discharge down creeks is reduced.

Closure knowledge gaps associated with surface water, as summarised in Section 5.16, Table 5-20, include:

- Closure strategies for pits, buttressing, abandonment bunds and landbridges will be refined through assessment of the floodplain modelling completed. Consideration of final surface design of pit areas backfilled to surface within floodplains to prevent head-cutting or scouring during periods of high velocity flow.
- Rock armouring required to prevent scouring of WRL toes in rare flood events.
- Management of surplus discharge cessation to ensure acceptable creek system health remains.
- Opportunities to reduce loss of Boolgeeda Creek catchment at BS1

5.12. Contaminated Sites

Rio Tinto maintains registers for potentially contaminating activities and known or suspected contaminated sites which have been formally reported under s11 of the *Contaminated Sites Act 2003* (WA). The registers are informed by regular review of operations and where required preliminary or detailed site investigations to assess contaminants associated with such activities and assess their risk of harm to human health, the environment and environmental values. Potentially contaminating activities and land uses as described in the 2021 Department of Water and Environmental Regulation guideline '*Assessment and management of contaminated sites'* (DWER 2021*)*, that may be associated with mining activities onsite include, but not limited to:

- automotive repair workshops (light and heavy machinery);
- substations and transformers;
- fertiliser and explosives storage;
- landfill sites;
- mineral processing, mining, screening and crushing facilities;
- rail transport corridors;
- hydrocarbon storage, handling and dispensing facilities;
- sewage wastewater treatment plants and irrigation areas;
- Emergency Response Training Grounds; and
- disturbance of potentially acid forming materials during mining.

At the Brockman operation, two areas have been reported to DWER under s11 of the Contaminated Sites Act 2003 (WA) *(the Act)*:

- BS2 – Former Power Station
- BS4 – Drainage Channel

Each area is summarised below:

- The BS2 Former Power Station was reported as a known contaminated site and subsequently classified as Contaminated – Restricted Use (CRU) on 17 April 2009 following two integrity tests in November 2007 and May 2008, confirmed a rupture in an underground diesel pipeline at 1.7m below ground level. A series of site investigations completed in 2008, identified soil impacts above ecological and health-based screening criteria. A comprehensive groundwater investigation was not undertaken, however risks to groundwater were considered unlikely based on a depth of >60m. Based on the risks assessment completed the site was considered suitable for ongoing commercial/industrial use. The site is currently restricted to industrial land uses (including mining) unless further investigation and risks assessment are completed. Additionally, a site-specific health and safety plan is required for any subsurface works below 1mbgl in the vicinity of the ruptured diesel pipeline.
- The BS4 drainage channel was reported as a suspect contaminated site and subsequently classified as Potentially Contaminated – Investigation Required (PCIR) on 24 November 2021, following a spill event in September 2021 where approximately 80 kilolitres of ‘oily water’ was discharged following a pipe connection failure in a transfer pipeline connecting an 'oily-water' pond to the 'in-pit turkey's nest'. Following the spill event, earther bunds and spill booms were deployed to limit any migration of contaminants. In addition, visually impacted soils were excavated, and a liquid remedial agent applied to accelerate the biodegradation of hydrocarbons. The site was reported on the basis that soil contamination levels recorded post remediation exceeded Tier 1 screening criteria. DWER have specified on the Notice of Classification (NoC) that further works are required, to adequately delineate and characterise the nature and extent of contamination at the site and assess the effectiveness of completed and ongoing remedial activities. The works are currently planned for 2023.

All potentially contaminating activities and land uses identified on the site register are managed as part of the ongoing mining operation. Prior to closure as part of the decommissioning process, a contaminated site assessment will be undertaken. Based on this assessment, specific plans will be developed to remediate or manage contaminants, where required, to support the final land use. This would include the Brockman 2 former power station, given current restrictions on land use.

5.12.1. Implications for closure and knowledge gaps

Closure implications associated with contaminated sites include:

- Ensuring that contamination risks have been assessed prior to the closure of the Brockman operation.

Closure knowledge gaps associated with contaminated sites include:

- A defined completion criteria of contaminated sites remediation requirements with changes to land use that considers source pathway receptors.

These knowledge gaps are required to be addressed to inform post-mining land use planning and understanding of any required remediation activities.

BIOLOGICAL ENVIRONMENT

The information presented in Sections 5.13, 5.14 and 5.15 is a summary of information from the appended Biological Knowledge Database (Appendix 7) which provides a detailed overview of the Brockman Operations biological environment and is an amalgamation of several baseline surveys undertaken to support the BSP. The Biological Knowledge Database will be treated as a 'live' document and updated as new information becomes available.

5.13. Conservation Significant Areas

5.13.1. National Parks

The closest conservation reserve to the Brockman Operation is Karijini National Park (also considered an environmentally sensitive area [ESA]), is located approximately 42km east of the closure boundary. Karijini National Park protects 627,400 ha of land within the Pilbara bioregion (Figure 1-1). The Woongarra Gorge Area is also considered an ESA and is located approximately 20km south of the Brockman Operation.

5.13.2. Threatened and Priority Ecological Communities

None of the vegetation types mapped within the Brockman Operation closure boundary represent TECs as defined by the EPBC or the BC Act (Refer to Section 4.2.1 of Appendix 7).

The closest TEC 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' is located approximately 1km west of the Silvergrass East closure boundary.

One vegetation type (P33) occurs within the closure boundary which is considered to represent a Priority Ecological Community (PEC), as defined by the Department of Biodiversity, Conservation and Attractions (DBCA 2022) and is also considered 'Regionally Significant' (Stantec 2021). P33: represents the Priority 1 PEC 'Brockman Cracking Clay Communities of the Hamersley Range' (Cracking Clay PEC). The Cracking Clay PEC is located in the north of the closure boundary in proximity to the SGE mining area and represents the westernmost known occurrence of this vegetation type (Biota 2019a). This community was classified as ranging from Poor to Very Good condition within the closure boundary (Stantec 2021).

Development of SGE pits may result in a minor reduction in surface water runoff reaching these communities from the east, however current understanding is that reliance is predominantly on incident rainfall rather than surface flows (Rio Tinto 2010b) although the latter does contribute to sustaining the communities. Surface water management is therefore not expected to have a significant impact on the values of these communities. Any impacts will also be partially offset at closure by the buttressing of the SGE Pit 1.

The Themeda grasslands on cracking clays (Hamersley Station) TEC and the Brockman Iron cracking clay communities of the Hamersley Range PEC are not expected to be directly impacted by mining operations.

5.14. Flora and Vegetation

Numerous (>360) vegetation surveys and mapping within or overlapping the closure boundary have been undertaken over many years which inform the appended Biological Knowledge Database (Appendix 7). The Brockman Operation and surroundings flora and vegetation survey area is displayed in Figure 5-27.

5.14.1. Vegetation Types

Vegetation mapping within the closure boundary has been reviewed and a consolidated vegetation mapping layer produced (Stantec 2021). A total of 112 vegetation communities and six mosaics have been described within the consolidated vegetation mapping area. Of these 112, 104 vegetation

communities (excluding ‘disturbed ‘areas) exist within the closure boundary (Refer to Section 4.2.2 of Appendix 7).

Dominant vegetation types within the closure boundary include the following:

- P17: *Eucalyptus leucophloia* subsp. *leucophloia (Corymbia deserticola* subsp. *deserticola* and *C. hamersleyana*) scattered low trees and/or *E. gamophylla* scattered low mallees over *Acacia atkinsiana*, *A. exigua* and *A. bivenosa* shrubland over *Triodia epactia* and/or *T. wiseana* hummock grassland (occupying 7,409.8 ha or approximately 17.0% of the closure boundary).
- H26: *Eucalyptus leucophloia* subsp. *leucophloia* scattered low tree over *Acacia maitlandii* shrubland over *Triodia wiseana* open hummock grassland (occupying 6,333 ha or 14.5%).
- P24: *Corymbia deserticola* subsp. *deserticola* scattered low trees to low open woodland over *Eucalyptus gamophylla* low open mallee woodland over *Acacia exigua* and *A. atkinsiana (A. kempeana*) tall open shrubland over *Triodia wiseana* and *T. epactia* open hummock grassland (occupying 2,920 ha or approximately 6.7% of the closure boundary).

5.14.2. Threatened and Priority Flora

Significant flora includes species listed under the EPBC Act, the BC Act, or Priority species identified by DBCA as requiring further protection (EPA 2016). Significant flora can also include species that are locally endemic or associated with a restricted habitat type, occur as range extensions, are a new species or have anomalous features that indicate a potential new species, represent a restricted subspecies, varieties or hybrids, or are relictual representatives of taxonomic groups that no longer occur widely in the broader landscape.

No Threatened flora species currently listed under the EP Act or EPBC Act have been recorded within the closure boundary. However, twenty-seven Priority flora species have been recorded in the closure boundary, including two Priority 1 (P1) flora species, *Tetratheca butcheriana* and *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354). Refer to Section 4.3.1 and Figure 4-7 of Appendix 7 for taxa and locations of Priority Flora within the closure boundary.

Given that *Tetratheca butcheriana* (P1) flora species is considered to have the potential to be listed as critically endangered flora species, all locations of this species within the closure boundary will be protected by MEZs to ensure avoidance of these areas (Figure 5-28).

No flora species recorded within the closure boundary are considered to represent potential range extensions or meet other criteria defining them as significant taxa.

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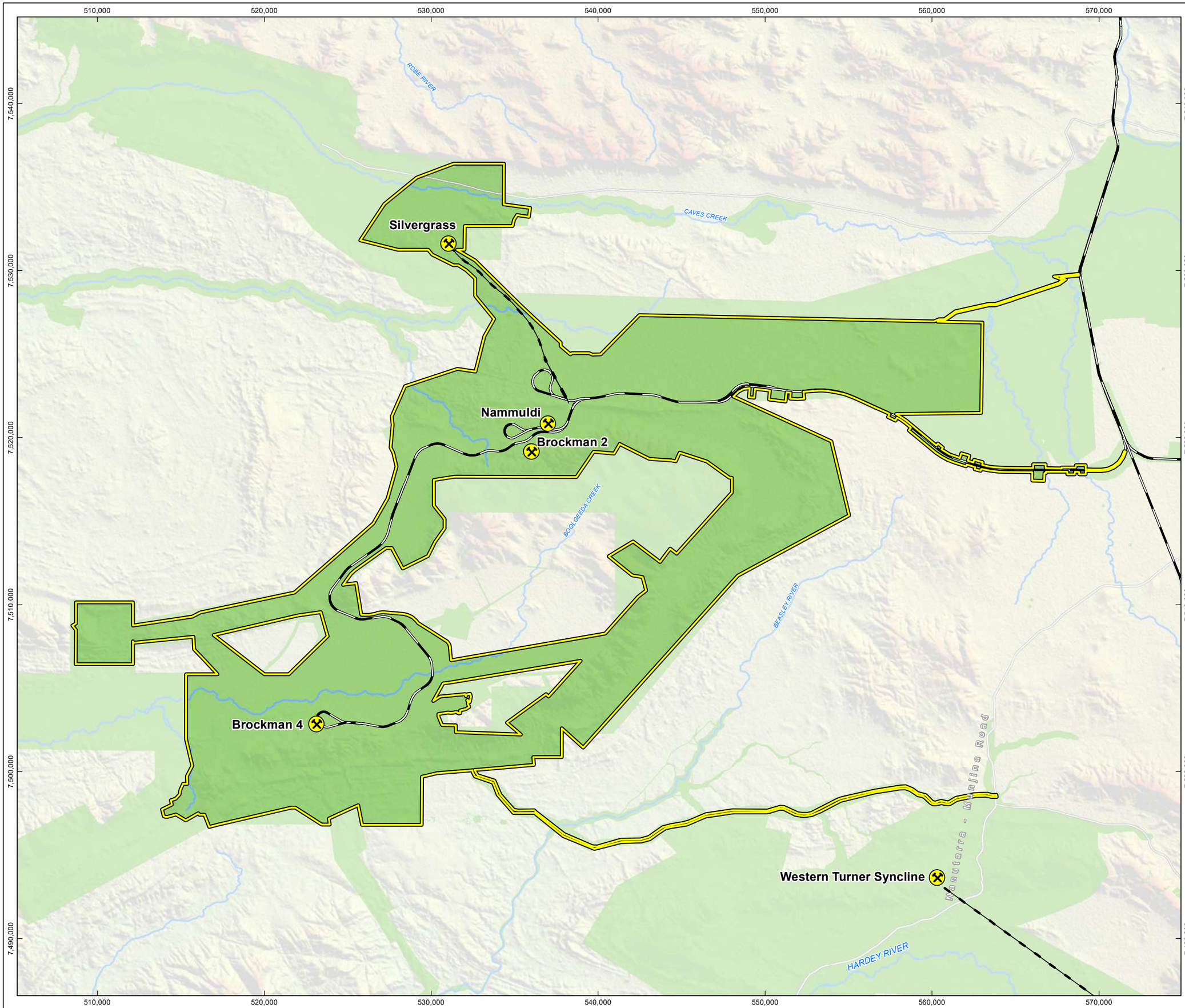
Figure 5-27
Brockman Operation Flora and Vegetation Surveys

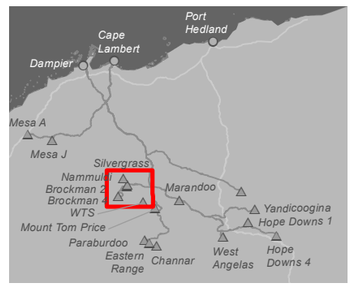
Drawn: L.Fuentes
Plan: PDE0172867v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:210,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Total Survey Coverage
- Rio Tinto Mine
- Conveyor
- Major Road
- Minor Road
- Major Creek





N

0 2 4 6 8 10

Kilometres

Map units in metres

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5.14.3. Riparian Vegetation

Riparian vegetation generally occurs in the major and moderate sized creeklines that intersect the closure boundary (Boolgeeda Creek, Duck Creek and Caves Creek and their larger tributaries) as well as within some parts of the minor tributaries of these creeklines. Nineteen vegetation types were identified that support riparian vegetation within the closure boundary, and vegetation types cover approximately 948 ha or 2.2% of the area. Riparian vegetation types are listed in Appendix 7-Section 4.24. Vegetation types of the Boolgeeda, Duck and Caves Creeks and adjacent floodplains are described in various survey reports and also the respective environmental management plans (EMPs) (Rio Tinto 2014, Rio Tinto 2022c). The current operation EMPs will be superseded by a consolidated EMP which is being prepared at the time of writing.

Riparian vegetation along the major creek lines associated with surplus discharge is managed through two EMPs. The Boolgeeda Creek discharge is managed by Monitoring and Management Plan (Rio Tinto 2014) in compliance with MS 1000. Approval to discharge to Boolgeeda Creek is limited by a maximum wetting front of 37km from the discharge point and no long-term impacts are the objective. No impacts are expected beyond the wetting front area.

Similarly, the surplus discharge to Duck Creek is managed by an EMP (RTIO 2022c) in compliance with MS 925 with a maximum wetting front of 67km. The objective is to avoid long term-impacts and there is no impact beyond the wetting front expected.

There is no surplus water discharge along Caves Creek. Riparian vegetation along Caves Creek is likely to be associated with surface water and groundwater systems. Dewatering activities at SGE have the potential to impact riparian vegetation by lowering the shallow groundwater table in connection to Caves Creek Alluvials. Dewatering and aquifer management at the Brockman Operation will be managed by the groundwater management strategy described in Section 2.5.4, which include Caves Creek and SGE MAR trials to investigate potential mitigation options for future and ongoing SGE below water table mining operations (see section 5.10.8).

5.14.4. Introduced Flora (Weeds)

A total of 39 introduced flora species (weeds) have been recorded within the closure boundary from multiple surveys (Stantec 2021, Biota 2019a, Mattiske 2019 and Stantec 2019). These species are listed in Table 4-9 of Section 4.4 within Appendix 7.

None of these species are listed as Weeds of National Significance or declared plants for the Pilbara region under the *Biosecurity and Agriculture Management Act 2007* (WA) or as a Weed of National Significance (WoNS) on the Western Australian Organism List (WAOL) database.

5.14.5. Flora and vegetation management during closure activities

MEZs have established around all known populations of *Tetratheca butcheriana* (P1) within the closure boundary. MEZs are areas where *no* direct disturbances are permitted. These MEZs will be maintained throughout the duration of closure activities to prevent any direct impact to *Tetratheca butcheriana.* MEZs in the closure boundary are shown in Figure 5-28. A MEZ refers to an area where no direct disturbance is permitted. Mine Restriction Zones (MRZ) are referred to as buffer zones round MEZs to allow access for monitoring sensitive areas, where no mining excavation will occur, although low impacts activities (such as access tracks) may be implemented.

5.14.6. Implications for closure and knowledge gaps

Closure implications for the Brockman Operation associated with flora and vegetation include:

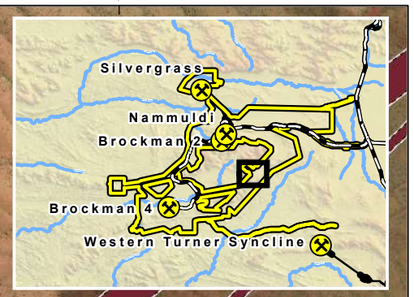
- Locations of conservation significant flora species have been considered in the closure strategy for waste landforms to minimise additional disturbance during closure implementation.

- Exclusion zones around conservation significant flora species will be maintained through the decommissioning, closure and rehabilitation implementation phases.
- Increase in abundance of introduced floral species hindering rehabilitation effectiveness.

Closure knowledge gaps associated with fauna and habitat values, as summarised in Section 5.16, Table 5-20, include:

- Detailed completion criteria such as percentage cover / percentage bare ground, species richness / diversity, keynote species, percentage weed cover etc.
- Abandonment bunding locations relative to MRZ and MEZs as the mine plan changes during operations
- Monitoring criteria to validate effectiveness of MEZs to carry over from the EMP.

542,000
544,000
546,000
7,512,000
7,510,000



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Figure 5-28
Mine Exclusion Zones around Population of *Tetratheca butcheriana* (P1) within the Closure Boundary

Drawn: L.Fuentes
Plan: PDE0191319v1
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:20,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Mine Exclusion Zone (*Tetratheca Butcheriana*)
- *Tetratheca butcheriana* (P1)

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform
- Infrastructure

N

0 0.25 0.5 0.75 1

Kilometres

Map units in metres

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5.15. Fauna

Numerous fauna surveys have been undertaken within the closure boundary (Figure 5-29) which inform the appended Biological Knowledge Database (see Section 4.1 of Appendix 7).

5.15.1. Terrestrial fauna habitat

Twelve broad fauna habitat types are mapped within the closure boundary (Figure 5-30) (Stantec 2020b). For a region context, mapped fauna habitats have been extended to a 15km buffer surrounding the closure boundary. These fauna habitats were identified based on observations in the field, vegetation mapping and interpretation of aerial photography (Stantec 2020a; Biologic 2022).

Of the 12 habitat types identified within the survey area, two are considered to provide high significance habitat regarding their importance of MNES fauna habitat used by MNES fauna species:

- **Gorge/Gully habitat:** Collectively comprises 1,650 ha (2%) of the survey area, including 880 ha (1%) within the closure boundary, and is considered the most important fauna habitat at a local scale due to the microhabitats it provides, such as caves, overhangs and crevices (Stantec 2020b; Biologic 2022). The rocky shelter and retention of surface water and moisture in this habitat type provides refuge for fauna from harsh climatic conditions. This habitat type is suitable for denning, shelter, roosting and foraging for significant fauna species such as the Northern Quoll, Ghost Bat, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Long-tailed Dunnart and Gane's Blind Snake.
- **Debris Slope/Rocky Outcrop habitat**: Collectively comprises 638 ha (1%) of the survey area, including 446 ha (1%) within the closure boundary, and is considered of high significance as it can form shelters such as caves and alcoves (Biologic 2020b, Stantec 2020b, Biologic 2022). Rocky outcrops provide denning and foraging habitat for the Northern Quoll and Long-tailed Dunnart. The Pilbara Olive Python may also utilise the habitat, particularly when it occurs near creek lines or Gorge/Gully habitat (Biologic 2020b; Stantec 2020b).

The remaining habitat types are of moderate to low significance. None of the identified fauna habitats are confined to the closure boundary and all are widespread throughout the Hamersley subregion (Biota 2019b, c, Biologic 2022). Fauna habitats are described in full in Section 5.2 of Appendix 7.

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Figure 5-29
Brockman Operation
Terrestrial Fauna Surveys

Drawn: L.Fuentes
Plan: PDE0172866v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:210,000 @A3
GIS.Team@riotinto.com

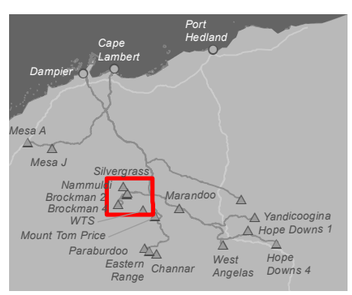
Legend

- Closure Boundary
- Total Survey Coverage
- Rio Tinto Mine
- Rio Tinto Railway
- Conveyor
- Major Road
- Minor Road
- Major Creek

Silvergrass
Nammuldi
Brockman 2
Brockman 4
Western Turner Syncline

ROBE RIVER
CAVES CREEK
BOOLGEEDA CREEK
BEASLEY RIVER
HARDEY RIVER
Nanutarra - Munjina Road

510,000 520,000 530,000 540,000 550,000 560,000 570,000
7,540,000 7,530,000 7,520,000 7,510,000 7,500,000 7,490,000



N

0 2 4 6 8 10
Kilometres

Map units in metres

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Figure 5-30
Brockman Operation
Terrestrial Habitat

Drawn: L.Fuentes
Plan: PDE0172865v2
Date: July 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:185,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Rio Tinto Mine
- Rio Tinto Railway
- Conveyor
- Major Road
- Minor Road
- Major Creek
- Pilbara Leaf-nose Bat Roost Location
- Ghost Bat Roost Location

Fauna Habitat

- Alluvial plain
- Colluvial plain
- Debris slope/rocky outcrop
- Disturbed
- Footslope
- Gently sloping rise
- Gorge/gully and free face
- Hardpan plain
- Hillslope
- Major creekline
- Minor creekline
- Midslope/upper slope
- Pediment slope
- Plains
- Plateau



N

0 2 4 6 8 10

Kilometres

Map units in metres

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7,540,000 7,530,000 7,520,000 7,510,000 7,500,000

Silvergrass
Nammuldi
Brockman 2
Brockman 4
Western Turner Syncline
CAVES CREEK
BOOLGEEDA CREEK
BEASLEY RIVER
Nanutarra - Munjina Road

5.15.2. Conservation significant fauna

Of the 179 vertebrate fauna species, eight species of significance have been recorded within closure boundary, whilst an additional four species are considered likely to occur within the closure boundary. The MNES fauna species known to occur in the closure boundary include the Endangered, Vulnerable and Migratory species listed below in Table 5-19.

Table 5-19: Significant Fauna recorded at or likely to occur within the closure boundary

Species	EPBC Act Listing	BC Act Lisitng	DBCA Priority Species
Known to Occur within the closure boundary			
Northern Quoll (*Dasyurus hallucatus*)	Endangered	Endangered	-
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Vulnerable	Vulnerable	-
Ghost Bat (*Macroderma gigas*)	Vulnerable	Vulnerable	-
Pilbara Olive Python (*Liasis olivaceus barroni*)	Vulnerable	Vulnerable	-
Fork-tailed Swift (*Apus pacificus*)	Migratory	Migratory	-
Peregrine Falcon (*Falco peregrinus*)	-	-	Other Specifically Protected
Western Pebble-mound Mouse (*Pseudomys chapmani*)	-	-	Priority 4
Lined Soil-crevice Skink (*Notoscincus butleri*)	-	-	Priority 4
Likely to Occur within the closure boundary			
Grey Falcon (*Falco hypoleucos*)	Vulnerable	Vulnerable	-
Gane's Blind Snake (*Anilios ganei*)	-	-	Priority 1
Long-tailed Dunnart (*Sminthopsis longicaudata*)	-	-	Priority 4
Short-tailed Mouse (*Leggadina lakedownensis*)	-	-	Priority 4

Short range endemic fauna

A total of 90 invertebrate species from six orders and 17 families have been identified within the survey area from surveys since 2005. Of these, 42 species have the potential to be short-range endemic (SRE) (Section 5.5 of Appendix 7). All of these species were recorded from habitat types that were observed outside of but in proximity to the survey area, suggesting they may not be restricted to the survey area. The distribution of potential SRE species within the survey area is shown in Appendix 7.

5.15.3. Introduced fauna

Five feral mammal species were recorded and include the Cat (*Felis catus*), Dingo (*Canis familiaris*), European Cattle (*Bos taurus*), Horse (*Equus caballus*) and House Mouse (*Mus musculus*).

5.15.4. Aquatic fauna

More than 200 zooplankton species, 80 hyporheic species, and 300 macroinvertebrate species have been recorded from within and adjacent to the Brockman Operation during aquatic ecosystem surveys from November 2009 to November 2019 (WRM 2020). This includes four conservation listed species, eight stygal taxa of conservation interest and five zooplankton species (rotifers) which are potentially new to science. A summary of aquatic organisms of international, national and State significance collected within the closure boundary and the approximate local and regional distribution of these species is provided in Section 6.2 of Appendix 7.

Aquatic fauna environments are typically associated with semi-permanent and permanent pools along creek lines. These wetland areas can be groundwater supported or may be persistent or ephemeral features after heavy rainfall or surface water flows during wet season that persist in dry conditions, where protected by well-shaded areas.

5.15.5. Subterranean fauna

Subterranean fauna includes troglofauna (terrestrial subterranean fauna) and stygofauna (aquatic subterranean fauna). Both groups have ecological importance due to their species richness, evolutionary history and adaptation to their environment (Humphreys 2017). Subterranean fauna species have the potential to have restricted distributions and as a result short-range endemism is common in this group (Harvey 2002).

Stygofauna

A total of 665 stygofauna specimens representing 75 stygofauna taxa (species or operational taxonomic units) were recorded within the closure boundary and immediate vicinity. The number of stygofauna taxa recorded in the Brockman Operation is comparatively high, i.e. subterranean fauna surveys at the nearest mining project at Eliwana recorded 15 stygofauna taxa.

Suitable habitats for stygofauna occur mainly within the synclinal valley in tertiary detrital aquifers and fractured/ weathered rock aquifers at varying depths from surface. The tertiary detrital aquifers are composed of colluvial and alluvial sediments of variable porosity, and patches of secondarily weathered calcrete and CID, which provide highly suitable stygofauna habitats. Further information on aquifer and hydrostratigraphy is in Section 5.10.

Troglofauna

A total of 350 troglofauna specimens representing 164 troglofauna taxa (species or operational taxonomic units) were recorded within the closure boundary and the immediate vicinity representing 16 higher level taxonomic groups comprising *Araneae, Palpigradi, Pseudoscorpiones, Schizomida, Scorpiones, Isopoda, Chilopoda, Pauropoda, Polydesmida, Polyxenida, Symphyla, Diplura, Blattodea, Coleoptera, Hemiptera and Zygentoma.*

Suitable above water table habitats for troglofauna occur widely throughout all four sections of the Brockman Operation, hosted within a variety of geological settings. The BrIF and MMIF ranges encircling the Brockman Syncline host the majority of suitable troglofauna habitat, as well as the flanks of these ranges, and in the valley areas between. Geological structures such dykes, sills, faults etc may influence local habitat connectivity either by increasing fracturing within the base rock or by providing impermeable/ fresh rock barriers.

5.15.6. Fauna management during closure activities

The reintroduction or translocation of fauna into rehabilitated areas is not proposed as part of this MCP. Instead, natural migration of fauna species into rehabilitated land will be 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 (e.g. 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.

Species associated with plains, drainage line or disturbed habitats have the potential to benefit from the rehabilitation of mine, due to returned or expanded habitat post-closure.

MRZs and MEZs have been placed around MNES fauna species habitat, including a cluster of several Ghost Bat roosts within the closure boundary, as to ensure activities during construction, operation and closure do not impact these roosts. Each significant roost is surrounded by a central MEZ, which is then bordered by an adjacent MRZ. These designated MEZs and MRZs will be maintained throughout the duration of closure activities to avoid any potential impacts to Ghost Bat roosts. MEZ for bat roosts and MNES critical habitat in the closure boundary are shown in Figure 5-31.

5.15.7. Implications for closure and knowledge gaps

Closure implications associated with fauna and habitat values include:

- Pit designs have been revised to ensure the PUPEZ does not extend over significant caves.
- All exclusion zones will be maintained through the decommissioning, closure and rehabilitation implementation phases.
- Progressive rehabilitation will be undertaken to re-establish native self-sustaining vegetation that support fauna.
- Monitoring programs of the Pilbara Leaf-nosed Bat and Northern Quoll will be refined during operations and continue through the decommissioning, closure and rehabilitation implementation phases as required/relevant.

Closure knowledge gaps associated with fauna and habitat values, as summarised in Section 5.16, Table 5-20 include:

- Abandonment bunding locations relative to MRZ and MEZs as the mine plan changes during operations.
- Monitoring criteria to validate effectiveness of MEZs to carry over from the EMP.

Mine Restriction and Exclusion Zones for Bat Roosts and MNES Critical Habitat

Drawn: L.Fuentes
Plan: PDE0189741v2
Date: May 2023

Proj: GDA 1994 MGA Zone 50
Scale: 1:185,000 @A3
GIS.Team@riotinto.com

520,000 540,000 560,000

7,520,000 7,500,000

Silvergrass
Nammuldi
Brockman 2
Brockman 4
Duck Creek
Boolgeeda Creek
Beasley River West
Wackina Creek

Plunge Pool

0 0.25 0.5 0.75 1 Kilometres

Legend

- Closure Boundary
- Ghost Bat Roost
- Bat Cave Exclusion Zone
- MNES Critical Habitat Exclusion Zone

Approved Mine Layout

- Pit
- Waste Rock Landform
- Infrastructure

Proposed Conceptual Footprint

- Pit
- Waste Rock Landform
- Infrastructure

- Rio Tinto Mine
- Rio Tinto Railway
- Conveyor
- Major Road
- Major Creek
- Minor Creek

N

0 2 4 6 8 10 Kilometres

Map units in metres

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5.16. DATA ANALYSIS CLOSURE KNOWLEDGE GAPS

This section provides a summary of all current closure knowledge gaps identified from the baseline and closure data analysis during closure planning and development of closure strategy for BSP operations. The knowledge base for the Brockman Syncline informs the closure risk assessment (Section 7) and the Brockman Syncline closure action register (Appendix 5). The knowledge gaps and proposed actions may inform future rehabilitation, closure trials and closure completion criteria refinement.

Each iteration of the Brockman Syncline MCP will include a review and refinement of the closure knowledge gaps that will be progressively addressed through the Rio Tinto risk management process.

Table 5-20: Current closure knowledge gaps for the Brockman Syncline

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
Aboriginal and cultural heritage	Update rehabilitation seed mix to incorporate traditional ecological knowledge in consultation with Traditional Owners.	Identify sites with existing ethnobotanical survey and knowledge reports and develop a schedule for remaining sites [1053968]	Next MCP
		Collate current ethnobotanical knowledge into a database [1053969]	
		Review of the appropriateness of the specific species for use in seed mixes considering such factors as suitability for rehabilitation domains and availability of seed volumes required. [1053970]	
		Establish a practice of the incorporation, where appropriate, of ethnobotanical species of importance into site seed mix lists for progressive rehabilitation [1053971]	
	Agreement on key heritage sites and places and social and cultural values, access requirements post closure, final site	Confirm final land use and post-closure access expectations with stakeholders and determine social and cultural heritage values to be maintained at closure [878255]	Progress update in next MCP

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
	closure outcomes, completion criteria and measurement tools, including visual amenity outcomes.	Develop a framework for iterative visual impact assessment for cultural heritage important sites [1085625]	Progress update in next MCP
	Strategy for the safe keeping or return of any artefacts or materials salvaged.	Develop a strategy for the safe keeping or return of any artefacts or materials salvaged during operations [1085629]	10 years from planned closure
	Surface water management through BS1 to reduce catchment loss to Boolgeeda Creek	Identify and model further opportunities to construct engineer permanent surface water diversion bunds or pit buttressing of BS1 pits to reduce catchment loss to Boolgeeda Creek [1085630]	Progress update in next MCP
Socio-Economic	Potential social and economic impacts to be considered as closure preparations commence including amenity, loss of employment and business opportunities.	Social and economic impact assessment to be completed during closure studies within 5 years of planned closure. [1085668]	5 years from planned closure
	Risks associated with post-closure pastoral activities within the mine footprint	Undertake studies to evaluate the risks associated with post-closure pastoral activities within the mine footprint [878256]	10 years from planned closure
Soils	Characterisation of subsoil is limited and will be updated through representative sampling of existing stockpiles.	Undertake representative sampling of existing subsoil stockpiles at BS4, B2N and SGE [1085669]	Progress update in next MCP
	Soil characterisation for areas associated with the BSP to ensure it is suitable for rehabilitation activities at closure.	Undertake a baseline soil assessment for the BSP disturbance areas [1085670]	Next MCP
	Review of actual soil recovery rates to date and update of predicted soil volumes available at closure.	Update actual recovery rates of soil to date and apply to calculation of predicted soil volumes available at closure [1085671]	Next MCP
Geology / Geotechnical	Final geotechnical stability review of PUPEZ that takes into account areas with adverse local structural geology to confirm the PUPEZ and abandonment bund locations.	Undertake risk-based review of PUPEZ in final landform, complete predictive modelling of pit wall stability where required, and determine which (if any) waste dumps and other structures need to be removed from within the zone and assess abandonment bund locations. [878341]	5 years from planned closure or as pits are exhausted.

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
	Engineered design of abandonment bunds that will act as permanent surface water diversion bunds within flood plains.	Develop engineering designs for mitigating surface water risks to permanent WRL and abandonment bunds located within flood plains [1085717]	10 years from planned closure
	Opportunities to progressively construct abandonment bunds during operations.	Identify opportunities for construction of abandonment bunds during operations and integrate into mine plan [878254]	Progress update in next MCP
	Extent of buttressing of the BS4 Main Pit 1 required to ensure an abandonment bund can be constructed between the Pit 1 PUPEZ and the Juukan Gorge Remediation Project.	Review Pit 1 final design PUPEZ relative to the Juukan Gorge Remediation Project and design pit buttress to ensure fundamental stability. [1085718]	Next MCP
Mineral Waste	Site-specific physical characterisation of all mineral waste units at the Brockman Operation.	Undertake physical waste characterisation on mineral waste units that do not have site-specific data and mineral waste from proposed pits once mining commences. [1085720]	Progress update in next MCP
	Rehabilitation designs of WRLs that are still conceptual in design. Removal of all ramps in rehabilitation designs, unless post-closure access is required, as designs are progressed.	Remove all ramps from WRL rehabilitation designs unless post-closure access is required. [1085721]	Next MCP
	Volume of waste material types required to meet closure commitments and outcomes, including: • Backfill material. • Competent material for capping of erodible WRLs and construction of abandonment bunds. • Suitable material to construct store and release covers on WRLs containing PAF material.	Develop a rehabilitation materials inventory to establish volumes required at closure, including competent capping materials, and identify material source and stockpiling areas. [878248]	Next MCP
		Undertake waste materials balance assessment across sites, and investigate settlement behaviour of backfill materials post-closure, challenging swell factor and loose material density assumptions to verify volume of material required to meet backfill commitments. [880209]	10 years from planned closure
		Identify suitable material to construct store and release covers on WRLs containing PAF material and calculate volumes required to cover all WRLs containing PAF material. [1085724]	Progress update in next MCP
		Complete backfill reconciliation ensuring volumes align with 5YP and closure backfill commitments [880168]	Next MCP
	Potential to use SR4 neutralising material, as defined in Table 5-10, to reduce the risk of AMD at closure.	Identify opportunities to use SR4 neutralising material to reduce the risk of AMD at closure. [1085725]	Progress update in next MCP

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
	Opportunities to reduce in-situ PAF exposures on the final Nammuldi Lens CD and Lens EF pit walls.	Assess alternative pit designs to reduce PAF exposures in final pit wall and/or potential to leave benches on which calcrete or alternative neutralising material maybe tipped to cover exposures. [992142]	In progress – next MCP
	Health and safety risk of fibrous mineral exposures on final pit walls	Confirm presence of in-situ designated hazardous material in final pit walls and complete a risk assessment for potential health and safety risks as required. [1085726]	5 years from planned closure or as pits are exhausted.
Tailings characterisation and storage	Potential for seepage from ex-pit WFSF at Nammuldi to impact downstream receptors such as the Alluvial aquifer beneath Duck Creek.	Investigate the trajectory of saline plume beneath Nammuldi WFSF, considering Duck Creek as a potential sensitive receptor [878266]	Outcomes related to closure of operational Actions will be presented in the next MCP
	Final closure designs for the WFSFs, in accordance with GISTM.	Determine closure design for WFSFs in accordance with GISTM [878267]	Next MCP
		Identify appropriate native plant species to grow on cover systems, taking into account requirements for specific requirements such as shallow rooting depth [878366]	Next MCP
	Groundwater recovery levels at both ex-pit and in-pit WFSFs.	Undertake hydrogeological modelling of WFSF facilities (ex-pit and in-pit) to understand groundwater recovery beneath the facility post-closure [878265]	Progress update in next MCP
Hydrogeology	Pit scale recovered equilibrium groundwater levels of BWT pits not proposed to form pit lakes at closure to inform backfill requirements to prevent a permanent pit lake.	Refine pit scale hydrogeological models for all BWT pits to better inform backfill heights required for pits with a closure outcome of no permanent pit lake. [1085729]	Progress update in next MCP
	The water quality of the proposed Lens CD and EF pit lake that considers geochemical interactions with the final pit walls to ensure the proposed pit lake strategy meets closure objectives.	Develop geochemical pit lake models for all pit voids with PAF exposure in the final pit wall and a strategy to leave as a pit lake [951343]	In progress – next MCP
	The potential for high salinity pit lakes to have density driven pit lake water outflow to the surrounding aquifer.	Assess the potential for density driver pit lake water outflow to the surrounding aquifer due to high salinity. [1085733]	In progress – next MCP
	The water balance at closure that considers surplus water (quality and quantity) stored during operations and potential	Complete Managed Aquifer Recharge trial with support from EG [561754]	In-progress – next MCP

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
	requirement for additional water source/s to meet the environmental and cultural objectives.	Develop a water balance during closure to ensure suitable and adequate water availability for the duration of the closure MAR scheme at Caves Creek [1086385]	Progress update in next MCP
		Develop in-pit storage and ASR strategies and conduct suitable disused pit utilisation assessments for surplus water storage [1086387]	Progress update in next MCP
		Assess the potential water quality, chemical composition, turbidity etc of stored water sources for Closure MAR scheme use suitability [1086390]	Progress update in next MCP
		Complete groundwater mounding modelling to assess risks that may adversely impact the health of surrounding ecosystems and development of effective monitoring and operational controls to ensure surrounding water levels are not adversely affected [1086392]	Progress update in next MCP
		Simulate timing, scale (water volumes, rates of recharge and infrastructure requirements) and identify location of a Closure MAR scheme along Caves Creek or SGE using the latest groundwater model following the MAR trial. [1086394]	Progress update in next MCP
Hydrology	Strategies for pits, buttressing, abandonment bunds and landbridges will be refined through assessment of the floodplain modelling completed. Consideration of final surface design of pit areas backfilled to surface within floodplains to prevent head-cutting or scouring during periods of high velocity flow.	Undertake a hydrological and engineering assessment of the final landform to assess risk areas related to surface water management at closure and design structures required to control erosion [880194]	Progress update in next MCP.
		Investigate closure outcomes associated with capture of surface water flows by mine voids [897073]	Next MCP
		Remove all ramps from WRL rehabilitation designs unless post-closure access is required. [1085721]	Next MCP
	Rock armouring required to prevent scouring of WRL toes modelled within rare event flood plains.	Develop engineering designs for mitigating surface water risks to permanent WRL and abandonment bunds located within flood plains [1085717]	10 years from planned closure
	Management of surplus discharge cessation to ensure acceptable creek system health remains.	Define acceptable creek health outcome on cessation of discharge to creeks given there may be permanent catchment area reduction. [1086402]	Progress update in next MCP.

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
		Develop strategy to gradually reduce surplus water discharge to creeks to ensure ecological values are retained. [1086405]	
	Opportunities to reduce loss of Boolgeeda Creek catchment at BS1	Identify and model further opportunities to construct engineer permanent surface water diversion bunds or pit buttressing of BS1 pits to reduce catchment loss to Boolgeeda Creek [1085630]	Progress update in next MCP.
Contaminated sites	A defined completion criteria of contaminated sites remediation requirements with changes to land use that considers source pathway receptors.	Undertake Preliminary Site Investigation 10 years prior to closure [1086414]	10 years from planned closure
		Undertake Detailed Site Investigation 5 years prior to closure. [1086415]	5 years from planned closure
		Develop post closure monitoring and maintenance plan [1086419]	5 years from planned closure
Biological Environment	Detailed completion criteria such as percentage cover / percentage bare ground, species richness / diversity, keynote species, percentage weed cover etc.	Assess baseline data and surveys to refine completion criteria applicable for rehabilitation [1086425]	10 years from planned closure
	Abandonment bunding locations relative to MRZ and MEZs as the mine plan changes during operations	Implement mine planning approval process to include evaluation of Abandonment bund locations and MRZ/ MEZs [1086429]	Next MCP
	Monitoring criteria to validate effectiveness of MEZs to carry over from the operational EMP.	Review effectiveness of MEZs during operations to ensure they are adequate to meet completion criteria. [1086435]	5 years from planned closure
Rehabilitation (Refer to Section 9.4.3)	Suitability of Brockman Syncline rehabilitation monitoring reference sites.	Review of Brockman Operation rehabilitation reference sites to determine if they are appropriate for ongoing use in the rehabilitation monitoring program. [1086440]	Next MCP

Factor	Closure knowledge gap	Associated closure risk assessment action/s	Comment (timing / progress)
	Rehabilitation completion criteria refinement	Assess baseline data and surveys to refine completion criteria applicable for rehabilitation [1086425]	10 years from planned closure
	Methods for rehabilitation of Pilbara creek line habitats	Undertake research to improve business knowledge of rehabilitation of riparian environments, including methods for restoration of Pilbara creek line habitats [880190]	Progress update in next MCP.

[#] Action identification number associated with risks captured in the Brockman Operation Closure Risk Register (Appendix 5) and Action Register Appendix 6)

DATA ANALYSIS AND IMPLICATIONS FOR CLOSURE

6. POST-MINING LAND USE

6.1. Pre-Mining Land Use

The Brockman Operation lies within the traditional lands recognised as belonging to the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People (Figure 2-1).

There are no permanent Aboriginal communities in close proximity to the Brockman Operation. The closest Aboriginal community is Wakathuni, located 20km south of Tom Price. There is a private camp located along White Quartz Road (WQR) (referred to as the White Quartz Culture Camp) which has one Muntulgura Guruma resident and is used intermittently by the Muntulgura Guruma People during lore time and for educational activities.

Since European settlement, land uses in the region have included cattle grazing, exploration, mining and conservation. Aside from mining activity and associated infrastructure, the Project area is largely undeveloped. Pastoral activity in the region has historically been cattle grazing, with the following pastoral leases underlying tenure of the closure boundary:

- Hamersley Station;
- Rocklea Station; and
- Cheela Plains Station.

Both Hamersley and Rocklea Stations are owned by Rio Tinto. Cheela Plains Station is privately-owned and, through consultation with Rio Tinto, the Station Owners have expressed their preference for Rio Tinto to purchase the portion of the pastoral lease (approximately 30,000 ha) which is intersected by the closure boundary. It is anticipated that Rio Tinto will reach agreement with Cheela Plains for this acquisition in terms of signing the required documentation and practical completion in mid-2022 (once necessary internal and external approvals, including confirmation of support from the PKKP AC, are received).

Mining is common in the Pilbara and FMG operate the Eliwana-Flying Fish iron ore mine, located adjacent (north and west) of the proposed BS1 mine area.

6.2. Proposed Post-Mining Land Use

The post-mining land use needs to be clearly articulated to allow for the development of specific closure outcomes, which are used in the development and formalisation of closure criteria. In accordance with the DMIRS Statutory Guidelines (DMIRS 2020a) the proposed post-mining land use should be:

- relevant to the wider regional environment;
- achievable in the context of post-mining land capability;
- acceptable to Rio Tinto stakeholders; and
- ecologically sustainable in the context of the local and regional environment.

Subject to the native title determinations noted above, Traditional Owner groups continue to access and use the land the subject of the closure boundary for traditional purposes (Section 5.1), and this will be factored into post-mining land use.

Options for commercial 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 (e.g. recreation or aquaculture) that might have potential in areas supported with a higher population base are unlikely to be viable.

While the current surrounding and underlying land use across much of the Brockman Operation closure boundary is Pastoral Lease, the natural topography and landscape changes that will result from mining, including deep voids and constructed landforms, a pastoral post-mining land use is not considered a viable land use for areas disturbed by the Brockman Operation.

6.3. ALUM Classification

The proposed post-mining land uses for the Brockman Operation area have been developed using the Australian Land Use Management (ALUM) Classification system (ABARES 2016) to provide a consistent framework for describing land use in Australia. Adopting an ALUM classification approach allows closure to be undertaken in such a manner that maximises the potential future land use opportunities. While the system focuses on the suitability of land for agricultural purposes, it also provides a comprehensive and concise definition of land uses that are consistent across other land planning institutions across Australia. The ALUM classifications have been adopted by WABSI in their framework for developing mine site completion criteria (WABSI 2019). The WABSI completion criteria framework is endorsed by DMIRS as a tool to assist with the development of an MCP.

While the site will have large areas classified as ‘Class 1 - Conservation and Natural Environments’ (ALUM 1.3.4 – Rehabilitation) which may support the surrounding area’s land use of pastoralism, a significant portion of the final landform will include large pit voids and WRLs which do not provide suitable range land for pastoralism. The Brockman Operation will be rehabilitated to develop safe, stable, non-polluting, self-sustaining, functioning ecosystems, but such rehabilitation will not attempt to fully restore the pre-mining environment.

Post-mining land uses will continue to be refined as further investigations are completed. Some examples of the alternative options for consideration post-relinquishment include pastoralism, mining tourism and solar farming. Land use options will continue to be investigated throughout the life of the project in consultation with local communities, pastoralist stakeholders, and Traditional Owners.

Table 6-1: Post-mining land uses of the Brockman Operation

ALUM Domain class	Relevant domains	Anticipated outcomes
1.1.3 Residual native cover	Undisturbed areas	Residual native vegetation not cleared by the operation
1.3.4 Rehabilitation	Infrastructure areas Roads, tracks and laydown yards WRLs including landbridges, stockpiles remaining at closure and areas of pits buttressed or backfilled to surface Ex-pit WFSF Pits backfilled to surface Infrastructure Haul roads and other disturbance Irrigated Agricultural Area - *Alternative beneficial use may be agreed to with stakeholders*	Safe, stable non-polluting landscapes vegetated with self-sustaining native vegetation of local provenance.
5.8.4 Extractive industry not in use	Pits, including in-pit WFSFs not backfilled to surface	Areas will be made safe, stable, and non-polluting, with access restricted to the public where appropriate.
2.1 Grazing native vegetation	*Some areas may fall under this ALUM domain class but have not yet been determined as post-closure tenure arrangements and alternative beneficial use have not been determined with stakeholders.*	

RioTinto

Figure 6-1
Proposed Brockman Operation
ALUM Code Classification

Drawn: L.Fuentes
Plan: PDE0172868v2
Date: September 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:200,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary

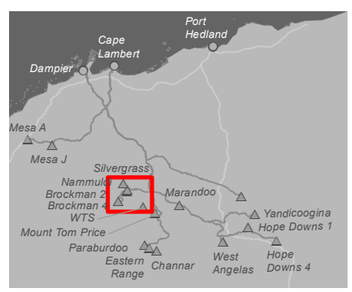
ALUM Codes

- 1.3.3 Residual native cover
- 1.3.4 Rehabilitation
- 5.8.4 Extractive industry not in use

- Rio Tinto Mine
- Airport
- Railway
- Conveyor
- Major Road
- Minor Road

Silvergrass
Nammuldi
Brockman 2
Brockman 4
Boolgeeda Airport
Western Turner Syncline
Mount Brockman Road
Nameless Valley Road
Nanutarra - Munjina Road
ABE RIVER

510,000 520,000 530,000 540,000 550,000 560,000 570,000
7,540,000 7,530,000 7,520,000 7,510,000 7,500,000 7,490,000



N

0 2 4 6 8 10
Kilometres

Map units in metres

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7. CLOSURE RISK ASSESSMENT

Risk assessment and management is an integral component of Rio Tinto's business framework and approach to closure planning. The objectives of risk management are to improve execution and reduce risk exposure. To achieve these objectives, Rio Tinto manages all business risks using the RSA Archer Integrated Risk Platform which provides the business with a consolidated and clear view of risks, including version and history tracking and unique identification of risks, controls and actions for tracking purposes.

Risk assessments are undertaken to qualitatively and quantitively guide the selection of closure options, assess specific risk and identify controls for the design and execution of closure. Successful management of risks requires the implementation of a clear risk management strategy supported by adequate resources, a strong risk-aware culture, and maintaining an up-to-date risk register that is regularly consulted and reviewed.

7.1. Risk Assessment Process

All Rio Tinto closure risk assessments are facilitated by competent personnel, involving a range of technical and subject matter experts.

The aims of the closure risk assessment process are to:

- Identify potential hazards that could influence successful closure of the mine.
- Evaluate the risks given the management controls/strategies described within the MCP and consideration of the risk likelihood and consequences (using the descriptors included within the Rio Tinto HSEC 5 x 5 risk determination matrix, refer to Table 7-1) to establish an overall risk class, which can range from Class I (Low) to Critical IV (Critical). The detailed likelihood and conbsequnce descriptors can be found in Appendix 5.
- Identifying additional control measures (actions) for significant threats rated as either Class III (High) or Class IV (Critical) to ensure the residual risk rating is as low as reasonably practicable (ALARP).
- Review and update risk, control effectiveness and action status.
- Communicate risk information.

Issues are assessed against set consequence criteria (environment, health and safety, cost of closure, community trust, and compliance) and risk is evaluated based on the maximum reasonable outcome consequence and the likelihood of that consequence occurring to derive an inherent risk rating, prior to the application of treatments, and a residual risk rating, inclusive of current management and commitments. The ALARP principle is to be used when determining which risk treatments to apply.

Table 7-1: Risk class determination

Likelihood	Most serious consequence				
	Very low	Low	Moderate	High	Very high
Almost certain	Class II	Class III	Class IV	Class IV	Class IV
Likely	Class II	Class III	Class III	Class IV	Class IV
Possible	Class I	Class II	Class III	Class IV	Class IV
Unlikely	Class I	Class I	Class II	Class III	Class IV
Rare	Class I	Class I	Class II	Class III	Class III

The risk classification identifies the level of management action that must be taken to mitigate the threat (Table 7-2). A risk determination of Class III or Class IV reflects a material risk that requires active management and consideration of additional control measures. All Actions associated with risk management and mitigation are captured in Archer and reflected in the Brockman Operation Closure Risk Assessment (Appendix 5).

Table 7-2: Risk management response

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

A control effectiveness rating is determined for each risk to evaluate whether the control will effectively mitigate the risk. If controls are deemed Marginal or Weak then actions are assigned to improve the control effectiveness.

Good – control is considered adequately designed and is operating effectively on almost all occasions.
Satisfactory – control is considered adequately designed and is operating effectively on most occasions.
Marginal – control is considered inadequately designed or is only operating to partial effectiveness on most occasions.
Weak – there is no control designed or the control is operating ineffectively on all occasions.

7.1.1. Risk evaluation

The following risks (threats and opportunities) were defined by considering the likelihood of different outcomes occurring across the Brockman Operation given the nature of the local environment established through collection of baseline data:

- The inherent risk presents the conditions that may result without implementing controls during operations or closure.
- The residual risk was determined by considering the likelihood of the consequences occurring after the nominated controls are implemented. When evaluating residual risk, Rio Tinto considers that future controls cannot be considered and therefore residual risk reflects the current risks status. Rio Tinto has not evaluated a final or treated risk.

Risks within the Brockman Operation closure risk register are reviewed and updated as conditions changes. The Brockman Operation closure risk register is also systematically reviewed and updated at least every three years in support of the update to the Brockman Syncline MCP or as required by the MS.

7.2. Brockman Operation closure risk profile

A summary of the current closure risk profile for the Brockman Operation is presented as Figure 7-1 which shows that there are 17 open risks. Actions are assigned to risks that exceed the risk acceptance threshold and therefore require additional control measures to reduce the risk at closure to an acceptable level. Actions are also assigned to address knowledge gaps where it is assessed that further information is

required to reduce uncertainty. This would typically be the case in the early stages of operations where the detailed knowledge of the issues may be low. These actions are captured in the Brockman Operation Action register (Appendix 6).

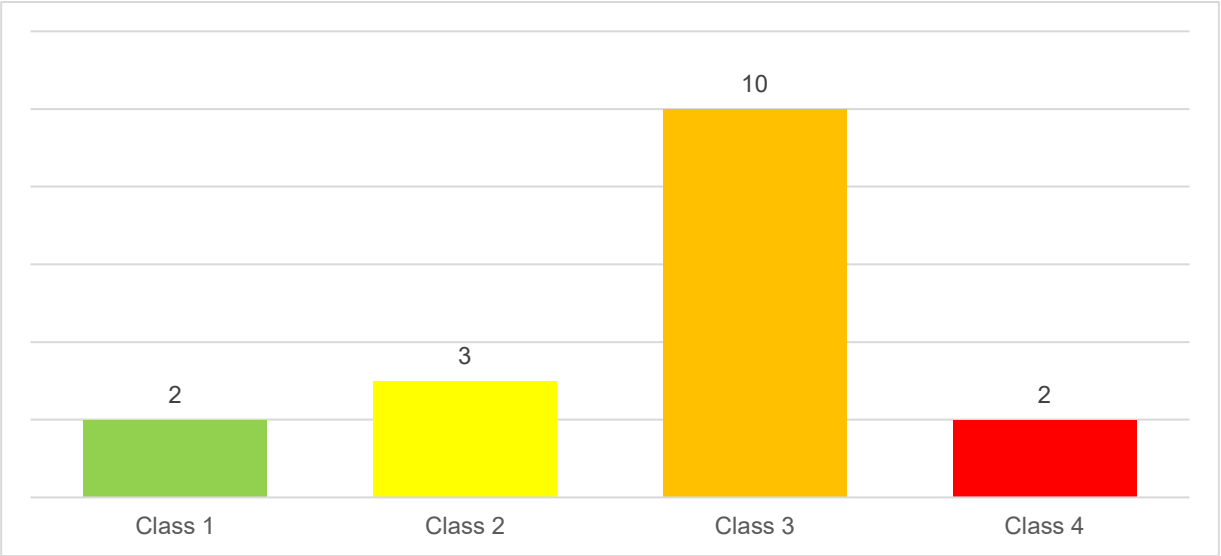


Figure 7-1: Risk Profile for closure of the Brockman Operation

7.2.1. Closure Class IV risks

The following two Class IV threats have been identified as relevant to closure of the Brockman Operation:

- Risk 880204 – Inability to maintain self-sustaining function of Palm Springs and restore pre-mining culture and environmental values of Caves Creek system.
- Risk 878376 – Implementation of the closure strategy does not achieve the required cultural heritage outcomes.

The causes, impacts, existing controls, evaluation rationale and planned actions for each of these threats are detailed within Appendix 5 and Appendix 6.

Risk 880204, “Inability to maintain self-sustaining function of Palm Springs, and restore pre-mining cultural and environmental values of Caves Creek system”, is pertaining to the potential to impact the function of Palm Springs located along Caves Creek, downstream of the SGE mining operations. The site has significant cultural and environmental values and is connected to Caves Creek Aquifers that are also in connection to the BWT resource at the SGE operation. Dewatering operations at SGE has the potential to reduce water levels at Palm Springs if effect mitigation is not developed, such as MAR. A MAR trial commenced in July 2022 to develop a mitigation strategy to prevent impacts to Palms Springs from occurring. An Operational MAR scheme is required to continue throughout Operations and closure to maintain the self-sustaining function of Palm Springs and to accelerate water level recovery of Caves Creek post-mining. At closure, the closure MAR water source for injection into the Caves Creek aquifer system is proposed to be from the Brockman Syncline operation surplus water storage or ASR and, if required, from other water sources that are compatible with the Caves Creek cultural and environmental values as discussed in Section 5.10.8.

Risk 878376, “Implementation of the closure strategy does not achieve the required cultural heritage outcomes”, is considered as a risk to implementation of closure strategies that are not agreed to with, or do not consider heritage sites and cultural values of the Traditional Owners groups. Further consultation with Traditional Owner groups specifically relating to closure are required to come to an agreement on the proposed closure strategies, closure completion criteria and closure outcomes. This includes agreed closure outcomes on changes to environmental conditions due to the cessation of operational or artificial support or mitigation activities such as dewatering, water supplementation and other aspects that include but are not limited to visual amenity of the closure landscape. Existing consultation and engagement forums

and proposed engagement strategies are proposed to establish agreed closure strategies through the SCHMPs to inform closure planning and closure outcomes to achieve cultural heritage outcomes. Development of the closure strategy will require identification of cultural heritage sites and social surrounds, including but not limited to incorporation of ethnobotanical species of importance for rehabilitation, safeguarding and return of cultural heritage artefacts, and opportunities for improving the altered mining landscape.

7.2.2. Closure Class III risks

The following ten threats have been identified as relevant to closure of the Brockman Operation:

- Risk 87778 – The safety risk for people entering the Brockman Operation after it has been rehabilitated and closed has not been effectively mitigated.
- Risk 878264 – Pit voids at Brockman Operation present an unacceptable environmental risk.
- Risk 878268 – Seepage is released from the Brockman Operation WFSFs into the surrounding environment.
- Risk 878269 – Consultation fails to identify and/or address stakeholder concerns.
- Risk 878352 – Waste dumps and/or landbridges at Brockman Operation are subject to excessive erosion.
- Risk 880176 – Rehabilitation outcomes at Brockman Operation do not meet closure outcomes.
- Risk 880193 – Implementation of the closure strategy does not achieve the required environmental outcomes.
- Risk 880208 – Failure to reach agreement with the State on suitable completion criteria for the Brockman Operation.
- Risk 880210 – Insufficient material for capping and/or backfill increases closure liability and complexity.
- Risk 877773 – Inadequate management of PAF material at Brockman Operation results in AMD and increased closure complexity and costs;

The causes, impacts, existing controls, evaluation rationale and planned actions for each of these threats are detailed within Appendix 5 and Appendix 6.

7.3. Management of key issues

Appendix 7 of DMIRS *Mine Closure Plan Guidance - How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans* (DMIRS 2020) lists a number of rehabilitation and closure issues that may be relevant for mine sites, including 13 that are identified as key issues at the Brockman Operation.

An evaluation of the relevance of each of these issues is presented in Table 7-3. The information in this table is intended to compliment the data and information presented in Section 5 of this MCP and that contained in the risk assessment presented as Appendix 5.

Table 7-3: Management of key closure issues at Brockman Syncline

Issue	Evaluation of issue
Key issues relevant to closure of the Brockman Operation	
Contaminated sites	One existing contaminated site in the B2N area was classified in 2009 as 'Contaminated – restricted use'. There are no other reportable contaminated sites across the Brockman Operation. A preliminary site investigation will be conducted prior to closure to identify any contaminated sites and determine management measures, if required, to support the post-mining land use.
Acid and metalliferous drainage	Geochemical characterisation of waste rock and management of potential AMD risk is discussed in Section 5.8. Geochemical studies of the waste rock to be mined has been undertaken across the Brockman Operation (Appendix 12 to Appendix 16). Preliminary closure geochemical risks have been developed for all pits in order to develop closure management measures. All PAF material mined at the Brockman Operation will be encapsulated to prevent AMD, as per the SCARD Management Plan (Appendix 11).
Fibrous materials	Fibrous minerals identification and management is discussed in Section 5.8. All excavated fibrous material will be permanently encapsulated within WRLs. Fibrous material may be exposed in final pit walls will be managed on a case-by-case basis as in-situ fibres are exposed.
Mine pit lakes	Seven pit lakes are anticipated to form post-closure. Three at B2N: • Lens EF, Lens CD; and Lens G. Four at BS4: • BS4MM O1 and M2; and BS4MN N1 and N2. Due to the compartmentalised nature of the Brockman Syncline aquifer, it is assumed all pit lakes will act as groundwater sinks and are not expected to have a degrading effect on regional groundwater quality or an impact on any downstream receptors (environmental/cultural). Pit lake water quality evolution modelling is underway for Lens CD and EF due to the PAF material exposures anticipated to be left on the final pit wall.
Surface and groundwater quality	Groundwater quality and closure management measures are discussed in Section 5.10. There are no significant impacts to surface water quality anticipated at closure.
Waste fines storage facilities	Tailings characterisation and storage is discussed in Section 5.9. The Nammuldi WFSF is an ex-pit valley fill facility and was commissioned in 2013. It will be decommissioned in 2027 and waste fines will then be directed to in pit storage at one or all of the following B2N pits (Pit 5, Pit 8 and Lens A).
Dispersive, sodic and erosive materials	Physical characterisation and erosion management of mineral waste is discussed in Section 5.7. There is a wide range of erodible mineral waste anticipated across the Brockman Operation. High erodibility material is specifically managed through

Issue	Evaluation of issue
	preferential dumping to the centre of WRLs or pit backfill or, when this is not available, erodible WRL batters will be rock armoured with competent material. No dispersive or sodic waste materials have been identified at the Brockman Operation.
Surface water management structures	Flood modelling on the conceptual closed landform has been completed for the current indicative mine layouts (Appendix 21). As the site layout is finalised and pit and WRL designs progressed, surface water management at closure may include permanent surface water management structures where the toe of WRLs or pit abandonment bunds are designed to interact with high velocity flood water. If required, these structures will be engineered to withstand 1:10,000 flood events.
Challenges associated with rehabilitation and revegetation	Performance of rehabilitation completed to date is described in the Brockman Operation Progressive Rehabilitation Summary (Appendix 22). Research and development initiatives are delivering tangible improvements that will be integrated into improving future outcomes in proposed mining areas. Topsoil inventory is provided in Section 5.5.2 and rehabilitation material availability is discussed in Section 5.7.6. There is currently forecast to be sufficient topsoil available across Brockman Operation to complete rehabilitation of disturbed areas.
Social and cultural heritage values including visual amenity	Significant social and cultural heritage values have been identified by the Puutu Kunti Kurrama and Pinikura People and Muntulgura Guruma People (Section 5.1) and closure strategies are required to ensure values are protected. Post-closure access to agreed sites of significance will be established in consultation with the respective Traditional Owner group. Visual amenity is considered in the development of the site layout and WRL designs. A final visual impact assessment of the anticipated closure landform will be undertaken during closure study stages.
Geotechnical stability and risk of inadvertent public access	Geotechnical stability of pits is discussed in Section 5.6.4. The PUPEZ for each pit will be updated as pit designs change through the LOM. The risk of inadvertent public access is discussed in Section 5.6.5. Abandonment bunds [and natural topography (>35 degrees)] will be required to restrict inadvertent public access to open voids.
Alteration of the direction of groundwater flow and alteration of the depth to water table of the local aquifer	Depth to water table of the local aquifer in the local mine footprint area will be increased due to operational dewatering. At SGE, operational and closure MAR is proposed to return the aquifer to pre-mining water levels. At Brockman, the water table depth is unlikely to return to pre-mining water levels due to compartmentalised nature of the Brockman Syncline aquifer and very low rate of recharge. Seven pit lakes are proposed at closure which are anticipated to act as groundwater sinks with limited outflow of pit lake water to the surrounding groundwater compartment.
Alteration of the hydrology and flow of surface waters	To enable safe mining of Pit 1 at SGE, a temporary levee is required within the Caves Creek floodplain. At closure, the Pit 1 will be backfilled to surface within the 1:10,000 floodplain. Reduction of catchment to creeks and pools due to the operation is not considered to result in significant environmental or cultural impact. Opportunities to partially restore surface water flows to Boolgeeda Creek from BS1 via pit buttressing will be investigated. Surplus water discharge to creeks once dewatering ceases discharge will be gradually reduced over a period of time until curtailment to enable creek system to return to ephemeral conditions.
Key issues considered not relevant to closure of the Brockman Operation	
Hazardous materials	Hazardous materials (e.g. hydrocarbons, ammonium nitrate) across the Brockman Operation will be removed prior to, or during, decommissioning activities. No hazardous material are anticipated to be used or left on site at closure.

Issue	Evaluation of issue
Hazardous and unsafe facilities	All infrastructure will either be demolished during decommissioning, handed to the State in accordance with State Agreement requirements or handed over to a third party who will assume liability.
Radioactive materials	No naturally occurring radioactive materials are expected to be encountered during mining.
Dust emissions	Closure dust management will be consistent with operational dust controls across the Brockman Operation. Closure implementation is not expected to require additional management measures above those adopted during operations.
Flora and fauna diversity / threatened species	Management of disturbance in proximity of conservation significant species and mining exclusion zones will be consistent with operational controls. Closure implementation is not expected to require additional management measures above those adopted during operations.
Community issues	There are no townships, remote communities, or pastoral stations directly impacted by the closure of the Brockman Operation. Note that the portion related to Cheela Plains is being purchased. Surface water discharge into Mt Stuart is also limited and considered indirect.

8. CLOSURE OUTCOMES AND CRITERIA

8.1. Closure Outcomes

Closure outcomes and objectives have been developed with consideration of DMIRS (2020c) objective for rehabilitation and closure is that mining activities are rehabilitated and closed in a manner to make them physically safe to humans and animals, geo-technically stable, geo-chemically non-polluting/non-contaminating, and capable of sustaining the proposed post-mining land use without unacceptable liability to the State. Outcomes are also aligned to Rio Tinto's general vision for closure in the Pilbara.

8.1.1. Vision for closure in the Pilbara

Closure outcomes are developed with consideration of Rio Tinto's general vision for closure, which is to:

- Relinquish its mining leases to the Western Australian State Government.
- 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 that consider the implications on local communities.
- Achieve completion criteria that have been developed with stakeholders and agreed with WA Government.
- Develop landforms that are safe, 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 that addresses the impacts of closure on employees and contractors.
- Achieve successful closure in a cost-effective manner.

8.1.2. Brockman Operation closure outcomes

The overarching goal for closure of the Brockman Operation is to relinquish the site to the State Government through demonstrating that the agreed closure outcomes haven met. This will be achieved once the government and community agree that the condition of the site is compatible with an agreed post-mining land use. Closure outcomes reflect the aspects of the closure plan that the government and community stakeholders have indicated are key to evaluating the site condition. They do not represent the full range of issues that need to be addressed upon closure; rather they represent the key outcomes against which the ability to relinquish will be assessed.

The closure objectives for the existing operations at BS4, B2N, and Silvergrass were approved through the current site MCP's by DWER in 2017, 2018, and 2020 respectively. Whilst the intent of these objectives (now outcomes as per DMIRS 2020 Guidelines) remain current, the proposed 11 closure outcomes for the Brockman Operation have been developed to address several key issues more explicitly and to support closure outcomes for proposed deposits (Table 8-1).

Due to the planned long life of the Brockman Operation these outcomes are likely to evolve as knowledge of closure grows and detailed closure stakeholder consultation progresses.

Table 8-1: Proposed Brockman Operation closure outcomes

Number	Outcome
1	The final landform is stable, and its design considers hydrological and ecological factors.
2	Contamination risks have been appropriately managed and do not preclude the proposed post-mining land use(s).

Number	Outcome
3	Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use.
4	Public health and safety hazards have been appropriately managed.
5	Pit lakes do not represent a significant ecological risk.
6	Infrastructure has been appropriately managed.
7	Cultural heritage values have been preserved where possible.
8	AMD and fibrous material risks are compatible with the proposed post-mining land use.
9	The hydrological function of Boolgeeda Creek, Duck Creek and Caves Creek are maintained post-closure.
10	The environmental values of the Threatened grassland TEC are maintained.
11	Groundwater systems support phreatophytic vegetation at Palm Springs.

These outcomes do not represent the full range of issues that need to be addressed upon closure of Brockman Operation; rather they represent the key outcomes against which the ability to relinquish will be assessed.

Indicative completion criteria and measurement tools have been drafted for each of these outcomes and are discussed further in Section 8.2.

8.2. Completion Criteria

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

Preliminary completion criteria, as detailed in Table 8-2, have been developed in consideration of the predicted closure outcomes. Measurement processes and the associated supporting data (evidence and / or metrics) that could be used to evaluate the success of closure are also described in Table 8-2.

The completion criteria are subject to ongoing review and update, informed by the outcome from studies, monitoring and ongoing stakeholder consultation. Given the number of years until scheduled closure, the completion criteria contained in this MCP are considered indicative only. As the site approaches scheduled closure, the completion criteria will contain more measurable and time-bound parameters.

Table 8-2: Preliminary Brockman Operation closure completion criteria

Outcome	Preliminary completion criteria	Verification process/method	Evidence
The final landform is stable, and its design considers hydrological and ecological factors.	No erosion features that compromise landform integrity or stability are present. Erosion from landforms does not threaten the health of surrounding natural ecosystems The final landform has been designed and constructed with consideration given to its geotechnical stability during intense rainfall and large flood events. Final landforms are outside pit crest zones of instability	Post-construction review by competent person to ensure landforms were built in accordance with plan, including QA/QC checks. Quantitative evaluation of behaviour of rills and gullies over time. Analysis of aerial imagery to provide qualitative analysis of landform stability.	Post-construction landform evaluation report. Survey data assessment. Analysis of aerial imagery.
Contamination risks have been appropriately managed and do not preclude the agreed post-mining land use(s).	Contaminated sites have been classified under the *Contaminated Sites Act 2003* (WA): • Not contaminated - unrestricted use; • Contaminated – restricted use; • Remediated for restricted use, or • Decontaminated. Restriction on use as defined on the Notice of Classification does not prevent the ability to conduct agreed post-mining land use(s).	The site has been appropriately assessed for the presence of suspected or known contaminated sites. Suspected or known contaminated sites have been appropriately reported under the Contaminated Sites Act 2003. Appropriate management measures to address contamination have been implemented to reduce contamination to an agreed level.	Contaminated sites investigation report(s) undertaken in accordance with the DWER Contaminated Sites Guidelines and the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM). Reports submitted to the Contaminated Sites Branch of DWER. Notice of classifications.
Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use.	Seed used in rehabilitation works is of local[1] provenance. Native plants within rehabilitated areas are observed to flower and/or fruit. Recruitment of native perennial plants is observed.	Seed management plan. Rehabilitation monitoring/site inspections. Analysis of historical monitoring data.	Rehabilitation close-out report (inclusive of seed list). Rehabilitation monitoring reports.

[1] Local is defined as Pilbara IBRA and/or as defined in NVCPs

Outcome	Preliminary completion criteria	Verification process/method	Evidence
	Species richness of native perennial plants within rehabilitated areas is of an appropriate range of that in reference sites Diversity and abundance of weed species recorded within rehabilitation areas will be no higher than within established reference sites.		
Public health and safety hazards have been appropriately managed.	Safety and health risks have been identified. Measures to mitigate the identified public safety (and fauna where appropriate) and human health hazards have been agreed with key stakeholders and have been implemented. Transfer of any residual liabilities is agreed with stakeholders.	Health and safety risk assessment completed, and hazard reduction actions implemented. Relevant stakeholders have been engaged on risk mitigation measures to be implemented Independent audit to confirm that hazard reduction measures have been implemented, and controls are effective. Process for transfer of residual liabilities is documented.	Risk assessment report and hazard reduction action plan. Audit report to confirm action implementation and control effectiveness. Records of stakeholder engagement. Liability transfer agreement/s.
Pit lakes do not represent a significant ecological risk.	Pit lake water quality in the Lens CD, Lens EF, Lens G, O, N1, N2 and M1 pits does not adversely impact downstream sensitive receptors. BS4 Main and SGE BWT pits have been backfilled to above the pre-mining water table as per MS 1000 and MS 925 respectively. All other BWT pit voids are backfilled so that the final surface levels are sufficient to suppress permanent pit lakes.	Pit lake modelling. Environmental monitoring. As constructed reports.	Environmental monitoring and investigation reports. Pit lake model validated using onsite monitoring data. As constructed reports.
Infrastructure has been appropriately managed.	Legal agreement to transfer residual liability completed (if required). Where transfer of liability is not established, infrastructure has been decommissioned and appropriately removed.	Appropriate agreements and transfer processes in place and communicated for any infrastructure remaining post-closure. Decommissioning and demolition plan.	Agreements in place with party assuming liability for infrastructure. Decommissioning and demolition audit report.

Outcome	Preliminary completion criteria	Verification process/method	Evidence
		Audit of post decommissioning and demolition works,	
Cultural heritage values have been preserved where possible.	Safe access to sites of cultural significance is implemented as agreed with key stakeholders. Key heritage sites have not been impacted by closure implementation where possible. Closure strategies have been developed in consultation with Traditional Owner representatives. The final landform has been subject to visual impact assessment.	Designated access pathways have been identified and communicated. Abandonment bund restriction areas are communicated. Heritage survey confirms heritage sites of significance have not been impacted. Stakeholder consultation. Visual impact assessment. Ethnographic survey and/or site inspection.	Maps of designated access pathways. Maps of abandonment bund locations. Heritage survey report. Consultation register. Visual impact assessment report. Survey report.
AMD and fibrous material risks are compatible with post-mining land use.	Containment landforms designed and constructed with consideration given to its stability during intense rainfall and large flood events. Passive AMD and fibrous material control measures have been implemented to limit the likelihood and / or consequence of potential impacts. The consequence of potential impacts from unexpected release of acid and / or metalliferous drainage is compatible with post- mining land use.	As constructed reports. Geochemical risk assessment and evaluation. Monitoring requirements are completed in alignment with the SCARD management and Fibrous Materials Management Plan. Contaminant migration monitoring program including surface and groundwater.	As constructed reports. Monitoring reports including store and release cover performance. Pit wall mapping. Static and kinetic geochemical tests.
The hydraulic function of Boolgeeda Creek, Duck Creek and Caves Creek are maintained post-closure.	Flow regimes and velocity from the surplus water discharge points to the wetting fronts at Boolgeeda Creek and Duck Creek are able to sustain natural ecosystems, including riparian vegetation. The Caves Creek flood protection levee required at Silvergrass East Pit 1 has been removed and Pit 1 has been buttressed to maintain Creek flow.	Monitoring and assessment of flow regimes and velocity comparable to the undisturbed creek environment. Review and assessment of realignment designs against the constructed landform. Rehabilitation close-out report and monitoring information.	Riparian vegetation monitoring reports. Audit report confirming as-built realignment conforms to construction design. Rehabilitation close-out and monitoring reports.

Outcome	Preliminary completion criteria	Verification process/method	Evidence
	Water quality in Boolgeeda Creek, Duck Creek, Caves Creek is comparable to regional pre-mining conditions.	Surface and groundwater level and quality monitoring.	Water quality and hydrological review reports.
The environmental values of the Themeda grassland TEC are maintained.	The final SGE landform is constructed to maintain the Caves Creek hydrological regime which does not significantly impact the condition of the Themeda grasslands TEC.	Hydrological assessment. Sediment drainage design. Vegetation condition assessment.	Monitoring reports. Final landform construction reports. Rehabilitation and monitoring close-out reports.
Groundwater systems support phreatophytic vegetation of Caves Creek and Palm Springs.	Water quality of Caves Creek and Palm Springs is comparable to pre-mining conditions. Groundwater levels at SGE and Palm Springs are similar to pre-mining conditions.	Surface and groundwater level and quality monitoring. Groundwater Dependent Vegetation monitoring program in accordance with the Nammuldi-Silvergrass Monitoring and Management plan.	Monitoring reports.

9. CLOSURE IMPLEMENTATION

Closure implementation occurs progressively throughout the life of mine and is an integral part of mine planning to ensure that resources (materials, machinery and personnel) are available to complete rehabilitation and closure tasks in accordance with the post mining land use. An outline of the general closure strategies to be implemented at the Brockman Operation are:

- Collection of baseline and operational data
    - Continual update of knowledge base as learning arises from various studies and investigations.
    - Closure research, investigations and trials (Section 9.6).
    - On-going monitoring during operations.
- Materials handling and utilisation
    - Harvesting and stockpiling of topsoil for use during rehabilitation.
    - Identification and segregation of PAF material, mineral-rich and fibrous mineral waste rock.
    - Temporary stockpiling of competent benign waste rock for use during rehabilitation.
- Design and construction of landforms
    - WFSF covers and capillary breaks.
    - Progressive encapsulation of PAF material, metalliferous or fibrous mineral.
    - Re-profiling of WRLs to meet specific slope angle and batter height parameters to ensure erosion resistance.
- Identification and management of site contamination
    - Areas with the potential for contamination will be assessed and managed in accordance with DWER requirements under *Contaminated Sites Act 2003*.
- Decommissioning and removal of infrastructure
    - Progressive removal of redundant infrastructure where possible.
- Rehabilitation of redundant landforms and disturbance footprints
    - Rehabilitation of WFSF will meet design requirements specific to each facility, particularly relating to placement of covers and / or encapsulation layers, prior to cover with growth medium.
    - Construction of pit abandonment bunds, surface water diversion bunds, levees.
    - Dispersal of seed mixes containing local provenance species.
    - Partial backfilling of selected pit voids.

9.1. Closure Domains

To aid implementation of the MCP, areas of the operation with similar features and with similar decommissioning, rehabilitation and closure requirements have been grouped into domains. The distribution of closure domains for the respective mine areas are illustrated in Figure 9-1 to Figure 9-3.

The closure domains of the Brockman Operation comprise:

- Pits – all voids remaining at closure:
    - AWT voids

  - BWT voids not backfilled
  - BWT voids partially backfilled to prevent a pit lake
- WRLs remaining at closure:
  - Inert external WRLs
  - AMD risk external WRLs
  - AMD risk in-pit WRLs
- WFSFs:
  - Ex-pit WFSF
  - In-pit WFSFs
- Infrastructure
- Haul roads and other disturbance
- Irrigated agricultural area

Closure measures associated with each closure domain are described in the associated Closure Work Program described in Section 9.1

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Figure 9-1
Brockman 4
Closure Domains

Drawn: L.Fuentes
Plan: PDE0172869v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A3
GIS.Team@riotinto.com

510,000
520,000
530,000
540,000
7,510,000
7,500,000
7,490,000

Boolgeeda Airport
Brockman 4
BOOLGEEDA CREEK

Legend

- Closure Boundary
- Major Creek

Closure Domains

Pits – all voids remaining at closure

- AWT voids
- BWT voids not backfilled
- BWT voids partially backfilled to prevent a pit lake

WRLs remaining at closure

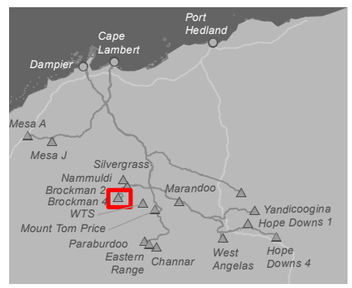
- Inert external WRLs
- AMD risk external WRLs
- AMD risk in-pit WRLs

WFSFs

- Ex-pit WFSF
- In-pit WFSFs

Others

- Infrastructure, haul roads and other disturbance
- Irrigated agricultural area



N

0 1 2 3 4 5
Kilometres

Map units in metres

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Figure 9-2
Brockman 2 - Nammuldi Closure Domains

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Plan: PDE0172869v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Major Creek

Closure Domains

Pits – all voids remaining at closure

- AWT voids
- BWT voids not backfilled
- BWT voids partially backfilled to prevent a pit lake

WRLs remaining at closure

- Inert external WRLs
- AMD risk external WRLs
- AMD risk in-pit WRLs

WFSFs

- Ex-pit WFSF
- In-pit WFSFs

Others

- Infrastructure, haul roads and other disturbance
- Irrigated agricultural area



N

0 1 2 3 4 5

Kilometres

Map units in metres

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Figure 9-3
Silvergrass
Closure Domains

Drawn: L.Fuentes
Plan: PDE0172869v2
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- Major Creek

Closure Domains

Pits – all voids remaining at closure

- AWT voids
- BWT voids not backfilled
- BWT voids partially backfilled to prevent a pit lake

WRLs remaining at closure

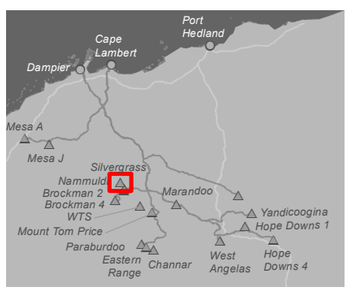
- Inert external WRLs
- AMD risk external WRLs
- AMD risk in-pit WRLs

WFSFs

- Ex-pit WFSF
- In-pit WFSFs

Others

- Infrastructure, haul roads and other disturbance
- Irrigated agricultural area



N

0 1 2 3 4 5

Kilometres

Map units in metres

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9.2. Closure Work Programs

The Brockman Operation Closure Work Programs, documented in Section 9.2.1 to Section 9.2.11 reflect the current level of site knowledge for each closure domain. As some aspects of the site are in operation and others are yet to be developed, the Closure Work Programs are considered preliminary and will continue to be developed over the LOM to provide detailed closure implementation requirements, final landform designs and closure strategies.

It is intended that the Closure Work Program for each domain will form the basis of a more detailed Decommissioning and Rehabilitation Plan, which will be used for closure implementation,

The Closure Work Program for each domain presents key information relevant to each domain, including:

- domain features, status and closure date.
- post-mining land use ALUM classification.
- relevant closure design information.
- closure assumptions.
- knowledge gaps.
- preliminary closure outcomes relevant to each domain.
- closure monitoring and maintenance requirements; and
- closure strategy and key tasks for rehabilitation and closure.

9.2.1. Above water table pits

Table 9-1 summarises the Closure Work Program for the AWT pit domain.

Table 9-1: Above water table pit domain Closure Work Program

Program Aspect	Program Summary
Domain features	BS1: E3 pit BS4 Main: 1, 8, 9, 13, 14, 19 BS4MN: M1 Endeavour: Endeavour 2 BS3: Stage 1 & 2 BS3Ext: Sandleford 1/2/3, Monkey 1/2/3, Creekside 1, Orbe 1/2, Lauriston, Brokenwood, MM-J-2 BS2 Main: 1, 2, 3, 6X, 7 BS2 West: 1a, 1d, 2b, 3a, 3b BS2 Extension: 9, 9c, 14a, 14b, 14c, South East Nammuldi: LF5 SGE: Pit 7
Domain Area	436.3 Ha
Status of domain features	Various (see Table 2-1)
Estimated closure date	Various (see Table 2-1)
Post-mining land use	5.8.4 Extractive industry not in use
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • AMD and fibrous material risks are compatible with post-mining land use. • Cultural heritage values have been preserved where possible.
Specific closure assumptions	• Prior to final closure, appropriate evaluation and implementation of measures to restrict inadvertent public access. • All permanent ex-pit WRLs will be located outside of the PUPEZ. • Elevated sulfur assays AWT have been oxidised and do not represent an AMD risk. • In-situ fibrous material exposures, if any, will not pose a health and safety risk at closure.
Landform design	• No rehabilitation of pit voids is planned at the Brockman Operation unless backfill height is within 10 m of the pit crest. • Indicative abandonment bund locations based on current PUPEZs are presented in Section 5.6.5 .
Knowledge gaps	• PUPEZ associated with final pit voids. • Abandonment bund location and design requires consultation with Traditional Owners and approval by DMIRS. • Surface water management implications of abandonment bund location. • Location/source of appropriate waste rock material for abandonment bund construction. • Extent of buttressing of BS4 Main Pit 1 required to allow for an abandonment bund to be built between the pit and Juukan Gorge.
Closure and rehabilitation materials required	• Competent NAF mineral waste for abandonment bund.

Program Aspect	Program Summary
Closure monitoring and maintenance	• Access assessment. • Geotechnical monitoring. • Assessment of abandonment bund.
Closure strategy – key tasks	
Progressive rehabilitation and closure activities	• Construction of abandonment bund as per DoIR 1997 guidelines.
Decommissioning and closure	• Final closure of abandonment bund and pit ramp. • Installation of signage, if required. • Monitoring / assessment as required.
Premature closure	• Access to pit made safe by construction of abandonment bund (where required) and blocking pit ramps. • Monitoring and maintenance program revised and implemented.

9.2.2. Below water table pits, no backfill

Table 9-2 summarises the Closure Work Program for the BWT pit, no backfill domain.

Table 9-2: Below water table pit, no backfill domain Closure Work Program

Program Aspect	Program Summary
Domain features	Seven pit Lakes: • BS4MM: O1 • BS4MN: M2, N1, N2 • Nammuldi: Lens CD, Lens EF, Lens G Five dry BWT voids - groundwater level not anticipated to return above pit floor: • BS4MM: O2, O3, Q • Endeavour: Endeavour 1 • Nammuldi: Lens B
Domain area	633.7 Ha
Status of domain features	Various (see Table 2-1)
Estimated closure date	Various (see Table 2-1)
Post-mining land use	5.8.4 Extractive industry not in use
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • Pit lakes do not represent a significant ecological risk. • AMD and fibrous material risks are compatible with post-mining land use. • Cultural heritage values have been preserved where possible.
Specific closure assumptions	• Recovered groundwater lever does not return above the pit floor of the BS4MM O2, O3 and Q pits, the Endeavour 1 pit and Nammuldi Lens B pit. • Pit lakes act as terminal sinks due to the very low aquifer recharge rate relative to evaporation. • Prior to final closure, appropriate evaluation and implementation of measures to restrict inadvertent public access. • All permanent ex-pit WRLs will be located outside of the PUPEZ. • In-situ fibrous material exposures, if any, will not pose a health and safety risk at closure.

Program Aspect	Program Summary
Landform design	• No rehabilitation of pit voids is planned at the Brockman Operation unless backfill height is within 10 m of the pit crest. • Indicative abandonment bund locations based on current PUPEZs are presented in Section 5.6.5.
Knowledge gaps	• PUPEZ associated with final pit voids. • Abandonment bund location and design requires consultation with Traditional Owners and approval by DMIRS. • Surface water management implications of abandonment bund location. • Location/source of appropriate waste rock material for abandonment bund construction. • Equilibrium recovered groundwater height to confirm it will not return to above the pit floor within pits not expected to form a permanent pit lake. • Health and safety risk of fibrous mineral exposures on final pit walls.
Closure and rehabilitation materials required	• Competent NAF mineral waste to construct abandonment bunds.
Closure monitoring and maintenance	• Access assessment. • Geotechnical monitoring. • Assessment of abandonment bund.
Closure strategy – key tasks	
Progressive rehabilitation and closure activities	• Construction of abandonment bund as per DoIR 1997 guidelines.
Decommissioning and closure	• Final closure of abandonment bund and pit ramp. • Installation of signage, if required. • Monitoring / assessment as required.
Premature closure	• Access to pit made safe by construction of abandonment bund (where required) and blocking pit ramps. • Monitoring and maintenance program revised and implemented.

9.2.3. Below water table pits, partial backfill to prevent a pit lake

Table 9-3 summarises the Closure Work Program for the BWT pit, partial backfill to prevent a pit lake domain.

Table 9-3: Below water table pit, partial backfill to prevent a pit lake domain Closure Work Program

Program Aspect	Program Summary
Domain features	BS1: E1, E2, W1, W2 BS4 Main: 2, 3, 4, 5, 6, 7, 10, 11, 12, 15, 16, 17, 18 BS4MM: R BS2 Main: BS2 BS2 Extension 10, 11, 12, 13, BS3 Extension: Diesel, Creekside 2, MM-J-1, MM-J-3 SGE: 1, 2, 3, 5, 8
Domain area	1977.8 Ha
Status of domain features	Various (see Table 2-1)
Estimated closure date	Various (see Table 2-1)

Program Aspect	Program Summary
Post-mining land use	5.8.4 Extractive industry not in use
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • AMD and fibrous material risks are compatible with post-mining land use. • Cultural heritage values have been preserved where possible. • The hydrological function of Boolgeeda Creek, Duck Creek and Cages Creek are maintained post-closure. • Maintain environmental values of the Themeda grassland TEC. • Groundwater systems support phreatophytic vegetation at Palm Springs.
Specific closure assumptions	• Prior to final closure, appropriate evaluation and implementation of measures to restrict inadvertent public access. • All permanent ex-pit WRLs will be located outside of the PUPEZ. • In-situ fibrous material exposures, if any, will not pose a health and safety risk at closure. • SGE Pit 1 buttress reinstates surface water flow to Caves Creek. • BS1 pit buttressing reduces surface water catchment loss from Boolgeeda Creek where practical.
Landform design	• No rehabilitation of pit voids is planned at the Brockman Operation unless backfill height is within 10 m of the pit crest. • Indicative abandonment bund locations based on current PUPEZs are presented in Section 5.6.5 . • BS2 pit required to be backfilled to sufficient depth to ensure the returned groundwater level remains at least 3 m below the backfill level. • BS4 Main pits and SGE pits required to be backfilled to above the pre-mining water table. • SGE Pit 1 buttress surface required to be resistant to head-cutting from high velocity flood water. • BS1 E1 and W1 pits buttressed to reduce catchment loss to Boolgeedaa Creek.
Knowledge gaps	• PUPEZ associated with final pit voids. • Abandonment bund location and design requires consultation with Traditional Owners and approval by DMIRS. • Surface water management implications of abandonment bund location. • Location/source of appropriate waste rock material for abandonment bund construction. • In-situ PAF material exposures on final pit walls above the backfill height. • Capping requirements for the top surface of the SGE Pit 1 buttress within the Caves Creek flood plain. • Equilibrium recovered groundwater height to inform backfill heights for pits not required to be backfilled to pre-mining water table height. • Health and safety risk of fibrous mineral exposures on final pit walls.
Closure and rehabilitation materials required	• Competent NAF mineral waste to construct abandonment bunds.
Closure monitoring and maintenance	• Access assessment. • Geotechnical monitoring. • Assessment of abandonment bund.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Progressive construction of abandonment bund as per DoIR 1997 guidelines. • Progressive backfilling of pits as mine scheduling allows.

Program Aspect	Program Summary
Decommissioning and closure	• Final closure of abandonment bund and pit ramp. • Installation of signage, if required. • Monitoring / assessment as required.
Premature closure	• Access to pit made safe by construction of abandonment bund (where required) and blocking pit ramps. • Monitoring and maintenance program revised and implemented.

9.2.4. Inert external waste rock landforms

Table 9-4 summarises the Closure Work Program for the inert external WRL domain.

Table 9-4: Inert external WRL domain Closure Work Program

Program Aspect	Program Summary
Domain features	BS1E: DP1 – DP6 BS1W: DP7 – DP9, DP13, DP14 BS4 Main: DP1, DP4 – DP6, DP8, DP17, DP22, Pit 1 Landbridge 1 & 2, Pit 8 Landbridge BS4MM: DP9, DP11 BS4MN: DP12, DP13, DP14 BS3: DP1 BS2 Main & Extension: Pit 1 WD, Pit 2 WD, Pit 6 WD, Pit 10 Landbridge, West WD, Central WD, B WD, Spod WD, Pit 1 LG SP, Pit 5 LG SP, Pit 8 LG SP, BS2 LB Nammuldi: Lens AB WD, Lens EF2 WD, Lens EF4 WD, Lens EF6 WD, Lens G DP1 & DP2, Lens AB LG SP, Lens C LG SP, Lens C Landbridge, Lens EF4 LG SP, Lens EF SP, NAWT ROM pad, NBWT ROM pad. BS3 Extension: Diesel DP1, Creekside DP1, MMJ DP1, Diesel LG SP, MMJ LG SP SGE: DHW WD
Domain area	1942.4 Ha
Status of domain features	Various (see Table 2-2)
Estimated closure date	Various (see Table 2-2)
Post-mining land use	1.3.4 Rehabilitation
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • The final landform is stable, and its design considers hydrological and ecological factors. • Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • Cultural heritage values have been preserved where possible. • AMD and fibrous material risks are compatible with post-mining land use.

Program Aspect	Program Summary
Specific closure assumptions	• All waste material stored in the WRL is NAF and have a low risk of metalliferous drainage. • High erodibility material has been preferentially tipped to in-pit locations or within the WRL to avoid exposure on WRL surface where possible. • WRLs have been constructed outside of the 1:100 AEP flood plain and PUPEZ. • Waste landforms are constructed in accordance with RTIO design criteria and rehabilitated in accordance with RTIO standards and procedures. • Landbridges will be modified or removed to reinstate natural surface water flow as required. • All fibrous material has been encapsulated during operations as per the FMMP (Rio Tinto 2019b). • 0.5 m of rock armour on WRL batters with high erodibility material is adequate to prevent long term rilling and gullying from exposing this material.
Landform design	• Target mean average erosion rate of 6t/ha/y and average peak rate of 12t/ha/y. • Berms designed to accommodate >200 years of sediment capture. • Crest bunds minimum of 1 m high. • Where available, conceptual rehabilitation designs are provided in Appendix 2. • Scour protection is required where WRL toe is modelled to be at risk of erosion due to high velocity flood water.
Knowledge gaps	• Site-specific physical characterisation of all mineral waste units at the Brockman Operation. • Rehabilitation designs to be developed for all permanent ex-pit WRLs.
Closure and rehabilitation materials required	• Rock armour material of low – moderate erodibility. • Topsoil and subsoil for use as growth medium. • Seed mix.
Closure monitoring and maintenance	• Landform construction monitoring. • Post closure landform stability monitoring. • Erosion monitoring. • Revegetation monitoring.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Re-profile batter slopes to closure design criteria. • Construct toe bunds and safety berms to design criteria. • Spread topsoil on all slopes and flat surfaces, rip and seed.
Premature closure	• Finalise detailed rehabilitation designs. • Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Final reshaping and rehabilitation of any waste landforms not completed progressively during operations.

9.2.5. AMD risk external waste rock landforms

Table 9-5 summarises the Closure Work Program for the AMD risk external WRL domain.

Table 9-5: AMD risk external WRL domain Closure Work Program

Program Aspect	Program Summary
Domain features	BS1: DP10, DP11, DP12 BS4 Main: DP2 BS2 Main: Pit 1 WD, Pit 4 WD Nammuldi: Lens CD WD
Domain area	550.7 Ha
Status of domain features	Various (see Table 2-2)
Estimated closure date	Various (see Table 2-2)
Post-mining land use	1.3.4 Rehabilitation
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • The final landform is stable, and its design considers hydrological and ecological factors. • Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • Cultural heritage values have been preserved where possible. • AMD and fibrous material risks are compatible with post-mining land use.
Specific closure assumptions	• PAF material has been encapsulated during operations as per the SCARD Management Plan (Appendix 11). • High erodibility material has been preferentially tipped to in-pit locations or within the WRL to avoid exposure on WRL surface where possible. • WRLs have been constructed outside of the 1:100 AEP flood plain and PUPEZ. • Waste landforms are constructed in accordance with RTIO design criteria and rehabilitated in accordance with RTIO standards and procedures. • All fibrous material has been encapsulated during operations as per the FMMP (Rio Tinto 2019b). • 0.5 m of rock armour on WRL batters with high erodibility material is adequate to prevent long term rilling and gullying from exposing this material. • Proposed ‘unclassified’ WRLs that are utilised for PAF material storage will be closed as per this Closure Work Program.
Landform design	• BS2 Main Pit 1 WD is considered an ‘Elevated Sulfur WRL’ and requires 1 m of inert material to be placed on the final rehabilitation design surface. • Target mean average erosion rate of 6t/ha/y and average peak rate of 12t/ha/y. • Berms designed to accommodate >200 years of sediment capture. • Crest bunds minimum of 1 m high. • Where available, conceptual rehabilitation designs are provided in Appendix 2. • Scour protection is required where WRL toe is modelled to be at risk of erosion due to high velocity flood water. • A ‘store and release’ cover is required on the top surface, to be constructed as per the SCARD Management Plan.

Program Aspect	Program Summary
Knowledge gaps	• Site-specific physical characterisation of all mineral waste units at the Brockman Operation. • Rehabilitation designs to be developed for all permanent ex-pit WRLs.
Closure and rehabilitation materials required	• Rock armour material of low – moderate erodibility. • Material appropriate for the construction of 'store and release' covers. • Topsoil and subsoil for use as growth medium. • Seed mix
Closure monitoring and maintenance	• Landform construction monitoring. • Post closure landform stability monitoring. • Erosion monitoring. • Revegetation monitoring. • Surface and groundwater monitoring
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Re-profile batter slopes to closure design criteria. • Installation of store and release cover. • Construct toe bunds and safety berms to design criteria. • Spread topsoil on all slopes and flat surfaces, rip and seed.
Premature closure	• Encapsulation of any PAF material not yet encapsulated as per the SCARD Management Plan. • Finalise detailed rehabilitation designs. • Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Final reshaping and rehabilitation of any waste landforms not completed progressively during operations

9.2.6. AMD risk in-pit waste rock landforms

Table 9-6 summarises the Closure Work Program for the AMD risk in-pit WRL domain.

Table 9-6: AMD risk in-pit WRL domain Closure Work Program

Program Aspect	Program Summary
Domain features	BS1: E1 Backfill WD, E3 Backfill WD, W1 Backfill WD Nammuldi: Lens CD Backfill WD BS2 Extension: Pit 10 Backfill WD
Status of domain features	Various (see Table 2-2)
Estimated closure date	Various (see Table 2-2)
Post-mining land use	5.8.4 Extractive industry not in use
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • AMD and fibrous material risks are compatible with post-mining land use. • Cultural heritage values have been preserved where possible.

Program Aspect	Program Summary
Specific closure assumptions	• PAF material has been encapsulated during operations as per the SCARD Management Plan (Appendix 11). • All fibrous material has been encapsulated during operations as per the FMMP (Rio Tinto 2019b). • Final pit depth remains such that it does not present a risk of surface water overtopping during rare flood events.
Landform design	• In-pit, internally draining WRLs will not be reshaped or rehabilitated. • In-pit WRLs backfilled to within 10 m of the natural surface will be rehabilitated as per the inert external WRL domain. • In-pit WRLs that extend above the natural surface are captured in the external WRL domains. • A ‘store and release’ cover is required to be constructed on the final backfill WRL surface, as per the SCARD Management Plan.
Knowledge gaps	• Rehabilitation designs to be developed for all in-pit WRLs.
Closure and rehabilitation materials required	• Competent material to construct an abandonment bund as per the Pits domains. • Material appropriate for the construction of ‘store and release’ covers.
Closure monitoring and maintenance	• Landform construction monitoring. • Groundwater monitoring.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Installation of store and release cover. • Construction of abandonment bunds as per the Pits domain.
Premature closure	• Encapsulation of any PAF material not yet encapsulated as per the SCARD Management Plan. • Finalise detailed rehabilitation designs. • Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Construction of abandonment bunds as per the Pits domain.

9.2.7. Ex-pit waste fine storage facility

Table 9-7 summarises the Closure Work Program for the ex-pit WFSF domain.

Table 9-7: Ex-pit waste fine storage facility Closure Work Program

Program Aspect	Program Summary
Domain features	Nammuldi WFSF
Domain area	187.5 Ha
Status of domain features	Operating
Estimated closure date	2027
Post-mining land use	1.3.4 Rehabilitation

Program Aspect	Program Summary
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • The final landform is stable, and its design considers hydrological and ecological factors. • Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • Cultural heritage values have been preserved where possible. • AMD and fibrous material risks are compatible with post-mining land use.
Specific closure assumptions	• Nammuldi WFSF has been constructed to design. • Waste fines surface has dried sufficiently to allow safe access.
Landform design	• Final Nammuldi WFSF closure design will be determined through the internal WFSF closure study process.
Knowledge gaps	• Final Nammuldi WFSF closure design.
Closure and rehabilitation materials required	• Inert capping material. • Material required to re-profile batter slopes, if required. • Topsoil and subsoil for use as growth medium. • Seed mix.
Closure monitoring and maintenance	• Landform construction monitoring. • Post closure landform stability monitoring. • Erosion monitoring. • Revegetation monitoring. • Surface and groundwater monitoring.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Capping material placed over tailings material to depth required by rehabilitation design. • Re-profile batter slopes to closure design criteria. • Construct toe bunds and safety berms to design criteria. • Spread topsoil on all slopes and flat surfaces, rip and seed.
Premature closure	• Capping of tailings material. • Finalise detailed rehabilitation design. • Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Final reshaping and rehabilitation to meet the closure design.

9.2.8. In-pit waste fine storage facilities

Table 9-8 summarises the Closure Work Program for the in-pit WFSF domain.

Table 9-8: In-pit waste fine storage facility Closure Work Program

Program Aspect	Program Summary
Domain features	BS2: Pit 5, Pit 8 Nammuldi: Lens A
Domain area	187.8 Ha
Status of domain features	Proposed

Program Aspect	Program Summary
Estimated closure date	TBC – pending scheduling
Post-mining land use	5.8.4 Extractive industry not in use
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • Cultural heritage values have been preserved where possible. • AMD and fibrous material risks are compatible with post-mining land use.
Specific closure assumptions	• PAF material exposed in the final wall of Pit 8 has been fully covered by either tailings material or capping material, after settlement. • Final pit depth remains such that it does not present a risk of surface water overtopping during rare flood events.
Landform design	• Final in-pit WFSF closure designs will be determined through the internal WFSF closure study process. • Final void remaining after cessation of tailings deposition at Lens A will be backfilled to surface to reduce surface water risks.
Knowledge gaps	• Final in-pit WFSF closure designs. • Potential for surface water scouring over area of Lens A that is backfilled to surface.
Closure and rehabilitation materials required	• Inert capping material. • Material to construct abandonment bund as per the Pits domain.
Closure monitoring and maintenance	• Landform construction monitoring. • Groundwater monitoring.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Capping material placed over tailings material to depth required by rehabilitation design. • Re-profile batter slopes to closure design criteria. • Construct toe bunds and safety berms to design criteria. • Spread topsoil on all slopes and flat surfaces, rip and seed.
Premature closure	• Capping of tailings material. • Finalise detailed rehabilitation design. • Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory.

9.2.9. Infrastructure

Table 9-9 summarises the Closure Work Program for the infrastructure domain.

Table 9-9: Infrastructure Closure Work Program

Program Aspect	Program Summary
Domain features	Areas where infrastructure is located including but not limited to roads, rail, powerlines and power related infrastructure, communications infrastructure, pipelines, borefields, pump stations, laydowns, wash downs, ANFO facilities, water treatment facilities, power generation and transmission facilities, workshops, laboratories, buildings, plant, conveyors, camps, airstrips, fuel facilities and any associated disturbances.

Program Aspect	Program Summary
Status of domain features	Operating
Estimated closure date	2054 with opportunities for progressive decommissioning of infrastructure.
Post-mining land use	1.3.4 Rehabilitation
Relevant closure outcomes	• Public health and safety hazards have been appropriately managed. • Contamination risks have been appropriately managed and do not preclude the agreed post-mining land use(s). • Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • Infrastructure has been appropriately managed. • Cultural heritage values have been preserved where possible.
Specific closure assumptions	• Unless transfer to an agreed third party, decommission and rehabilitation of infrastructure will occur. • Contaminated sites assessment has been completed and remediation measures in place if required. • Chemicals and hazardous materials are appropriately removed and managed prior to decommissioning phase. • Pipelines have been drained and chemicals and hazardous materials (from pipelines and elsewhere across the site) have been removed in accordance with Controlled Waste Regulations. • Processing infrastructure will be decommissioned, removed and disturbance rehabilitated. • Removal of below-ground infrastructure will occur to a depth of 1 m • Infrastructure will be salvaged, recycled or buried on-site as appropriate. • Cap landfill with a layer of competent inert material to a thickness of 2 m. • Where linear infrastructure is removed, reinstate drainage lines where appropriate.
Landform design	• Where linear infrastructure is removed, reinstate drainage lines where appropriate.
Knowledge gaps	• Third party transfer or sale of infrastructure. • Contaminated sites investigation at closure.
Closure and rehabilitation materials required	• Topsoil and subsoil for use as growth medium. • Seed mix.
Closure monitoring and maintenance	• Revegetation monitoring. • Surface water monitoring.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.

Program Aspect	Program Summary
Decommissioning and closure	• Retain or remove infrastructure in accordance with State Agreement Act requirements and stakeholder engagement. • Drain pipelines and remove hazardous materials in accordance with Controlled Waste Regulations. • Where infrastructure is removed, reinstate drainage lines where appropriate. • Undertake contaminated sites assessment and remediation measures, if required. • Dispose of inert materials that are not retained, reused or recycled in an inert landfill area. • Spread topsoil, rip and seed
Premature closure	• Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Closure designs and provision revised and updated as required. • Implementation of revised rehabilitation and closure works as appropriate. • Monitoring and maintenance program revised and implemented.

9.2.10. Haul roads and other disturbance

Table 9-10 summarises the Closure Work Program for the haul roads and other disturbance domain.

Table 9-10: Hauls roads and other disturbance Closure Work Program

Program Aspect	Program Summary
Domain features	Haul Roads Other disturbance areas – all areas of disturbance that are not categorised by any of the above landform domain categories. This domain has been broken down into 'high disturbance', 'moderate disturbance' and 'low disturbance' sub-domains, based on the amount of earthworks that will be required during final landscaping, to allow for more accurate closure cost estimation.
Status of domain features	Operating
Estimated closure date	2054 with opportunities for progressive rehabilitation.
Post-mining land use	1.3.4 Rehabilitation
Relevant closure outcomes	• Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • Cultural heritage values have been preserved where possible.
Specific closure assumptions	• All roads will be rehabilitated unless ownership is transferred to a third party. • Disturbance will be rehabilitated to according to relevant Rio Tinto standards and procedures.
Landform design	• Install cross bunds where appropriate (at approximately 50 m to intervals if the gradient of the reshaped road corridor is greater than 10 degrees). • Where linear infrastructure is removed, reinstate drainage lines where appropriate.
Knowledge gaps	• N/A
Closure and rehabilitation materials required	• Topsoil and subsoil for use as growth medium. • Seed mix.

Program Aspect	Program Summary
Closure monitoring and maintenance	• Revegetation monitoring. • Surface water monitoring.
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Where infrastructure is removed, reinstate drainage lines where appropriate. • Dispose of inert materials that are not retained, reused or recycled in an inert landfill area (may be a used pit area). • Spread topsoil, rip and seed
Premature closure	• Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Implementation of revised rehabilitation and closure works as appropriate. • Monitoring and maintenance program revised and implemented.

9.2.11. Irrigated agricultural area

Table 9-11 summarises the Closure Work Program for the irrigated agricultural area domain.

Table 9-11: Irrigated agricultural area Closure Work Program

Program Aspect	Program Summary
Domain features	NAP
Status of domain features	Operating
Estimated closure date	2054 with opportunities for progressive rehabilitation.
Post-mining land use	1.3.4 Rehabilitation
Relevant closure outcomes	• Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use. • Infrastructure has been appropriately managed. • Cultural heritage values have been preserved where possible.
Specific closure assumptions	• Crop species seeds have been eradicated from soil profile (strategy to be developed as the site approaches closure). • Removal of below-ground infrastructure will occur to a depth of 1 m • Infrastructure will be salvaged, recycled or buried on-site as appropriate. • Disturbance will be rehabilitated to according to relevant Rio Tinto standards and procedures.
Landform design	• Natural surface water drainage will be maintained where appropriate.
Knowledge gaps	• Potential for infrastructure to be retained for beneficial use by Hamersley pastoral station or a third party. • Strategy to eradicate crop species to allow revegetation of native species or species appropriate for pastoral land use.
Closure and rehabilitation materials required	• Topsoil and subsoil for use as growth medium if current topsoil is required to be removed. • Seed mix.
Closure monitoring and maintenance	• Revegetation monitoring. • Surface water monitoring.

Program Aspect	Program Summary
Closure Strategy – key tasks	
Progressive rehabilitation and closure activities	• Implementation of progressive rehabilitation during operations as per RTIO standards and procedures.
Decommissioning and closure	• Where infrastructure is removed, reinstate drainage lines where appropriate. • Dispose of inert materials that are not retained, reused or recycled in an inert landfill area. • Spread topsoil, rip and seed
Premature closure	• Closure outcomes and completion criteria revised. • Revised materials rehabilitation inventory. • Implementation of revised rehabilitation and closure works as appropriate. • Monitoring and maintenance program revised and implemented.

9.3. Closure Landscape

The post closure landform is the final expected landform at the completion of the closure measures outlined in Section 9.1. A conceptual image of the landforms at the end of mining and post closure for the Brockman Operation is included in Appendix 2. The closure landscape is likely to change as the BSP mining activities commence construction and move into the operational phase and as mine designs are revised. Closure landscapes will also likely change in response to regulator, stakeholder and Traditional Owner feedback on the proposed closure strategies within this MCP. Updates will be presented in each future iteration of this MCP in consultation with key stakeholders.

9.4. Progressive Rehabilitation

Rio Tinto undertakes progressive rehabilitation activities across its operations, which allows for the trialling of rehabilitation methods and strategies. The learnings taken from these trials inform future closure activities across the business.

Within the Brockman Operation closure boundary, all disturbed areas (except pit floors) that can be accessed safely will be rehabilitated.

A total 911.5 ha of disturbance within the Brockman Operation closure boundary has been rehabilitated to date (Q1 2022), ranging from low disturbance areas to highly disturbed waste landforms. Rehabilitation not included in this total count, are locations that do not have vegetation monitoring transects installed and recently completed rehabilitation which has yet to be monitored, including other disturbance, including exploration; and infrastructure areas.

A Brockman Operation Progressive Rehabilitation Summary has been prepared to summarise Rio Tinto's internal completion reports and annual rehabilitation monitoring program for the BS4, B2N and SGE areas (Appendix 22). The objective of the rehabilitation program is to evaluate successional development of the rehabilitation and thereby provide feedback for the improvement of rehabilitation techniques, and to help assess progress towards long term rehabilitation goals

Current rehabilitated features within the Brockman Operation closure boundary which are monitored utilising the vegetation transect method are summarised in Table 9-12 and detailed in the Progressive Rehabilitation Summary (Appendix 22).

Table 9-12: Completed progressive rehabilitation within the Brockman Operation closure boundary

Disturbance type	Domain type	Rehabilitation Sites[4]
Low	Topsoil Stockpiles	Various
Moderate	Borrow Pits	B2N 1991 Borrow Pits
		B2N 2009 Borrow Pits
		BS4 Borrow Pits
		B2N to BS4 Access Rd Borrow Pits
		BS4 White Quartz Rd Borrow Pits
		Nammuldi ANFO Facility Borrow Pits
		Nammuldi BWT HV Borrow Pits
		Nammuldi Rail Loop Borrow Pits
	Landfill	Nammuldi BWT Landfill
	Road	B2N Old Haul Road
	Mine Backfilled Pit	Brockman 2 Pit 3
	Mine Backfilled Pit	Brockman 2 Pit 2 Backfill
	Airstrip	Boolgeeda Aerodrome
	Infrastructure	BS4 Fuel Hub
	Camps / Villages	Boolgeeda Camp
High	Waste Dumps	Nammuldi Lens C Waste Dump
		B2N Central and Pit 2 Waste Dumps
		B2N Pit 6 Waste Dump
		B2N South POD Waste Dump
		B2N Waste Dump West
		B2N B Dump
		BS4 DP1 and DP4

9.4.1. Progressive rehabilitation approach

Progressive rehabilitation activities allow for the trialling of rehabilitation methods and strategies to inform future closure activities and practices. Monitoring of the rehabilitation completed across Rio Tinto's operations is used to indicate the likely success of this and future rehabilitation activities in establishing self-sustaining areas of native vegetation, or if areas of rehabilitation may require rework due to poor performance.

Rehabilitation is conducted in accordance with the Rio Tinto Rehabilitation Handbook (Rio Tinto 2016), which are periodically reviewed and updated to: reflect changes in industry standards; reflect new

[4] Rehabilitation sites are presented as examples of rehabilitation completed within the closure boundary and do not reflect the full area (ha) of disturbance that has been rehabilitated.

knowledge obtained through research and development; and to adopt learnings from progressive rehabilitation.

Current rehabilitation practices are included below. In addition to on-ground activities, management, research and development initiatives, and internal governance practices are applied to improve planning and implementation of rehabilitation.

- Landform specific rehabilitation designs based on mineral waste characterisation and site-specific climatic conditions.
- Survey control of rehabilitation earthworks to ensure conformance to the rehabilitation design.
- Use of local provenance native species mixes for seeding the landform (revegetation), which are based on species that are local to the area and appropriate for the landform being rehabilitated.
- Production of close out reports from each substantial earthwork projects to ensure rehabilitation protocols are captured and learnings are shared across the Pilbara mining operations.

9.4.2. Rehabilitation planning and implementation

Implementation of progressive rehabilitation will occur, where possible, during operations at the Brockman Syncline and Silvergrass East areas. Progressive rehabilitation will enable opportunities to undertake trials, reduce financial closure liability and demonstrate to key stakeholders Rio Tinto's commitment to meet the social and environmental licence to operate. Table 9-13 indicates the development schedule for the Brockman Operation and subsequent rehabilitation opportunities.

9.4.3. Progressive rehabilitation knowledge gaps and implications for closure

Closure knowledge gaps associated with rehabilitation monitoring, techniques, and refinement of the rehabilitation completion criteria as summarised in Section 5.16, Table 5-20 include:

- Suitability of Brockman Syncline rehabilitation monitoring reference sites.
- Rehabilitation completion criteria refinement
- Methods for rehabilitation of Pilbara creek line habitats

.

It has been noted that the same reference sites are not consistently used in rehabilitation comparison in the past and topographical representation of reference sites may not be sufficient. As such, a review of reference sites is required to help determine suitability for ongoing use and if additional sites require establishment. In addition, monitoring of landform erosion is not undertaken in a systematic manner by a suitably qualified specialist at Brockman Operation and systematic approach needs to be developed.

A consolidated summary of rehabilitation techniques employed on sites rehabilitated at the Brockman Operation is planned to be developed to assist in establishing successful rehabilitation techniques and may be used in further refining completion criteria related to revegetation.

Table 9-13: Indicative development schedule for Brockman Syncline Proposal

** green shading indicates mining occurring at these times*

Location	Pit	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
B2N	1 - 6x, 7, 8, 10																																			
B2N	9, 11, 12, 13, 14a, 14b																																			
B2N	Lens A, B																																			
BS4	3, 5, 16																																			
SGE	1																																			
SGE	2																																			
BS3 Ext	Orbe 1, 2																																			
BS4	BS3																																			
BS3 Ext	Brokenwood, Lauriston																																			
BS4	Endeavour 1, 2																																			
BS4	1, 2, 4, 6-15, 17, 18																																			
BS4	M, N, O, Q and R																																			
BS4	BS1 East 1-3, West 1-3																																			
BS3 Ext	Diesel, Sandleford																																			
B2N	14c, Lens C, D, E, F, G																																			
BS3 Ext	Monkey 1-3, Creekside 1-2																																			
SGE	Pit 5																																			

9.5. Juukan Gorge

Juukan Gorge is situated within Puutu Kunti Kurrama country and was included within the western extent of the BS4 Main Pit 1 (Figure 9-4). Juukan Gorge contains several heritage sites; including the highly significant Juukan 1 rock shelter and the now destroyed Juukan 2 rock shelter. Juukan 2 was considered of high archaeological significance with excavations conducted in years prior to the blast recovering evidence of human occupation dating back 46,000 years. In addition, the culturally significant Snake Pool, a surface water dependent ephemeral pool, and a scar tree are located within the Gorge. The Purlykuti Creek runs immediately west of Juukan Gorge and is of very high ethnographic value to Puutu Kunti Kurrama People.

Previous mining activities in the wider Juukan Gorge area altered the original landscape and impacted the Juukan Gorge valley and surrounds. Furthermore, on May 24th, 2020, a blast at the BS4 Main Pit 1 damaged the Juukan Gorge valley and destroyed the culturally significant Juukan 2 rock shelter.

Following the Juukan Gorge incident, the Puutu Kunti Kurrama Land Committee set up a Sub-committee to engage with Rio Tinto. The Sub-committee, which consists of Puuti Kunti Kurrama representative, and Rio Tinto have undertaken a series of engagements including workshops and targeted meetings to examine what actions need to be undertaken in the short, medium and long term to remediate the impacted areas (Appendix 4). Immediate actions to make the area safe for access and prevent further impacts included:

- A temporary Moratorium area agreed to which includes the entire Juukan Gorge valley and the areas to the west of Juukan Gorge (Figure 9-4). All mining and exploration activities ceased within the moratorium area.
- Completion of a water run-off assessment and, in partnership with Puutu Kunti Kurrama representative, development of a stabilisation design to prevent any further detrimental impact to the Juukan Gorge from erosion and sediments. In October 2020, prior to the commencement of the wet season, the endorsed design was implemented by RTIO operations in partnership with representatives of the Puutu Kunti Kurrama Sub-committee monitoring the works.
- Establishment of a redirection windrow/trench across the northern end of the blasted material to the north of Juukan 1 and Juukan 2 to prevent/minimise water ingress into the blasted material and further damage to the heritage sites.
- Removal of loose material above the two rock shelters to make it safe to access from below.
- Removal of minimal loose material on the southern side of Juukan Gorge in front of the rock shelters to allow for safe access to the Gorge and prevent inadvertent runoff from the large southern blasted area.
- Establishment of a temporary mechanism to minimise any silt run-off into the downstream portion of Juukan Gorge.
- Development of a Juukan Gorge Remediation Project to the satisfaction of the Puutu Kunti Kurrama People and Rio Tinto (Section 9.5.1).

RioTinto

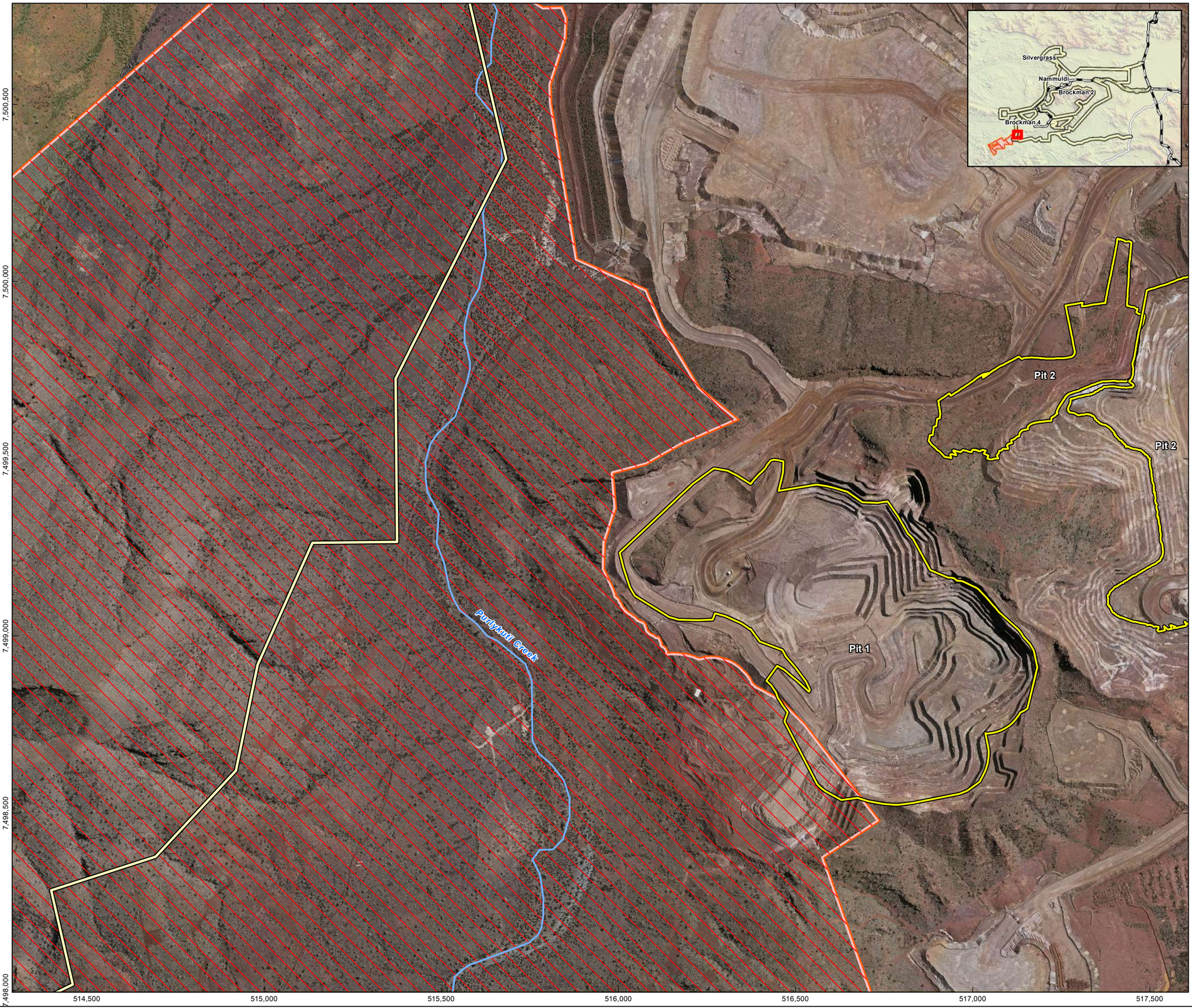
Figure 9-4
Juukan Gorge and Brockman 4 Main Pit 1 Overview

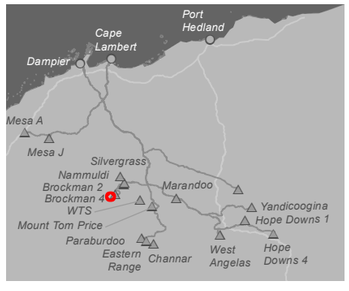
Drawn: L.Fuentes
Plan: PDE0191311v1
Date: July 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:10,000 @A3
GIS.Team@riotinto.com

Legend

- Closure Boundary
- PKKP Moratorium Area
- Pit
- Major Creek
- Rio Tinto Railway
- Major Road





N

0 100 200 300 400 500

Metres

Map units in metres

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9.5.1. Juukan Gorge Remediation Project

The aim of the Juukan Gorge Remediation Project is for Rio Tinto and the Puutu Kunti Kurrama People to co-design the final rehabilitation landform of the Juukan Gorge valley to ensure the area and landform:

- is safe for access by Traditional Owners;
- returns a sense of place to the Puutu Kunti Kurrama People.
- reduces visual amenity impacts related to visibility of the mine, from a number of agreed vantage points within the gorge area;
- maximizes surface water flow back into the Juukan Gorge catchment; and
- is fundamentally and erosionally stable, with consideration for geotechnical and hydrological factors.

As discussed in Section 9.5, this co-design approach has been facilitated through regular meetings with both the Puutu Kunti Kurrama and Pinikura Land Committee and the corresponding Sub-committee through which Rio Tinto received guidance on how the landform may be rehabilitated to return a sense of place.

The scope of the Juukan Gorge Remediation Project extends approximately 1.5 to 2km to the north, south and west of the Gorge and encompasses disturbance related to resource evaluation drill tracks. Four Remediation Zones were developed based on the level of complexity and resources required to remediate the area (Figure 9-5). Zones 1 and 2 represent the complex Juukan Gorge valley and surrounds and together form the landform discussed in Section 9.5.2. Zones 3 and 4 are defined as the resource evaluation disturbance areas west of the Juukan Gorge valley and were identified as an early opportunity to begin rehabilitation activities at the Project.

Rehabilitation of disturbance within Zones 3 and 4 was conducted in line with the RTIO Resource Development Rehabilitation standard which is aligned to the Rehabilitation Handbook (Rio Tinto 2016). Rehabilitation works in Zones 3 and 4 commenced in March 2021 and were completed by May 2021. Puutu Kunti Kurrama representatives were engaged as monitors to observe the program of works. Outcomes of the rehabilitation completed within Zones 3 and 4 have been endorsed by the Puutu Kunti Kurrama Sub-committee.

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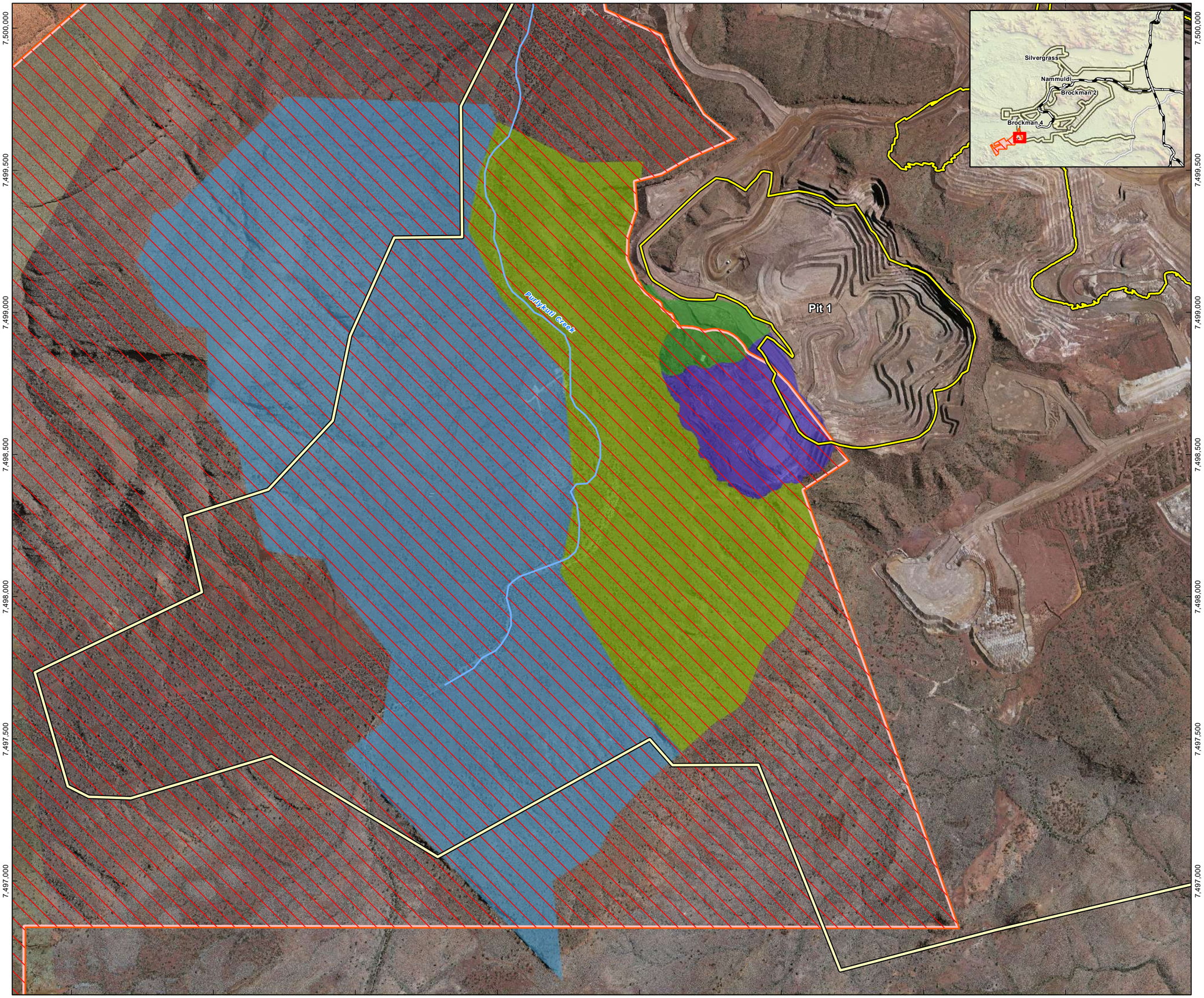
Figure 9-5
Juukan Gorge Remediation Project Zones

Drawn: L.Fuentes
Plan: PDE0191311v1
Date: August 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:12,500 @A3
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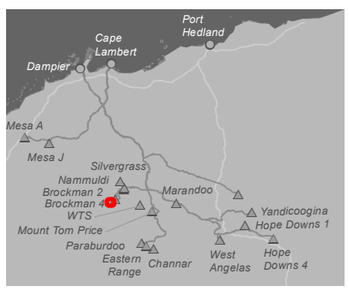
Legend

- Closure Boundary
- PKKP Moratorium Area
- Pit

Remediation Zones

- Zone 1
- Zone 2
- Zone 3
- Zone 4

- Major Creek
- Rio Tinto Railway
- Major Road



N

0 100 200 300 400 500

Metres

Map units in metres

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9.5.2. Juukan Gorge final landform

Landform design process

Rio Tinto commissioned Golder Associates Inc. to undertake the final landform design for remediation Zones 1 and 2, including the destroyed Juukan 2 rock shelter, to ensure the modelling and design process is independent to Rio Tinto.

To enable co-design of the final landform with the Puutu Kunti Kurrama, different landform design options were continually communicated, and feedback incorporated into the designs and the options presented again. Through the design process it was identified and agreed with Puutu Kunti Kurrama Sub-committee that the design criteria for surface water catchment extent and visual amenity were of the most importance, though these may be conflicting in some instances.

Landform designs were developed that maximised the following prioritised design solutions:

- a minimal option – only the slopes of the gorge were reshaped;
- a natural option – attempted to match the pre-mining surface;
- a catchment maximisation option – maximised the area flowing toward the gorge; and
- a visual amenity maximisation option – maximised height of landform in areas to shield the mining benches so as to improve the natural appearance of the landform.

Based on these bookend designs, a hybrid geomorphic design (Golder 2022) was endorsed by the Puuti Kunti Kurrama Sub-committee and developed to balance the requirements for catchment area and visual amenity (Figure 9-6).

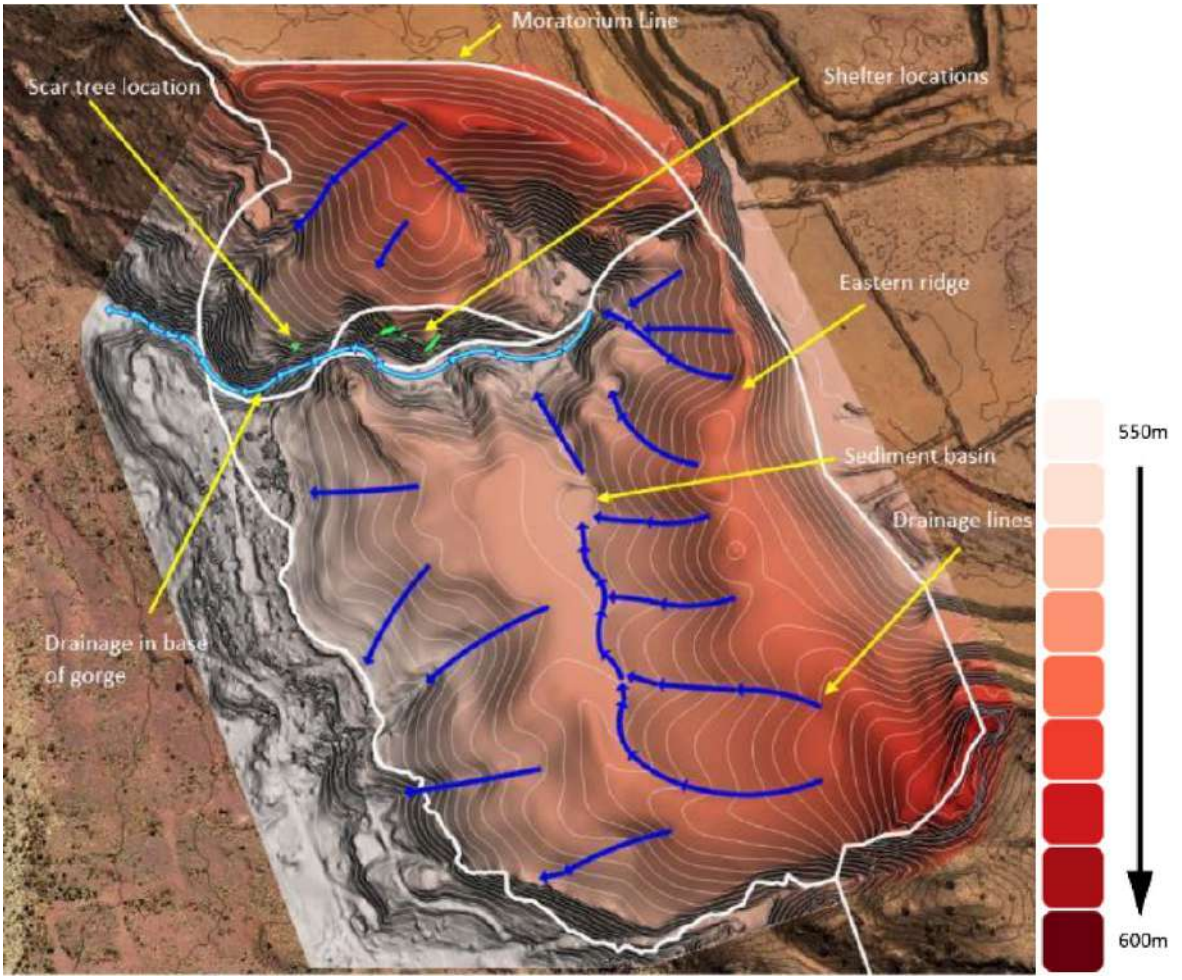


Figure 9-6: Features of the conceptual Juukan Gorge landform hybrid geomorphic design

Hydraulic modelling

Hydraulic modelling was undertaken to estimate the runoff response of the closure landform and surface water flow characteristics, including peak flows, flow velocities and flood depths during significant rainfall events. To undertake this analysis a two-dimensional (2D) TUFLOW hydraulic model was developed using the direct rainfall approach (Golder 2022).

The landform has been designed to withstand a minimum 1:2,000 AEP flood event over the design life of the landform (300 years). The hydraulic model was therefore run for design storm events ranging from the 1:1 to 1:2,000 AEP to estimate peak flow rates, flow velocities and flood depths. This modelling has been used to inform the requirement for rock armouring in areas where high flows and velocities are predicted (Golder 2022).

Sediment and erosion control

The geomorphic landform design is free draining to ensure there will be minimal ponding on the landform. Every point on the surface will be connected to the downstream environment, the run-off path from which will consist of flow over the hillslopes and drainage lines. The materials used on the final surface of the landform will consist of the low erodibility Joffre and Dales Gorge material (Section 5.7) to minimise the potential for rilling and gullying. The targeted average erosion rate for the hills slopes was 5 t/ha/annum. To further reduce the risk of sediment transport off the landform, a sediment basin has been designed to contain sediment transported from the landform from the southern east catchment of the landform. There were no suitable locations in the northern catchment of the landform to construct sediment basins to contain runoff and drainage to the gorge, however high sediment loads are not expected from these smaller northern catchments. The gorge itself experienced high sediment loads in pre-mining conditions and will be able to accommodate the expected northern catchment sediment loads.

The-south-western catchment area does not drain into the gorge, however drains directly onto the floodplain of the Purlykuti Creek. Sediment control from the south-western catchment is under review, however several options have been identified:

- sediment basins formed by excavation of ponds;
- sediment basins formed by the construction of water retaining berms across the drainage lines; or
- a berm constructed on contour to contain runoff over the slope and in the drainage lines.

Landform evolution modelling completed shows that the proportion of coarse soil fraction increased over time and this armouring effect serves to stabilise the surface over time. The modelled erosion rate remained below the design criteria of 5 t/ha/annum for most years, with a reduction in the observed rate with time. Cumulative erosion, deposition and material leaving the southern catchment was modelled over a 300-year simulation period. The model showed that material only starts to leave the southern catchment after 100 years, indicating that the sediment basin is effectively containing the higher rates of erosion early in the life of the landform. The effective erosion rates from the catchment over the last 200 years of the simulation equates to an average erosion rate of 0.75 t/ha/annum. An erosion rate of 0.75 t/ha/annum is below anticipated natural erosion rates and the downstream environment can be expected to accommodate this sediment discharge (Golder 2022).

Snake Pool

Snake Pool is a small scour hole at the outlet of a small rocky ravine. Little erosion and sediment transport is expected in the section of the gorge immediately west of the shelters (where Snake Pool is located) due to the extensive presence of shallow bedrock. Landform evolution modelling shows that the volume of sediment increases to a maximum at approximately 100 years before the system behaviour alters and the volume of deposited sediment becomes largely stable (Golder 2022). Large rainfall events resulted in a drop in deposited material, where sediment is flushed further down the gorge. The anticipated sediment loads (and type of sediment) to be transported to Snake Pool are not

anticipated to be significantly different to what the Pool has encountered in the past and, as such, should continue functioning as previously.

Landform Geotechnical stability

The geotechnical stability of the landform was assessed considering the distribution of fill used in the landform, the damaged rock mass, blasted material and in-situ ground. Geotechnical stability issues are not anticipated due to the landform slopes being designed to be both fundamentally and erosionally stable.

BS4 Pit 1 Geotechnical stability

Since the incident at Juukan Gorge occurred, Pit 1 at BS4 has been redesigned to avoid a mining moratorium line agreed to with the Puutu Kunti Kurrama and Pinikura People and to avoid exposing any PAF material exposures on the final pit walls. The final PUPEZ of Pit 1 is currently under review based on pit design changes and backfill heights. If required, buttressing of Pit 1 is proposed to ensure the PUPEZ, 10 m buffer and construction of an abandonment bund will not interact with the landform associated with the Juukan Gorge Remediation Project. The need for and extent of buttressing required at Pit 1 will be progressed as the pit design and backfill heights are finalised.

9.6. Research, investigations and trials

Rio Tinto undertakes research and development to increase its understanding of the local natural ecosystems, optimise its rehabilitation techniques and improve confidence in the ability to reach closure outcomes. Research and development projects range from opportunistic on-ground trials to large-scale multi-partner Commonwealth funded research programmes. Rehabilitation monitoring data is reviewed regularly to identify opportunities to refine rehabilitation techniques.

Lessons learnt from other Pilbara mining sites are used to inform and update our standard rehabilitation management practices. Implementation of such advances includes:

- Landform specific rehabilitation designs based on mineral waste characterisation and site-specific climatic conditions.
- Rehabilitation requirements considered when determining landform placement.
- Survey control of rehabilitation earthworks to the rehabilitation design.
- Improved soil and seed management practices (viability testing and pre-treatment).
- Targeted research and development scopes.
- Development of guidance documentation and management procedures.
- Development of databases to house raw rehabilitation monitoring data.
- Production of close out reports and sharing of learnings across the Pilbara mining operations.

Although rehabilitation outcomes are largely variable, with success highly dependent on the climatic conditions and rehabilitation methods associated with works, these advances have resulted in an overall improvement in rehabilitation quality seen across the company's Pilbara operations and continue to contribute to the refinement of rehabilitation management develop successful outcomes.

Rio Tinto undertakes research and development to increase its understanding of the local natural ecosystem, optimise its rehabilitation techniques and be at the forefront of technological advances; with the over-arching goal of continually improving the rehabilitation quality it can achieve. Rehabilitation monitoring data is reviewed regularly to identify opportunities to refine rehabilitation techniques i.e., rates of recruitment from sown seed. A selection of recent research and development initiatives is summarised below.

Research and trials that have occurred at across the Brockman Operation and have informed the closure and rehabilitation strategy, are detailed in Table 9-14.

Table 9-14: Research and trials applicable to Brockman Operations

Date	Scope	Outcome	Relevance to closure strategy
Physical Waste Characterisation			
2018 and ongoing	Landloch undertook a gap analysis of the BST in 2018 and provided input on key wastes to consider in future revisions of the tool. In 2020, a project was developed that focussed on collecting waste samples for characterisation based of the gap analysis completed in 2018. The characterisation of the waste would feed into the BST.	Throughout 2021, over 31 bulk container ($1m^3$) samples and 48 small samples were obtained by over 15 mine sites or deposits. Through 2021 and early 2022 these samples were tested for erosion characteristics. Initial results are confirming the current parameters allocated to waste materials in the BST, however, in a couple of cases, the original parameters were conservative, and a more optimised approach can be taken by way of lift height and slope angle. These assessments are ongoing.	As discussed in Section 5.7.1, the erodibility of waste material informs the Batter Selector Tool and WRL design parameters.
Below water table strategies for open pit mines			
2021	A review of hydrological and geochemical processes and closure options for below water table open pit mine. Discusses innovative and integrated strategies for minimising post-closure environmental impacts and the potential for delivering beneficial and economic use from pit lakes where these are part of the post-mining landscape. It discusses strategies for minimising the impacts of water table drawdown on groundwater-dependent ecosystems.	Several innovative approaches are suggested for reducing the environmental footprint of mines and producing better environmental and economic post-closure outcomes and would benefit from further investigation. These include (i) the use of engineered barriers to limit groundwater connections between mines and adjacent ecosystems, (ii) managed aquifer recharge during mine operations and/or diversions of river water into pits post-closure to enhance water table recovery, (iii) modification of pit backfill, revegetation, and evaporation to achieve desired pit water levels, (iv) amendment of pit backfill materials to reduce oxygen levels and the development of acidic conditions in backfilled pits, and (v) the use of bioremediation approaches to improve pit lake water quality.	Below water table pit closure implementation strategy considerations as discussed in Section 9.1.
Store and release cover system			
2003 - 2022	Two test plots were constructed at the Marra Mamba South (MMS) waste dump at Tom Price Mine in 2003. Test Plot #1 consisted of a 4 m thick layer of banded iron formation (BIF) material, while Test Plot #2 consisted of a 2.4 m thick layer of oxidised Mount	Vegetation root analysis and tap root tracing indicated the presence of Acacia and Senna species roots within the cover system material (0 - 2.4 m) and extending to 3 m into the underlying waste rock. Roots of native grass species (Poaceae) were present in the cover system material but were not	As discussed in Section 5.7.6 and 5.8.2, suitable material required to construct store and release covers on WRL's containing PAF material.

	McRae Shale (MCS), overlying a non-acid forming region of the MMS waste dump. Both cover system trials used the 'moisture store-and-release' concept as a means of minimising the potential for acid and metalliferous drainage (AMD) to be generated and released from the waste dump. In addition, Test Plot #2 was excavated, where field and lab work were undertaken to support the following objectives: Assess geotechnical and geochemical evolution of the cover system material after 17 years of climate cycling; Assess the influence of the cover material in terms of plant health; Clarify expectations of root distribution (depth and density) within the cover system; Assess the potential for metal uptake by overlying vegetation; and Assess the degree of bioturbation.	detected in the underlying waste rock. Material characterisation findings indicate the Mount McRae Shale (MCS) is a suitable material for cover system design from a stability perspective and to support the establishment of native vegetation cover. Findings on root depth analysis can be used to inform suitable seed mixes to minimise risks related to potentially acid-forming waste rock dumps. The autopsy demonstrated minimal degradation of the MCS cover system profile over its 17-year lifespan and indicated that MCS is a suitable material for use in store and release cover systems.	
Mineral Waste as AGM Opportunities			
2017 and ongoing	Opportunity to utilise mineral waste as topsoil substitutes or supplements for rehabilitation activities. The waste materials with topsoil-like properties are referred to as 'alternative growth media' (AGM). It is anticipated that AGM will provide a suitable growth medium in rehabilitation areas where topsoil and subsoil are unavailable. Research is underway to determine if rehabilitation quality in areas rehabilitated with alternative growth media will be acceptable	Rehabilitation trials using alternative growth media commenced in 2017, including the application of alternative media at the Marra Mamba West 4 (MMW4) WRL at Tom Price, which utilised waste material known as 'Section 652 gravels'. Monitoring of this rehabilitated area was undertaken in 2018 and again in September 2019; results indicate potential for successful establishment of self-sustaining native vegetation.	If AGM proves viable in rehabilitation success, it is proposed that topsoil application be prioritised on higher risk rehabilitation areas (e.g. WRLs containing PAF or fibrous materials) and lower risk areas such as laydown or infrastructure areas will receive the alternative growth media or potentially no growth medium.
Seed Delivery Techniques			
2018 - 2022	The project aims to: critically evaluate the field limitations of current mechanised seeding techniques used in large-scale rehabilitation efforts to improve	Some emerging successful techniques have already been incorporated into Rio Tinto progressive rehabilitation trial areas. These include the use of flamed seed in rehabilitation projects, Spinifex pre-treatment trials and the evaluation of several new species for flaming treatment. Work has also	By improving seed recruitment and germination, revegetation of native species will improve. This will impact on

	precision-delivery of native seeds in adverse rocky, uneven and sloped landforms; design, construct and field test prototype seed enhancement and direct seeding machines that can accommodate and efficiently deliver a wide range of seeds including those that differ in shape, size, and weight; and quantify seed placement, seedling recruitment and rehabilitation performance using the engineered direct seeding machines across different mining growth media and soil types;	included an engineering trial to optimise the placement of seeds under the soil surface for increased germination results. Several trials are underway in a lab testing environment.	the economics and large-scale success of Pilbara native species. Learnings are then incorporated into seed management, rehabilitation procedures and monitoring programs.
Acceptable WRL Erosion Rates			
2016 – 2018; ongoing	Rio Tinto, BHP, Fortescue Metals Group and Roy Hill, initiated a project aimed at defining acceptable rates of erosion for rehabilitation landform design for the Pilbara region.	A guideline was developed to define acceptable erosion rates for use in the design of stable mine waste landforms in the Pilbara region (Landloch 2018b). The guideline uses a risk-based approach, with erosion thresholds being linked to the physical properties of the waste material, and the adverse environmental impacts that may result from landform failure	Assessing the long-term erosion stability of a landform using erosion and/or landform evolution models and defensible erosion thresholds below which rehabilitation landform designs are considered acceptably erosion resistant or ‘stable’.

9.7. Unexpected Closure

Premature closure of the Brockman Operation would likely result in modifications of the proposed mine closure strategies detailed in this MCP and its subsequent revisions.

In the event of unexpected or premature closure, revision and update of the closure risk assessment would occur to determine key areas for closure works and any change in residual risk from premature closure. Outcomes of the review will be used to prioritise closure tasks.

As a result of unexpected closure, a revision and update of the MCP and development of a Decommissioning Plan will be completed to address changed circumstances and gain approval from relevant key stakeholders where strategies may need to be amended.

These plans would require the following as a minimum:

Stakeholder engagement to communicate the strategy to be implemented and address concerns of key stakeholders.

Review closure outcomes and completion criteria to determine any which may be difficult to achieve given premature closure. Communicate these with relevant key stakeholders to determine a way to resolve issues.

Amended landform designs for WFSFs, WRLs, permanent landbridges, mining voids and surface water control structures where the proposed design could no longer be met.

Review of topsoil and other rehabilitation materials balances to determine any deficiencies in materials, and options to address this.

Undertake contaminated land assessment, and where required, remediation works, of all areas of the Project used to manufacture, store or utilise hazardous materials.

Update the final void groundwater model where the proposed extent of mining did not occur to determine if the closure strategy requires amendment.

Finalise any rehabilitation or closure trials to determine if findings are adequate to implement.

Review and update monitoring and maintenance requirements.

Revision and update of the closure cost estimate to determine any financial constraints associated with altered designs or deficit of rehabilitation materials.

Address all safety obligations required under Sections 42 and 88 of the *Mines Safety and Inspection Act 1994* (WA) relating to mine suspension or abandonment. One of those obligations is to notify the relevant DMIRS District Inspector before a mining operation is suspended or abandoned.

9.8. Decommissioning

A Decommissioning Plan will be developed based on the Closure Work Programs presented in Section 9.1 for implementation and stakeholder approval where required.

Once ore processing has been completed, decommissioning of equipment and facilities prior to removal of those items not identified to remain post closure will be undertaken. Equipment and facilities that will not remain post-closure will either be dismantled for reuse or resale, or demolished for on-site disposal, with the approach selected being based on economic conditions at the time of closure. Contaminated land assessments will be undertaken following removal of infrastructure, or within the vicinity of infrastructure to be handed over to a third party. Where required, remediation activities will occur and the monitoring and maintenance requirements within the MCP updated.

Final WRLs will be constructed, including any installation of covers, placement of topsoil, abandonment bunds and surface drainage structures. Where required, soil amendments will be made, and seed mixes spread.

Groundwater production and monitoring bores not required for the post-closure monitoring program, or being handed over to a third party, will be decommissioned to meet DWER requirements.

Monitoring activities will commence within the required timeframes following completion of rehabilitation activities. Revision and update of the closure cost estimate will occur, to determine any financial constraints associated with altered designs or deficient materials.

10. CLOSURE MONITORING AND MAINTENANCE

10.1. Closure Monitoring Program

The primary purpose of closure monitoring is to assess whether the agreed completion criteria have been met for the Brockman Operation. A specific monitoring program will be finalised as the site approaches closure, therefore, this MCP outlines the principles that will be employed rather than specific details.

For the purposes of this plan, monitoring is assumed to be conducted in several phases including:

- 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.
- 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.
- 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 either:
    - there is a demonstration that closure criteria have been met and that the site is able to be relinquished; or
    - parameters being monitored reach a steady state.

This MCP considers pre-closure, closure and post-closure monitoring, while baseline monitoring informs the closure knowledge base and development of closure strategies.

The closure monitoring program will be refined and finalised during the five to ten years prior to planned closure. A preliminary plan of the monitoring program has been presented here and would include components as indicated in Table 10-1. Specific and appropriate monitoring will be conducted to ensure data is obtained to allow assessment of performance against completion criteria (Section 8.2). The monitoring program will be sufficiently flexible to enable adaptive management if results indicate that more or less monitoring is warranted at any particular phase. Specific parameters within each aspect will be further defined.

Table 10-1: Preliminary plan for closure phase monitoring

Aspect	Phase		
	Pre-closure	During closure implementation	Post-closure
Rehabilitation monitoring	✓	✓	✓
Groundwater monitoring	✓	✓	✓
Surface water monitoring	✓	✓	✓
Contaminated sites assessment	✓	✓	As required
Cultural Heritage monitoring	✓	✓	
Geotechnical stability	✓	✓	

10.2. Rehabilitation Monitoring

The purpose of the rehabilitation monitoring program is to evaluate successional development of the rehabilitation, and thereby provide useful feedback for the improvement of rehabilitation techniques, and to help assess progress towards long term rehabilitation goals. Monitoring also provides information which can be used to set realistic and achievable completion criteria. This objective can be achieved

by examining changes in key parameters over time and comparing results from the rehabilitation with those from corresponding reference sites in undisturbed areas.

Reference sites, also known as control sites or analogues, are positioned within remnant native vegetation representative of the local area. Such sites should contain the vegetation community commensurate with those existing at the rehabilitated site prior to disturbance and be situated in a similar topographical position within the landscape, and as such serve as an indicator of what the rehabilitated area may achieve over time. However, suitable references sites may not be available for all rehabilitation sites as landforms undergoing rehabilitation are often highly modified, and in such cases references sites provide a guide only. Reference site data also assists in planning aspects of the rehabilitation program i.e., seed lists and the species of which they comprise.

Rehabilitation monitoring is completed in the cooler months (June to September) each year. The monitoring program design (i.e., monitoring technique and frequency) for each rehabilitated area considers the following factors:

- the level of complexity of the rehabilitation and therefore rehabilitation quality risk i.e., waste rock landforms are high risk; exploration rehabilitation is low risk;
- regulatory monitoring requirements;
- rehabilitation age;
- rehabilitation quality;
- rehabilitation area size;
- part of a rehabilitation trial area;
- natural disturbance i.e., fire, cyclonic rainfall;
- safe access for monitoring personnel; and
- efficient use of monitoring resources.

Several rehabilitation monitoring techniques are used which are usually matched to the level of rehabilitation quality risk. For example, the intensive quantitative method is used on high-risk waste rock landform areas.

Rehabilitation Quality Assessments are used on low to medium risk areas, historical rehabilitation with no monitoring history, or on areas too small for transects. They can also be used in combination with the above transect methods on large rehabilitation areas to manage monitoring resources efficiently. The purpose is to gain an overview of the rehabilitation quality including erosion, growth medium, vegetation cover, species richness, vegetation structure, plant density, weed presence and general condition. Each characteristic is compared between the rehabilitation and local undisturbed native vegetation and given a score according to the RQA field book guidelines. A representative photograph is taken of both the rehabilitation and reference areas.

Rehabilitation monitoring will be undertaken in accordance with the procedures outlined in Appendix 22.

Environment and erosion monitoring

Environmental monitoring is for the purpose of habitat rehabilitation to meet conditions compatible with post-land use and ecological values in disturbed areas and where required return the land comparable with baseline conditions. The monitoring will involve but may not be limited to, revegetation programs and vegetation condition assessments, survey data assessments, aerial imagery and visual inspection assessments, climate data monitoring, sediment and erosion assessments and historical data reviews. Key outcomes of this monitoring is to provide sufficient evidence that meets the closure criteria outcomes.

The baseline and operational monitoring phases will assist in refining these programs suitable for monitoring for the closure phases. Environmental Management Plans for example will be considered for ongoing reference in the closure phase given primary objective of these plans is to have no-long

term impacts from operational activities. Baseline and reference sites used in these operational management plans will have acquired historical data for which closure outcomes can be compared with. In conjunction, environmental monitoring management plans are analogous with surface water and groundwater management plans that are associated with key closure criteria outcomes.

10.3. Groundwater Monitoring

Groundwater monitoring during closure will focus on confirming groundwater quality at and downstream of the closed site. Data gathered during operations and pre-closure will be used to inform a specific program of both groundwater monitoring in the closure and post closure phases. The groundwater monitoring programs used for operations will be revised to be closure specific and able to measure successful achievement of the final agreed completion criteria related to groundwater. Groundwater monitoring will be targeted at groundwater quality (field chemistry and laboratory analysis), groundwater levels and hydraulic connection to surrounding areas. Existing groundwater monitoring points that are available at closure will be utilised for closure phase monitoring.

Water quality monitoring will be utilised to demonstrate completion criteria has been met for AMD and pit lake assessments and downstream sensitive receptor outcomes (including creek and riparian environments, Pams Springs and groundwater dependent pools such as Plunge Pool). Water quality sampling will be undertaken by suitably qualified personal in alignment with Australian Standard AS/NZS 5667.1-1998 (Water Quality – Sampling – Guidance on the design of sampling programmes, sampling techniques and the preservation and handling of samples). All water samples for laboratory analyses will be submitted to a laboratory with current National Association of Testing Authorities (NATA) accreditation.

Groundwater level monitoring will all also be utilised to assess post-abstraction drawdown response and groundwater levels recovery. Groundwater level recovery assessment and operational monitoring investigations may indicate further modelling requirements to ensure proposed backfill, pit-lake, WFSF and potential MAR strategies are consistent with the closure outcome criteria.

Managed Aquifer Recharge

Should a closure MAR scheme be implemented at SGE to accelerate water level recovery post mining, groundwater monitoring associated with MAR performance will include groundwater level recovery rate and water quality.

10.4. Surface Water Monitoring

Monitoring of key surface water features will continue in the closure and post-closure phases in accordance with the existing Ministerial Statements and as part of demonstrating the closure outcomes of Boolgeeda Creek, Caves Creek and Duck Creek. Surface water monitoring during closure will use the EMP (Rio Tinto 2014 and RTIO 2022c; or subsequent updates/revisions of a consolidated EMP) as a basis of design and will focus on the long-term effects on the hydraulic function of Boolgeeda and Duck Creek after cessation of surplus water discharge. It is anticipated that cessation of discharge to Boolgeeda and Duck Creek will occur during operations based on the implementation of the proposed Brockman Operation LOM water management strategy (Section 2.5.4) and as such closure and post closure monitoring may not be required if achievement of closure outcomes can be demonstrated.

Closure and post-closure surface water monitoring program will also consider the sampling requirements in the following pools:

- Plunge Pool;
- Palm Springs;
- Kurwillinha Pool;
- Snake Pool; and
- Ridge Pool.

10.5. Contaminated Site Assessment

Post-closure monitoring will be required to demonstrate that any contamination has been remediated to an appropriate level to achieve completion criteria. The monitoring approach, locations and frequency will be developed based on the outcomes of the Contaminated Site Assessment. Any identified contaminated sites are expected to be managed and remediated during operations. Rio Tinto currently maintains registers for potentially contaminating activities and known or suspected contaminated sites which have been formally reported under s11 of the *Contaminated Sites Act 2003* (WA).

10.6. Cultural Heritage Monitoring

Heritage surveys and assessment will occur prior to closure to ascertain potential cultural heritage impacts of closure implementation and inform the development of alternative strategies if required. Assessments are also undertaken post-closure to confirm that implementation has been undertaken in an appropriate manner. The SCHMPs for the Brockman Operation set out consultation processes in respect of broader social and cultural values, throughout the life of mine and prior to closure.

Visual impact assessment will be undertaken prior to closure to ascertain any potential visual impacts of the closure implementation and inform the development of alternative strategies if required.

Cultural heritage monitoring will consider the significance of water features in the surface water and groundwater monitoring programs.

10.7. Geotechnical Stability

Operational geotechnical stability monitoring of pit walls is undertaken using manual and automatic prisms, extensometers, visual inspections, and aerial survey data, and will continue throughout the pre-closure and closure implementation phases. The purpose of this monitoring is to ensure the safety of operational and closure implementation personnel. Post-closure geotechnical stability monitoring will focus on waste landforms, including those waste landforms remaining within PUPEZs, to identify any signs of large-scale geotechnical instability that would prevent the closure outcome of having stable final landforms from being achieved.

The post-closure geotechnical stability monitoring program will be refined over time and will utilise the most appropriate available technology to demonstrate the closure outcome of safe and stable landforms has been achieved. Should post-closure monitoring identify conditions that do not meet the agreed closure outcomes, maintenance and rework measures will be determined and implemented as appropriate.

10.8. Post-closure Maintenance

Post closure, maintenance will continue as required until it is determined that the closure outcomes have been met or it is otherwise agreed with Government to allow relinquishment of the site.

11. FINANCIAL PROVISIONING 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.

11.1. Principles of Rio Tinto closure cost estimation

Closure cost estimates are determined based on methods outlined in the Rio Tinto Closure Standard (2021a) and the Rio Tinto Accounting Policy. Closure costs are considered in the following two formats:

Present Closure Obligation (PCO) - indicative of costs associated with closure of the mine given its current footprint; this accounts for the progressive development of a site over .

Total Projected cost of Closure (TPC) - predicts the cost (in current terms) associated with closure at the end of LOM. The TPC includes areas that are not currently approved, but that feature within the LOM plan and that are considered likely to be developed in the future.

The cost estimates consider the following components[1]:

- Pre-closure studies;
- Decommissioning (i.e., removal of infrastructure)[2];
- Final landform construction;
- Rehabilitation and biodiversity management;
- Heritage management;
- Workforce management (i.e., training costs and redundancy payments) [3];
- Monitoring costs;
- Costs associated with the development of the final closure plan;
- Costs associated with undertaking a final shutdown of operations;
- Allowance for failed rehabilitation or pollution that may necessitate rework of rehabilitation areas;
- Assignment of indirect costs in accordance with Rio Tinto Accounting Policy; and
- A contingency factor.

11.2. Closure cost estimation methods

Closure cost estimation is based on methods outlined in the Rio Tinto Closure Standard (2021a) and Rio Tinto Accounting Policy, with the level of accuracy increasing as the site approaches closure[4]. The closure cost estimates are conducted based on the most recent information of mine plans and infrastructure, with the estimate generally undertaken by specialist external consultants.

The PCO estimate for each site is revised annually to account for incremental mine development during the year. As part of Rio Tinto assurance processes these cost estimates are audited annually by external financial auditors to ensure adequate processes to generate the provisions are maintained.

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[1] Costs associated with decontamination are assessed during closure plan development but are costed separately as they are classified as operating costs, not closure costs.

[2] The decommissioning cost estimate assumes that infrastructure will be demolished and buried on site. The site is sufficiently 20112015remote 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.

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

[4] The level of accuracy applied to Rio Tinto estimates is as follows: greater than 10 years from closure: ±30% / between 10 years and 5 years from closure: ±20%; / less than 5 years from closure: ±15%.

The TPC estimate is revised following a formal MCP update, usually triennially, to capture any changes to the LOM design.

Note that for commercial reasons the actual estimate is not documented in this closure plan.

12. MANAGEMENT OF INFORMATION AND DATA

The management of baseline, closure risks and issues data, as well as legal and other obligations and stakeholder consultation records is critical to the management of closure planning and implementation activities. The following data management systems support the management of this data to inform closure planning for the Brockman Operation.

12.1. Iron Ore Document Management System

The Company 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 be accessible for historical information following site closure, and all relevant data will be retained according to appropriate data retention requirements. At the time of writing, Rio Tinto is progressing with a transition to an alternative document management system, referred to as Information Management System. Future changes to the document management system will be updated in the next MCP as required.

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 or the relevant Information Management System to ensure that it is appropriately retained post-closure.

12.2. Closure Knowledge Database

The closure knowledge database is a knowledge management process designed to bring closure-related research and monitoring outcomes together into one searchable location. It uses a single entry form to capture where the report is stored, and how and where the research can be applied for all new ongoing and completed closure-related studies. This information is then managed by the Closure team within a secure database.

12.3. EnviroSys

EnviroSys is an environmental database that is used by Rio Tinto to manage environmental and hydrogeological data. The tool is used to store, monitor and analyse those parameters and report trends on data collections. Data collected currently includes:

- groundwater – biological, chemical, field, levels, production;
- marine water – biological, chemical, field;
- soil chemistry;
- surface water – biological, chemical, field, levels, production;
- tonnes and moisture;
- rehabilitation monitoring;
- water meters; and
- weather (rainfall, temperatures etc.).

EnviroSys is used to support the building of closure knowledge bases, as well as ensure compliance with operating licenses pertaining to data management. At closure this data would be appropriately stored to allow for review of post-closure completion criteria.

12.4. Archer Risk Management

The Archer system is a centralised database of all operational and closure risks. This database is used by Rio Tinto to manage risks and address actions to progress closure related planning during the life of mining.

Archer currently stores risks, controls and actions and the system functionality also enables the user to rate the effectiveness of these risks and controls, as well as verify actions have been completed.

The Brockman Operation closure risk register is currently stored in Archer, with closure planning actions aiming to address knowledge gaps highlighted in this closure plan. As indicated in Section 7.1, quarterly review of actions and controls is undertaken for the life of the asset.

12.5. Tenement Management System

The tenement management system is used to store tenement, licencing, permitting and other land management data, as well as legal and other obligations. This database is maintained to inform the Brockman Operation Closure Legal Obligations Register (Appendix 3) and will continue to be updated as changes to legal obligations associated with land management change.

13. REVIEWED MINE CLOSURE PLANS

This is a new consolidated MCP for the Brockman Operation, therefore this section will be expanded in the next iteration of the MCP. The most recently Approved MCP documents for the three operating sites are as follows:

- Brockman Syncline 4 MCP, 23rd March 2018 (V3)
- Brockman 2 Nammuldi (B2N) MCP, 31st March 2017 (V1)
- Silvergrass East MCP, 5th February 2018 (V2)

Appendix 1 provides a summary of feedback from regulatory agencies relating to the three MCPs with Rio Tinto's response to comments and how these have been considered in the development of this MCP.

13.1. Mine Closure Plan Updates and Review

The Table 13-1 below outlines the MCP (v2) summary of changes following the latest feedback and review of the latest submitted MCP (Brockman Operation MCP 2022 v1 submitted in October 2022).

Table 13-1: Summary of changes reflected in this MCP (v2)

Section (MCP v2)	Change	Comment
General Form	Minor update from MCP v1 to MCP v2. MCP sections re-ordered to align with the 2020 MCP Statutory Guidelines (DMIRS, 2020) and Rio Tinto internal forms	Order of some sections were not as per the 2020 guidance. This MCP retains the same information as per MCP v1 and aligns to the Rio Tinto MCP planning requirements
Executive Summary	Minor updates	Purpose added with clearer MCP EP Act requirement. Closure outcomes updates to include reference to DMIRS (2020c) Rehabilitation and Mine closure objectives
Figures	Minor update - MNES Ghost Bat exclusion zones figure updated Figure 5-31	Exclusion zone expanded following preliminary review of the Draft BSP ERD
Hydrology	Minor update – additional context in Section 5.11.5. Surface water quality and sediment considerations and interations with surface water pools (eg Plunge Pool)	Regulator and traditional owner concerns on Plunge Pool catchment changes have raised concerns about surface water quality and sedimation risks to Plunge Pool. The review and rehabilitation practices of WRL at closure will reduce sedimentation risks and pit void strategies will be refined with surface water considerations prior to closure.
Closure Risk Assessment	Moderate update. Modification of Appendix 5 format – Risk assessment/ risk register and inclusion of Key issue management section.	Changes made to align with the 2020 MCP Statutory Guidelines (DMIRS, 2020).
Reviewed Mine closure plans	Moderate update - Addition of Table 13-1, Table 13-2, Table 13-3, and indicating changes to the Mine Closure plan and feedback of Mine closure plan.	Tables added indicate changes to the MCP since the last submission.
Appendix 5	Moderate update- Format of Risk assessment table updated to include likelihood and consequence ratings for the residual and inherent closure risks. Addition of consequence and and likelihood definitions of Rio Tinto's core-non financial risk evaluation scheme	Changes made to align with the 2020 MCP Statutory Guidelines (DMIRS, 2020).

13.1.1. Regulator feedback

Prior to the Brockman Operation MCP v1 submission, historical feedback is providedin Appendix 1. Table 13-2 is the regulator feedback related to the Brockman Operation MCP (v1) October 2022 submission and the subsequent responses from Rio Tinto applied to this MCP (v2).

Table 13-2: Regulator feedback

	Regulator comment	Rio Tinto Response
DWER response (reference: DWERT4195) to 2022 Brockman Operation Mine Closure Plan v1 (RTIO-0214255_v1) submitted with BSP ERD		
27	• The proposal infers that the State Agreement requires a MCP however, a MCP is required under the *Environmental Protection Act 1986* and not the State Agreement.	Purpose added to the executive summary reflects Environmental Protection Act 1986 requirements
28	• MCP v1 requirement: *Prepare a Closure Plan consistent with DMP and EPA Guidelines for Preparing Mine Closure Plans (2015)* ○ MCP v1 does not meet the DMIRS guidance in terms of risk assessment format and reference to DMIRS Closure Objectives	Appendix 6 has been modified to include risk evaluation and risk treatment for derived current risk evaluation. Reference to DMIRS rehabilitation and mine closure objectives have been included in the Executive Summary and in Section 8.1
	○ The order of the various sections differs from the 2020 MCP guidelines	MCP Section order has been updated in Brockman Operation MCP v2 to align with the 2020 Mine Closure Plan Guidance (DMIRS, 2020a and 2020b).
	○ The Risk Register provided in Appendix 5 does not show how the inherent raw and treated risks are arrived at.	Appendix 5 has been modified to include risk evaluation and risk treatment for derived current risk evaluation
	○ Executive summary closure outcomes should refer to the DMIRS Rehabilitation and Mine Closure Objectives and explain how these are being met	Reference to DMIRS mine closure objectives have been included in the Executive Summary and in Section 8.1 as per the Environmental Objectives Policy for Mining in Western Australia (DMIRS, 2020c). The MCP includes preliminary completion criteria for each of the proposed outcomes; however, these are not yet agreed with key stakeholders and will continue to be refined throughout the mine life stages. Rio tinto consideres the criteria to be adequate for the current stage of mine planning and operations.
	○ Executive Summary Closure outcomes 2 and 8 cannot be assessed as there is no current agreement on the Post Mining Land Use	Updated to “proposed” as indicative in Section 6.2.
	○ Geotechnical stability objective should be stated in the Executive Summary, not just section 12.7 of the MCP	Geotechnical stability is mentioned throughout the document (Sections 5.6.4 and 5.6.5 discusses this in further detail). The closure outcome objective 1 including “stable” is implicit of geotechnical stability. Objective remains unchanged in MCP v2. DMIRS Rehabilitation and mine closure objective has been added to the Executive Summary and Section 8.1. “Geotechnical’ has been added to Closure Outcome 1 preliminary completion criteria in Table 8-2.
29	• MCP Section 7 risk assessment should include likelihood and consequences definitions	Rio Tinto risk evaluation scheme definitions have been added to Appendix 5. Consequence evaluations exclude financial definitions.

30	• MCP Section 8 management of key issues should be derived from the risk assessment process ○ The geotechnical stability issue tied to the PUPEZ is also relevant to the placement of WRL that are often located adjacent to pit to minimise haulage cost considerations. To meet the DMIRS geotechnical stability objective the WRL as built closure footprint and any associated access or erosion or surface drainage features required post closure must be located outside of the PUPEZ	Section "Management of key issues" has been moved to risk assessment Section 7. Geotechnical stability and PUPEZ is discussed in Sections 5.6.4 and 5.6.5. While a PUPEZ has been calculated for all pit designs, at this stage of closure planning, abandonment bund locations are conceptual due to the likelihood of changes to pit design, WRL rehabilitation footprint, buttressing requirements and backfill heights resulting in a change to the final PUPEZ. A review of the PUPEZ calculated from the current final pit designs and its interaction with WRLs and natural topography has been completed and conceptual abandonment bund locations shown in Figure 5-9 to Figure 5-11.
31	• MCP Appendix 4, In relation to the WRL DP1 proponent response to the erosion event, the 10m wide berm and capacity to hold water over the long term is questionable. Landloch, who are involved in the erodible assessments of materials used for the Rio WRL, generally do not recommend batter and berm designs from a closure risk reduction perspective (Hydrological Function of berms within a waste rock landform design/Mine Closure 2016 - AB Fourie and M Tibbet (eds)): ○ *Berms remain a persistent feature in waste dump landform designs as they are perceived to provide the benefits of reduced slope length, protection against future batter erosion by partitioning the slope with level or back sloping berms, and reduced flow velocity. Underpinning this rationale is the belief that the berms will be a permanent and unchanging feature that controls erosion over the long term. These assumptions are not true.*	Noted. WRL's are designed and constructed as per the Landform Design Guidelines (Rio Tinto Iron Ore RTIO-HSE-0015708) and rehabilitation is conducted in accordance with RTIO standards and procedures. Rock armouring is used in addition where waste dump material has high erodible % content. Backslopes of berms are designed as 11 degrees. Batter Selector Tool developed for Rio Tinto Iron Ore includes the recommended maximum and minimum design parameters for WRL by material type. The Batter Selector Tool was developed in collaboration with Landloch (as per Section 5.7.4).
32	• MCP Appendix 5, risk register format does not show how the likelihood is decreased as a result of the proposed controls. The risk register should follow the format shown in the DMIRS MCP Guidance document How to Prepare in Accordance with part 1 of the Statutory Guidelines for MCPs and Appendix 6.	Appendix 5 has been modified to include risk evaluation and risk treatment (controls) for derived current risk evaluation.

13.1.2. Knowledge database and actions update

Data knowledge base progress since last MCP submission is outlined in Table 13-3. Knowledge gaps and action progress is not listed where investigations are on-going or are in-progress. Actions and knowledge database gaps are provided in 5.16 and in Appendix 6.

Table 13-3: Knowledge database updates since previous MCP

Factor	Closure knowledge gap	Type (MCP date)	Associated closure risk assessment action/s	Comment (timing / progress)
Hydrogeology	The water balance at closure that considers surplus water (quality and quantity) stored during operations and potential requirement for additional water source/s to meet the environmental and cultural objectives.	Existing (MCP v1)	ACTION: Complete Managed Aquifer Recharge trial with support from EG [561754]	Action completed. MAR scheme implementation investigations are ongoing.

14. REFERENCES

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APPENDICES

Appendix 1: Summary of Previous Site Specific MCP Regulatory Feedback

Table 1 Agency comments and Proponent responses on 2017 Brockman Syncline 4 MCP

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
Section 7 of MCP An objective relating to ecological and hydrological factors of Boolgeeda Creek should be added. It is noted that "landform" in objective 1 is limited to mining constructed features, such as pit voids and waste dumps, therefore, post mining ecological and hydrological factors associated with Boolgeeda Creek have not been considered. Based on the outcomes of monitoring of riparian vegetation and presence of weeds required under the RTIO *Water Discharge Monitoring and Management Plan*, some closures work may be required to restore both the hydrological process and ecological functions within/surrounding the creek. While including an objective on contamination risk (objective 4, 2017 MCP) is appropriate, the removal of an objective relating to AMD (objective 4, 2014 MCP) is not appropriate given the sites AMD risk is moderate. The objective relating to AMD should be reinstated. An objective relating to the absence of pit lakes post-closure should be added, particularly as this factor is relevant to minimising impacts to groundwater levels post-mining and of particular interest to the pastoral lease holders. An objective relating to fibrous minerals should be included, as these minerals require special management (encapsulation within waste dumps and/or covering by pit backfilling) during operations I closure phases of the project to provide a safe post-mining land use. Objectives do not consider fauna safety, a factor relevant to the pastoral lease holders due to potential impacts to cattle. This can be either covered under the public safety objective by rewording, or inclusion of a new objective.	An objective specific to Boolgeeda Creek, incorporating ecological and hydrological outcomes has been included in the completion criteria table. The objective is '*Boolgeeda Creek functions similarly to the pre-mining state*'. The proposed objective *'Contamination risks have been appropriately managed*' has been adopted across our Iron Ore operations and is intended to incorporate AMD related contamination risks. However, given the focus of recent regulator feedback regarding AMD management an objective has been reinstated to ensure AMD risk is specifically covered. The objective is the same as supplied in the 2014 closure plan. In order to maintain alignment between our operations and criteria it is proposed this objective will be reviewed, refined and adopted across relevant operations. Fibrous materials have been incorporated into the objective. The current closure strategy involves backfill to a level that prevents the formation of pit lakes. Inclusion of an objective that prevents pit lakes would restrict the ability to consider alternative closure scenarios. This objective is not proposed to be incorporated into the closure criteria. Section 19.4.1 highlights the need to consider cattle exclusion from pit voids. Section 6.1 states the Brockman 4 mine footprint is generally on areas of rugged terrain of low pastoral land value and as such, cattle were not grazed or mustered directly in the BS4 area prior to mining. It is recognized that surrounding flat areas are likely to remain subject to pastoral activity. Abandonment bunds have been proposed around all pits and section 19.3.1 commits to engagement of stakeholders regarding the development of post closure access plans. The wording *'and fauna where appropriate'* has been added to the completion criteria regarding safety. The updated completion criteria are attached with this letter.	Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" have been updated based on the latest site knowledge and landform planning designs and align with the intent of the previous approved objectives in the 2017 Brockman 4 MCP.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
Section 8 - DMIRS - Completion Criteria: Objective 1 - Final landform is stable and considers ecological and hydrological factors. • Criteria 2 for this objective should read "was designed and constructed"; • All criteria for this objective relate to stability (linked to hydrological processes), and as such there are no completion criteria relating to ecological factors. These should be added to the MCP. Objective 2 - Vegetation on rehabilitated land is self-sustaining and compatible with the final land use. • Criteria 4 - Reference sites need to be established and agreed with stakeholders, linked to this criterion, and presented in a figure. • Criteria 5 needs to be reworded to include both the diversity and abundance of weed species in rehabilitated areas will be the same as within the local area. A definition of "local" in this context should be provided. Objective 4 - Contamination risks have been appropriately managed. These criteria are inadequate as AMD was not included. Completion criteria should either be added to this objective to cover AMD related contamination, or the former objective 4 (2014 MCP) relating to AMD be reinstated as an additional objective (with associated completion criteria).	Note that Objective numbers have been updated to align between table 4 and table 5. Objective 3 – Final Landform is stable and considers ecological and hydrological factors. The criteria have been amended to include designed *and constructed* to criteria 2. Rio Tinto acknowledges that ecological factors of this objective may not have been specifically covered in the criteria and are somewhat linked to Objective 4 regarding vegetation. As criteria are subject to ongoing refinement ecological factors for this objective will be considered in the next compliance closure plan submission. Reference sites will evolve over the life of the operation as new mining areas commence. Several existing reference sites exist at the operation. Rio Tinto acknowledges the location of current reference sites could be provided in future closure plans. The business is currently progressing a large rehabilitation data project which will enable an efficient review of past rehabilitation data and references sites to be undertaken across our operations. Rio Tinto notes comments regarding weed abundance, diversity and local area definition and will consider these comments in future submissions. Inclusion of an objective regarding AMD has been addressed in above comments.	Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” have been updated based on the latest site knowledge and landform planning designs and align with the intent of the previous approved objectives in the 2017 Brockman 4 MCP.
Sections 19.1.1 and 19.1.2 – DMIRS - Potentially Acid Forming (PAF) Material Management As in-pit PAF disposal is not currently proposed, the MCP needs to state this, unless ongoing waste characterisation and groundwater modelling indicates that this would be a viable option for a number of pits. It appears that the MCS unit includes hot black MCS, cold black MCS and oxidised MCS. Provide a tabulated summary of geochemical characteristics of all MCS units so it is clear which are classified as PAF.	This section of the closure plan does not state that in-pit storage of PAF material is not proposed. In-pit storage and backfilling to cover PAF exposures is proposed in Pit 3, 5, 7 and 18. This information is included in table 15. At Brockman 4 the Mount McRae Shale (MCS) can be classified into three; oxidised MCS, cold black MCS and hot black MCS. Both the cold and hot black MCS units are managed as PAF during operations with the hot black shale having higher total sulfur content (generally > 0.3%) and a greater potential for spontaneous combustion and reactivity with explosives. Oxidised MCS is considered inert. A tabulated summary has been included in Section 10.4.2.	Section 5.8 provides the latest geochemical data and risk assessment for all current and planned operations, including management measures.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
Section 10.4; 10.7; and 11.2 – DMIRS - Baseline Data <u>Groundwater</u> Progressive development and refinement of the groundwater model should be clearly summarised and detail the implications to closure and post-closure requirements. If these results presented are from the 2013 model, the 2015 groundwater modelling results pertinent to closure should be summarised. <u>Soils</u> DMIRS agrees with the approach of preferentially using the limited topsoil stores on high priority areas such as waste dumps to aid stability. The MCP must state where preferential use will occur, particularly where revegetation is required for store and release covers over PAF / fibrous minerals encapsulation cells. Comment needs to be included regarding the requirement for seed broadcasting and/or amendments to subsoils and/or other growth medium to achieve closure objective 4. <u>Waste Rock Volumes</u> It is noted that tabulated waste rock volumes have been removed from the 2017 MCP. These volumes should be summarised, using the same unit of measure, in the MCP.	The 2015 Groundwater model has been summarised in updated section 11.2. Rio Tinto Soil management procedures specify the priority areas for placement of higher quality topsoil, subsoil and alternative growth media. PAF waste dumps and store and release covers are the top priority areas. Rio Tinto will give consideration for including additional detail for the domain classes regarding soil in future revisions of the closure plan. The site is still relatively early in its mine life so this detail will be refined as the site approaches closure. Seeding information is subject to continual review and refinement as part of the rehabilitation monitoring program. Section 13 discusses the progressive rehabilitation projects undertaken to date on the site. The majority of areas are construction related and relatively fresh topsoil was able to be utilised removing the requirement for additional seeding. As the site begins to undertake rehabilitation utilising older and lower quality soils monitoring and discussion of results will be included in the closure plan. Waste material types were presented as a percentage in Table 6. Rio Tinto will present as a volume in the next closure plan submission.	Section 5.9 provides a summary of the latest groundwater modelling (2021) for all current and planned operations across the Brockman Operation. The latest topsoil balance forecast is presented in Table 5-2 to Table 5-4. Across the Brockman Operation there is forecast to be a surplus of topsoil available for rehabilitation. Waste rock volumes for all current and planned operations are summarised in Section 5.7.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
Section 19 – DMIRS - Management of Key Issues <u>Erodible Mineral Waste Management</u> It is noted that a conceptual closure design for DP9 has been presented in Appendix F, however it is recommended to that a cross-section be provided for this waste dump, illustrating the general location of erodible material in relation to final slopes and waste dump height. <u>Fibrous Mineral Waste Management</u> Refer to comments below under "groundwater management / pit backfilling" regarding tabulated and graphic presentation of management of in-situ fibrous minerals in pit walls. <u>Groundwater Management Pit Backfilling</u> The results of the 2015 groundwater modelling for closure and backfill options (RTIO-PDE-0137785) have not been presented in the MCP. A sub-section detailing requirements for pit backfill for groundwater management has not been presented. Provided a tabular summary for all pits including: • pre-mining groundwater level; • modelled (predicted) post-mining groundwater level; • proposed maximum backfill elevation; • average level of natural surface adjacent to the pit crest; • upper and lower elevation of any identified PAF material remaining in exposed pit walls; • upper and lower elevation of fibrous minerals remaining in exposed pit walls. A schematic cross-section, along the ridge, showing post-mining (recovered) groundwater levels in relation to final pit shells, pit backfill elevations and elevations of in-situ fibrous and PAF materials would be beneficial.	The DP9 waste dump has been designed to final landform parameters that allow for all the waste being a high erodibility class. It is a landform with 5-meter-high lifts rather than the more common higher lift heights. A cross section will not be provided as there is no designated area as such for the erodible material. The landform parameters have been overall designed to suit the higher erodibility material. The 2015 Groundwater model has been summarised in updated section 11.2. A tabular summary for all pits detailing requirements for pit backfill for groundwater management as requested has been included in updated section 19.7. In-situ fibrous material exposures in the pit walls are currently being monitored during mining with no airborne fibres being detected. It is proposed that a risk-based approach will be adopted for fibrous minerals remaining in pit walls at closure. Additional details will be provided in future closure plans including which exposures will require backfill. Note section 19.1.2 states that no PAF exposures on pit walls are proposed at closure. Rio Tinto notes the suggestion to include a schematic cross section and will consider this inclusion in future closure plan submissions.	Erodible material management l discussed in Section 5.7. Where available, conceptual rehabilitation designs are presented in Appendix 2. As rehabilitation designs are finalised, cross-sections will be provided to illustrate material management. Management of pit voids post mining is summarised in Section 5.10.8, including pit backfilling strategies. Closure Domain wide strategies are outlined in Section 9.1, Closure Work Programs.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
DMIRS - Closure Implementation The pit domain "AMD risk" should also include fibrous mineral risk. <u>Closure implementation strategies</u> Review of information in Table 15 relating to pit backfilling highlights the absence of some pre-mining groundwater levels (Pit 5) and post-mining groundwater levels (Pit 3, 4, 5, 12 and 18). Where an evaluation of the depth of backfilled waste above predicted post-mining groundwater levels has been possible, concerns exist about the depth of backfill in Pit 1 being only two metres above the pre and post-mining groundwater level, both reported as 490 RL. All other pits will have greater than 20 metres of backfill above pre-mining groundwater levels. DWER (Water) may provide comment / make an assessment of this issue as it is likely that evaporative losses of groundwater will occur through the two metres of waste rock proposed for Pit 1. No comments are provided for Pit 1 or 3 as to the expected maximum elevation of in-situ fibrous minerals to ensure that backfill covers this material. The MCP should include all pre and post-mining groundwater levels and indicate the thickness of backfill above the pre-mining groundwater level so that the adequacy of backfill depth can be assessed	Fibrous risk will be incorporated into the Geo-chemical risk in future revisions of the closure plan. Pre and post mining groundwater levels including backfill are included in Table 16 in updated Section 19.7. As stated in Section 11.2 the groundwater model is predicting recovery level to remain lower than initially thought. The varying depths of backfill are driven by the waste dumping strategy for the operation. Groundwater evaporation from backfilled areas will be negligible.	In-situ fibrous material exposure in final pit walls will be managed on a case-by-case basis through a pit specific risk assessment. The geo-chemical risk is used as a tool to broadly domain pit voids based on potential for AMD at closure and does not incorporate fibrous risk. Groundwater modelling will be refined to a pit scale in order to inform backfill depth required to meet the proposed closure outcomes.
DMIRS – Closure Monitoring and Maintenance Section 24.1 states that post-closure monitoring will be conducted until it is demonstrated that closure objectives have been met and that the site is able to be relinquished, however, the 2015 MCP guideline requires post-closure monitoring to continue until agreed completion criteria have been met.	Section 24.1 will be updated to reflect ‘criteria’ rather than objective.	Section 9 updates the previous closure plans to align with the 2020 DMIRS Statutory Guidelines for MCPs for the preparation of Closure Outcomes and Closure Criteria.
DWER – EPAS The text in the "Page No." column for Question 9 in the Closure Plan Checklist should be amended to read: "23 and Appendix B". The number 9 in the "Page No." column for Question 16 in the Closure Plan Checklist should be replaced with "29". The number 33 in the "Page No." column for Question 17 in the Closure Plan Checklist should be replaced with "34". The acronym "PAF" in the 2nd line of the 151 paragraph in Section 19.1.1 needs to be replaced with the following text: "Potentially Acid Forming (PAF)". Also, the acronyms "AMD" and "SCARD" in the last line of the 1st paragraph need to be replaced with the following text: "acid and metalliferous drainage	MCP has been updated.	Previous updates to the MCP have been carried forward to this MCP in line with the 2020 DMIRS Statutory Guidelines for MCPs.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
(AMO)" and "Spontaneous Combustion and Acid Rock Drainage (SCARD)", respectively. The text "Decommissioning Plan to be prepared" in the 1st paragraph need to be replaced with the words "Mine Closure Plan". The heading for Appendix C needs to be amended to read as follows: "Appendix C - Closure knowledge database (Confidential)". The number 9 in the "Page No." column for Question 16 in the Closure Plan Checklist should be replaced with "29". The text / font size in Appendix B needs to be increased significantly as it is currently too small and difficult to read.		
DWER-EPAS The text in the "Page No." column for Question 26 in the Mine Closure Plan Checklist indicates that Appendix E contains a schedule of progressive rehabilitation activities. However, Appendix E only contains a "Closure Task List" rather than a schedule with indicative dates / timeframes for research and trial activities as required by the Checklist. Please amend the information in Appendix E to include applicable dates / timeframes for research and trial activities that will be undertaken. The title of Appendix E should be changed to: "Schedule for research and trial activities".	Appendix E has been renamed to 'Task, Research and Trial Activities Schedule'. An indicative schedule has been included. It should be noted that over time, the progressive rehabilitation Section 13 will begin to discuss some of the rehabilitation progress and learnings that may arise from works undertaken as part of the list in Appendix E.	Previous updates to the MCP have been carried forward to this MCP.
DWER-EPAS The text in the "Comments" column for Question 27 in the Closure Plan Checklist indicates that an indicative closure schedule has been provided but does not indicate where this information is located. Furthermore, the 2nd column in the Checklist for Question 27 indicates that a schedule of progressive rehabilitation has not been included in the Mine Closure Plan. Please clarify the location of the information on the indicative closure schedule and amend the Mine Closure Plan to include an indicative / preliminary schedule of progressive rehabilitation in order to meet the requirements of Question 27 in the Checklist.	An indicative closure schedule is supplied in Table 1 and 2. Closure timeframes are linked to the mining schedule with closure likely to be proposed on completion of the final mined pit in 2033. However, mine plans are dynamic and continually subject to change as new and improved orebody knowledge is gained and future approvals sought. The checklist has been updated to indicate that Table 1 and 2 are the indicative closure schedules and potential progressive rehabilitation opportunities. Rio Tinto Iron Ore undertakes progressive rehabilitation projects annually. Our plans are developed at a whole of business level and coordinated by a central rehabilitation and closure team. Additional rehabilitation activities are undertaken during construction projects and exploration activities. Future versions of closure plan submitted will provide some additional detail including maps of current areas under rehabilitation. This should enable some context setting regarding where the sit sits in relation to its operating life and	Section 9.3 and Appendix 22 provides the latest update on progressive rehabilitation across the Brockman Operation. Section 9.3 provides an indicative development schedule (Table 9-13) for the Brockman Operation.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
	the business commitment to continual completion of progressive rehabilitation. Due to the dynamic nature of our mine plans it is important that areas are only approved for rehabilitation once detailed consideration is given to future impacts. If an area sits within a potential future resource, it may not be responsible to rehabilitate until a clear plan is known to ensure valuable resources such as topsoil are not used on areas that may be re-disturbed in future.	
DWER-EPAS The Mine Closure Plan needs to be amended to include an indicative / preliminary schedule of decommissioning activities in order to meet the requirements of Question 29 in the Checklist.	Due to the relatively young age of the operation and conceptual nature of the closure plan at this stage a schedule of decommissioning activities has not been provided. Decommissioning activities would largely relate to infrastructure areas which would not become available until the end of mine life. Additional detail and a Decommissioning Plan will be provided as the site approaches closure. Indicative methods for decommissioning various domains are briefly described in Section 21 Closure implementation strategies. The checklist has been updated to reflect the above statements.	Section 9.3 provides an indicative development schedule (Table 9-13) for the Brockman Operation.
DWER-EPAS The Mine Closure Plan needs to be amended to include an indicative / preliminary framework, including methodology, quality control and remedial strategy for closure performance monitoring including post-closure monitoring and maintenance in order to meet the requirements of Question 31 in the Checklist.	Question 31 in the checklist has been updated. Section 24 of the closure plan contains information regarding closure performance monitoring. It is currently at a conceptual level appropriate for the stage of closure plan. As part of the Rio Tinto Closure Standard, Closure Study's at Order or Magnitude, Pre-Feasibility and Feasibility are required at intervals as the site approached closure. A detailed plan for monitoring is prepared during these closure studies. As the BS4 site approaches closure additional detail regarding closure monitoring will be included in the closure plan. The checklist has been updated to reflect this.	Section 9 "Closure Implementation" outlines the approach Rio Tinto expects to undertake leading into full site closure execution.
DWER-EPAS The heading "Contents Page" on page 7 should be changed to "Table of Contents". A list of appendices and a table of acronyms need to be inserted into the Mine Closure Plan after the existing list of figures. The heading for Appendix C in the new list of appendices should read as follows: "Appendix C – Closure knowledge database (Confidential)".	Contents page has been amended to Table of Contents. A list of Appendices has been added and the Closure Knowledge Database marked as confidential. A table of acronyms will be included in the next closure plan update	Table of Contents adopted for this document and a table of acronyms has been included.

Agency Comments	Rio Tinto Response to Comment	
Brockman Syncline 4 MCP August 2017 (RTIO-HSE-0205402), condition 6 of MS 1000		
DWER correspondence December 2017 (DWERA-000386): the plan requires amendments before it can be approved for implementation. Details of amendments are provided below.	**Rio Tinto response February 2018** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
DWER-EPAS As progressive rehabilitation is currently being undertaken and mine pits will be backfilled, Section 22 needs to include an additional figure which shows the post mining landform where progressive rehabilitation and the backfilling of pits has been undertaken. Furthermore, the size of Figure 32 on page 78 needs to be increased significantly as it is too small and difficult to read.	The size of Figure 32 has been increased and an additional Figure included showing the Post Mining Conceptual layout.	Appendix 2 provides an indicative post-mining landform.
DWER correspondence February 2018 (DWERA-000386): the plan requires further amendments before it can be approved for implementation.	Rio Tinto response March 2018 (RTIO-HSE-0319538)	
DWER-EPAS The response provided to the following concern that was raised by DMIRS is inadequate given that the back filling of mine pits is a requirement stipulated in Table 2 of Attachment 2 of Ministerial Statement 1000. "An objective relating to the absence of pit lakes post-closure should be added, particularly as this factor is relevant to minimising impacts to groundwater levels post-mining and of particular interest to the pastoral lease holders." Section 7 of the MCP needs to be amended to include an objective relating to the absence of pit lakes post-closure.	Objective "Permanent pit lakes do not form within the pit voids" has been added to the indicative completion criteria table 5.	Pit lakes are proposed at the Brockman Operation. A separate Completion Criterion has been developed to meet the requirements of MS 1000 in Section 8.2.
DWER-EPAS The corporate endorsement sign-off date in the MCP checklist needs to be updated once the requested amendments have been incorporated into the document. The date that appears on the front cover of the MCP needs to be updated to coincide with the update corporate endorsement sign-off in the MCP checklist. The text/font size in Appendix B needs to be increased significantly as it is still too small and difficult to read. The amended figure that was provided also appears to have lost the first column that was included in the original version. It is recommended that a fold-out A3 sized page format us used for the table in Appendix B. The requested change in text/font size in Appendix D was not incorporated into the revised version for the MCP.	MCP was updated and resubmitted.	Previous updates to the MCP have been carried forward to this MCP in line with the 2020 DMIRS Statutory Guidelines for MCPs.
Based on Proponent responses and updates to the MCP DWER approved (DWERA-000386) the revised 2017 BS4 MCP (RTIO-HSE-0205402). **In accordance with condition 6-3:MS 1000 the BS4 MCP was due for review and revision by March 2020.** **The Brockman Syncline Proposal was referred to EPA via section 38 (s38) of the EP Act in August 2019. As a result, Rio Tinto sought approval to defer submission of the March 2020 MCP in lieu of the development of the Brockman Operation MCP to support the Part IV assessment and ultimately supersede the BS4 MCP.**		

Table 2: Agency comments and Proponent responses on 2017 Brockman 2 Nammuldi MCP

Agency Comments	Rio Tinto Response to Comment	
Brockman 2 Nammuldi (B2N) MCP July 2017 (RTIO-HSE-0181030), MS 131/867/925		
DWER correspondence August 2017 (DWERDA-001500): the plan requires amendments before it can be approved for implementation.	**Rio Tinto response August 2017** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
Acid and Metalliferous Drainage: Further information is required to determine the adequacy of in-pit Potentially Acid Forming (PAF) disposal and pit wall exposures (particularly in relation to Pit 8, Pit 4/6 and Lens CD). Any PAF material not fully saturated by groundwater at closure may pose a risk of acid generation. Information on PAF location in relation to rebounding groundwater level should be in a location that will not be saturated with groundwater, then measures to mitigate the risk of oxygen and water ingress should be outlined.	Interpretation confirmed with Rowan Inglis (1/8/17) Response needs to address: The location of PAF in relation to the rebounding groundwater levels in each pit; and If the PAF is located such that it is not fully saturated with groundwater, then measures to mitigate the risk of oxygen and water ingress should be outlined. Rio Tinto acknowledges the risks associated with in-pit PAF waste disposal and pit wall exposures of PAF material. Although in-pit PAF waste disposal is preferred to above ground waste dump disposal for various reasons such as the risk of inert encapsulation failure is lower and convective oxygen transport is inhibited. The management strategies presented in the closure plan are consistent with those previously assessed and approved under MS 867. Rio Tinto considers that geochemical risks associated with Pit 4/6 have been appropriately managed. PAF waste material has been fully encapsulated within an in-pit dump located within an above water table section of Pit 4/6. When the dump is completed a store and release cover will be installed to limit infiltration. Groundwater is not predicted to recover to within proximity of the dump base, and the dump is therefore not expected to ever be saturated with groundwater. The section of Pit 4/6 where there were exposures of PAF in the pit wall has been backfilled with inert waste and the exposures are now substantially covered, backfill is ongoing. The backfill will mitigate the risk of oxygen and water ingress to the now covered PAF. Surface and ground water monitoring data indicates that acidification and/or metalliferous drainage has not occurred and that the management strategies have been effective in managing this risk. Initial modelling has suggested that the water table is unlikely to recover to a level where previously exposed PAF is located. This will be reviewed as further data and knowledge is collected. Rio Tinto acknowledges that further work is required to evaluate risks for PAF exposures	Currently all proposed in-pit PAF storage dumps are within AWT stages of pits. Pit 8 will be converted to an in-pit WFSF that, once completed and covered with inert waste, will not have any in-situ PAF exposures in the final wall. Mining has ceased in Pit 4/6. The void has been backfilled with inert waste to 600mRL, 20m above the forecast groundwater recovery level. The in-pit PAF material within Pit 10 and Lens CD has been encapsulated within AWT stages of these pits.

Agency Comments	Rio Tinto Response to Comment	
Brockman 2 Nammuldi (B2N) MCP July 2017 (RTIO-HSE-0181030), MS 131/867/925		
DWER correspondence August 2017 (DWERDA-001500): the plan requires amendments before it can be approved for implementation.	**Rio Tinto response August 2017** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
Pit lakes: There is concern regarding pit lake water quality at Brockman 2 extension Pit 8, should it not be backfilled, along with the identified impacts to pit lake water quality at Nammuldi Lens CD. It is noted that Hamersley Iron has identified these issues and has committed to progressively backfill Pit 8 where possible and to conduct further investigations at Lens CD. It is expected that the outcomes from the further investigations will be used to inform appropriate management measures which should be presented in future versions of the Mine Closure Plan	Noted	Pit 8 is proposed to be converted into a WFSF. A pit lake water salinity assessment was recently completed indicating that Lens CD remains a low to moderate risk of rising salinity post-mining. Section 5.16 describes the pit lake geochemical assessment planned.
Stability of landforms: Section 20.4.2 states that waste dumps within the 1% annual exceedance probability flood extent will have erosion controls and abandonment bund construction requirements incorporated into their design to ensure flood protection. Given the waste rock dumps are intended to stay in perpetuity at closure, the design should be for more extreme events.	Waste dumps within the 1% AEP flood extent will have controls installed, such as rock armouring of the waste dump toe or permanent flood diversions, to mitigate erosion risks arising from more extreme events. The closure task list in Appendix F states the following action: BNAM-6 - Undertake detailed hydrological and engineering assessment to determine the extent of structures required to control erosion. The outcomes of this action will assist to determine appropriate controls for each waste dump. Given the dynamic nature of both mine development and local hydrological processes, this action is not proposed to occur until the site approaches closure.	Section 5.11.4 summarises the most recent flood modelling assessment across the Brockman Operation. Outcomes of this work will inform the rehabilitation designs of WRLs presented in the next MCP.
Stability of landforms: Another concern identified is the inclusion of ramps in a number of Waste Dump designs (Pit 4/6 BS2 PAF, Lens CD and Pit 8 LG), as outlined in Appendix E. Ramps are likely to channel water during rainfall events and increase the probability of erosion. The incorporation of ramps in waste dump rehabilitation designs is therefore not supported.	Rio Tinto acknowledges that ramps should be avoided in rehabilitation designs. Revised designs will be presented in the next closure plan update.	Ramps have been progressively removed from rehabilitation designs as they are updated. Some ramps remain in rehabilitation designs, however these will be removed from the designs as part of an update or during the implementation phase.

Agency Comments	Rio Tinto Response to Comment	
Brockman 2 Nammuldi (B2N) MCP July 2017 (RTIO-HSE-0181030), MS 131/867/925		
DWER correspondence August 2017 (DWERDA-001500): the plan requires amendments before it can be approved for implementation.	**Rio Tinto response August 2017** (RTIO-HSE-0313864)	**Reference in the Brockman Operation MCP**
General comments: Figure 13 appears to show some waste dumps within, or in very close proximity to zones of potential pit instability. Waste dumps within the zone of potential instability present a high risk for the site not being able to meet the objective of leaving the site in a stable state at closure. Further clarification is requested on the locality of waste dumps in relation to pit zones of potential instability. Should any waste dump be located within a zone of potential pit instability, then the proposed management measures should also be outlined.	As stated in section 10.3 of the Closure Plan, preliminary zones of geotechnical instability have been presented in this plan. The zones are based largely on conceptual waste dump and pit designs which are subject to further refinement and orebody knowledge increase. The final locations of the zones of instability at closure will be subject to geotechnical review, as they are currently conservatively based on the assumption that all pit walls are embedded into weathered rock. Should any existing landforms be reviewed to be within the zone of instability, they will be managed by being utilised as future material available for backfill and abandonment bunds. The final landform will remain outside the zone of instability unless approved alternate arrangements are agreed with the regulator. As the mine progresses and pit shells potentially change, the ZOI will be updated and provided in future versions of the closure plan.	As per 2017 response.
Based on Proponent responses DWER approved (DWERDA-006419) the 2017 B2N MCP (RTIO-HSE-0181030), noting the MCP was to be reviewed and submitted by 31 March 2020. **The Brockman Syncline Proposal was referred to EPA via section 38 (s38) of the EP Act in August 2019. As a result, Rio Tinto sought approval to defer submission of the March 2020 MCP in lieu of the development of the Brockman Operation MCP to support the Part IV assessment and ultimately supersede the B2N MCP.**		

Table 3: Agency comments and Proponent responses on 2017 Silvergrass East MCP

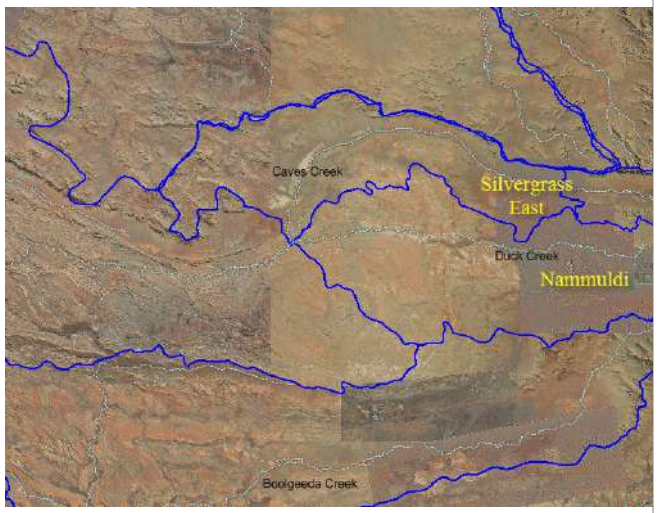
Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
General: Variations to closure objectives are proposed subsequent to the environmental approvals of the project, and the proponent must first submit a request to vary these objectives. Suitable supported evidence or justification of these proposed changes should accompany any such request. The 2017 Silvergrass East MCP does not provide suitable evidence or justification for the proposed changes to the 2012 closure objectives.	Noted	Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” have been updated based on the latest site knowledge and landform planning designs and align with the intent of the previous approved objectives in the 2017 SGE MCP.
General: The cross referencing of other plans including the "Greater Nammuldi Closure Plan" ensure difficulty in having to cross reference between multiple plans to establish if all impacts identified as part of the original project approval and the subsequent requirements of Ministerial Statement (MS) 925 have been addressed.	The rehabilitation and closure related conditions imposed by Ministerial Statement 925 apply to both the Silvergrass East and the Greater Nammuldi operations. Although they operate in a “hub” fashion and do share a substantial level of common baseline information, they are viewed as individual sites with their own key issues from a planning perspective and therefore separate closure plans are prepared for these operations. This aligns with the approach taken during the original project evaluation in 2012 in which a separate Silvergrass Closure Plan was appended to the Greater Nammuldi Closure Plan.	The Brockman Operation MCP (this document) merges all operations across BS4, B2N and SGE.
Section 8: The updated closure objectives no longer specify current commitments to: • maintain Caves Creek hydrology functionality; • maintain the cultural heritage values of Palm Springs and Significant cultural sites; and • maintain the environmental values of the Themeda grassland Threatened Ecological Community (TEC) adjacent to Silvergrass.	We refer to the letter provided to the Department of Water and Environmental Regulation dated 4th May 2018, in which the Company’s position regarding closure objectives was detailed. The Silvergrass East closure objectives presented in the October 2017 closure plan were revised from those presented in the 2012 Closure Plan to better align with the Company’s standard set of objectives which are applied to all of its Pilbara iron ore mines. As noted in the October 2018 closure plan, since the Silvergrass Closure Plan was first submitted in 2012, the mine plan and layout for the site has been amended, in part to limit the potential for impacts to the Themeda grasslands area and it was therefore considered that the objective which requires consideration of hydrological issues in the final landform was sufficient to address any potential for operational impact to this protected area.	Refer Section 9.4 “Closure Outcomes” and Section 9.5 “Completion Criteria” for further discussion.

Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
	The revised objective 'Caves Creek functions similarly to the pre-mining state" was considered to combine the previous objectives related to Caves Creek and Palm Springs, with Palm Springs being a key feature of the creek system, in order to address MS 925 condition 6.1 that 'dewatering and discharge do not cause long term impacts to the health and abundance of ground-water dependent vegetation communities in Duck and Caves Creek'. In response to DWER's concerns Rio Tinto has reviewed the closure objectives. The updated objectives are included in the enclosed closure plan for your reference. Rio Tinto is committed to ongoing engagement with our key stakeholders to continue the development of these criteria over time.	
The revised objectives remove reference to Palm Springs, Duck Creek, heritage values and significant cultural sites, as well as the Themeda grassland TEC – and propose to replace and consolidate the above objectives within the following two (2) objectives: • Final landform is stable and considers ecological and hydrological issues; and • Caves creek functions similar to the pre-mining state.	As noted above, the intention of the revised objectives was to incorporate these factors into the updated objective 'Caves Creek functions similarly to the pre-mining state'. As discussed above this objective has now been refined to refer to Palm Springs. As discussed in item 13, Duck Creek is considered in relation to the Greater Nammuldi operation. Additional details regarding environmental receptors in to proximity to operations will be expanded in future closure plans following DWER feedback. The Themeda Grasslands objective has been reinstated and a separate objective in relation to cultural heritage has been added in the revised Closure Plan, as enclosed.	Refer Section 9.4 "Closure Outcomes" and Section 9.5 "Completion Criteria" for further discussion, specifically Closure Outcome:
The plan states that the additional issues not covered under this current plan are addressed in the "Greater Nammuldi Closure Plan". It is difficult cross-referencing between multiple plans to establish if all impacts are identified as part of the approval.	Rio Tinto assumes that DWER refers to the management of surplus groundwater (Section 11) at the operation. Silvergrass East conveys water abstracted to enable below water table mining to the Nammuldi operation where it is used by the plant or mine, used in the Nammuldi Agricultural Project or discharged by Greater Nammuldi into Duck Creek in accordance with approval conditions. As all of these actions are managed and take place at or in proximity to the Nammuldi operation it is seen as appropriate that they are discussed and	The Brockman Operation MCP (this document) merges all operations across BS4, B2N, and SGE.

Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
	addressed within the Nammuldi Closure Plan rather than the Silvergrass Closure Plan. The Silvergrass Closure Plan Section 11 has been updated to provide further information on this to assist in cross referencing between the two plans.	
Themeda grassland TEC An objective which "considers" ecological and hydrological issues as part of a stable land, is not considered equivalent to an objective which aims to "maintain the environmental values" of the TEC. The plan asserts that maintaining drainage and flooding as part of the final landform objective is sufficient to ensure surface flows are maintained for the TEC. The proposed completion criteria and monitoring to demonstrate achievement of this objective does commit surface flows of the health of the TEC, post closure.	In response to feedback provided, the company has reinstated the objective *Maintain the environmental values of the Themeda grassland Threatened Ecological Community (TEC) adjacent to Silvergrass*.	Refer Section 9.4 “Closure Outcomes” and Section 9.5 “Completion Criteria” for further discussion, specifically Closure Outcome:
Section 19.5: Development of Silvergrass East pits may result in a minor reduction in surface water runoff reaching these communities from the east, however studies to date indicate that they rely predominantly on incident rainfall rather than surface flows and this is therefore not expected to have an impact on the values of these communities. There is no data/study to support this statement.	Rio Tinto refers DWER to the Hydrology section of the Closure Knowledge Database summary contained within Appendix C. An investigation and subsequent report were completed in 2010 titled ‘Hydrology Drivers for the TEC at Silvergrass East’ (RTIO-PDE-0078487). This report concluded that incident rainfall is the dominant water source for the TEC. The mining footprint was predicted to reduce the catchment area to the TEC, and that whilst this may impact some species within the central creek, it is unlikely to have a significant impact on the wider TEC ecosystem.	Refer Section 9, Closure Implementation. Rio Tinto has: - Committed to buttressing the SGE Pit 1 within the 1:10,000 AEP flood event. As a result of this modification, Rio Tinto does not expect that the Caves Creek flow regime will be impacted by mining at SGE
Page 41/42: The significance of Palm Springs from both a cultural and ecological perspective. Discussion include that the values of Palm Springs (as identified during the Part IV process) can be adequately addressed by the revised objective *'Caves Creek functions similarly to the pre-mining state'* and it's supporting indicative completion criteria.	Noted. The revised objectives have been amended to include indicative completion criteria specific to Palm Springs. The objective ‘*Key cultural Heritage values have been preserved’* has also been included in the updated enclosed closure plan.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion, specifically Closure Outcome:

Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
Based on the statement (2016 updated Appendix 8) that: *"Groundwater modelling continues to be updated as monitoring information becomes available and show potential for impacts to extend further along the Creek system. This will continue to be actively investigated and appropriate management measures considered if required."* It is considered that Caves Creek objective (which is based on maintaining a surface water system) is inadequate for addressing the impacts on Palm Springs – a groundwater dependent system. The past assertion that impacts to the area will not occur as the spring area is downstream of the "predicted" cone of depression is not justified. The 2016 Appendix B does not support removal of Palm Springs from the Silvergrass East Mine Closure plan's closure objectives. Monitoring drawdown should continue in this area, compared against the original modelling predictions and demonstrate that the area will not be impacted by drawdown – before the EPA accepts removal of Palm Springs from any closure commitment or obligation. In relation to Caves Creek, the objective of attaining a creek which functions "similarly" is not specific or measurable and the completion criteria suggested for this objective does not follow the S.M.A.R.T principle of being time-bound.	Monitoring and modelling of the Caves Creek system in response to mine dewatering has been ongoing since before operations commenced. In 2017 additional monitoring bores were installed along the Creek system to assist in modelling predictions. The modelling is updated on a regular basis. Rio Tinto will communicate any changes to stakeholders as required. The objective *'Caves Creek functions similarly to the pre-mining state'* has been updated to include criteria specific to Palm Springs. Rio Tinto notes feedback regarding the SMART principle for this objective and will consider revision in future iterations of the closure plan as the site progresses towards closure.	Section 5.10.8 discusses proposed closure groundwater management at SGE.
It is proposed to compare the flow regime and velocity of the creek to an undisturbed creek environment, however this reference site(s) is not identified, and the actual detail of how this will be measured is not provided. Water quality monitoring, and surface and groundwater quality monitoring will not offer valuable hydrologic/flow data to verity that the completion criteria or the objective of creek function has been achieved. The baseline creek flow data should be used as the baseline for comparison.	In referring to the undisturbed creek environment Rio Tinto was referring to its intent to use baseline information for the Caves Creek system rather than comparing it to a separate reference site or sites. Rio Tinto thanks DWER for pointing out that this could potentially be interpreted differently to how it is intended. The completion criteria associated with this objective have been refined in the revised Silvergrass East Closure Plan to ensure that the flow regime and velocity of the Creek will be measured and assessed comparable to baseline conditions.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion, specifically Closure Outcome:

Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
It should be considered that inclusion of the *Groundwater Dependent Vegetation Monitoring and Management Plan* as one of the methods/tools which can be used to verify the completion criteria and objective for Caves Creek has been achieved.	Groundwater Dependant Vegetation monitoring has been included in the verification requirements for the objective *'Caves Creek functions similarly to the pre-mining state'.* Reference to a specific management plan has not been included to limit cross referencing of external plans within the closure plan document.	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion, specifically Closure Outcome:
Fulfilment of Condition 6-2(2) MS 925 regarding a Groundwater Dependent Vegetation Monitoring and Management Plan means that baseline data should be held (including health and abundance parameters) that can be used to inform an understanding of how the vegetation associated with Caves Creek functioned pre- mining, and therefore used to demonstrate "similar pre-mining function"'	Rio Tinto assures DWER that baseline information is collected in accordance with the Groundwater Dependent Vegetation Monitoring and Management Plan. The status of compliance is included in Annual Environmental Reporting. As above, Groundwater Dependant Vegetation monitoring has been included in the verification requirements for the objective *'Caves Creek functions similarly to the pre-mining state'* Reference to a specific management plan has not been included to limit cross referencing of external plans within the closure plan document.	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion, specifically Closure
The revised objective and related completion criteria, verification process and evidence do not demonstrate the proponent can meet their Part IV obligation to ensure that: 'dewatering and discharge do not cause long term impacts to the health and abundance of ground-water dependent vegetation communities in Duck and Caves Creek'.	The *Groundwater Dependent Vegetation Monitoring and Management Plan* forms the basis for ensuring compliance with the Part IV obligations to ensure that *dewatering and discharge do not cause long term impacts to the health and abundance of ground-water dependent vegetation communities in Duck and Caves Creek*. The completion criteria currently refer to aspects of this Management Plan which will be used to monitor for, manage and report on any potential impacts.	Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" have been updated based on the latest site knowledge and landform planning designs and align with the intent of the previous approved objectives in the 2017 SGE MCP.
Duck Creek is not mentioned or addressed in any of the updated closure objectives – however it is stated that Duck Creek and the associated closure issues are addressed in the Greater Nammuldi MCP. Caves Creek is a tributary of Duck Creek, which discharges into the Ashburton River – however, given that MS 925 requires addressing impacts on Duck Creek and Caves Creek, compliance can be difficult if the management of these Creeks is considered in isolation to each other. This should be justified as an appropriate approach. The "functioning" of Caves Creek will ultimately impact on the "functioning" of Duck Creek, especially once discharge to Duck Creek ceases.	As stated by DWER, the functioning of Caves Creek will ultimately impact on the functioning of Duck Creek. However, in terms of locality, Silvergrass East is located within the Caves Creek catchment system which covers an area approximately 1530kms^2. The Creek is formed by the merging of Wackilina and Barnett Creeks and the mine operation at Silvergrass East is located 32km downstream from this confluence. Palm Springs is located on this Creek system, some 30kms downstream from the mine operation. Nammuldi operations are located at the headwaters of the Duck Creek and Beasley River regional catchments,	The Brockman Operation MCP (this document merges all operations across BS4, B2N, and SGE. The following closure outcome for Duck Creek, Caves Creek and Boolgeeda Creek has been developed to ensure compliance with both MS 867, 925 and 1,000, respectively.

Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
	predominantly within the Duck Creek catchment. As shown in the below image, Duck Creek is in proximity to the Nammuldi operation and given that Nammuldi is discharging surplus water to this creek from both operations it was considered that the best approach was for the Nammuldi Closure Plan to address Duck Creek and the Silvergrass Closure Plan to address issues pertaining to Caves Creek. We would be happy to discuss these interactions and the approach taken with you further.  	
The omission of Palm Springs and Cultural and Heritage values from the revised objectives is not supported. The original 2012 objectives and corresponding completion criteria for these values should be retained.	Please refer to our response in item 2. A heritage specific objective has now been incorporated into the revised plan, and the Caves Creek objective has been adjusted to include reference to Palm Springs.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion.

Agency Comments	Rio Tinto Response to Comment	
Silvergrass East MCP October 2017 (RTIO-HSE-0293538), MS 925		
DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
The Silvergrass Cultural Management Plan was drafted in 2013 and is scheduled to be reviewed. The Silvergrass East closure plan, 2017 does not include consultation with the Traditional Owner groups (Eastern Guruma). As the Palm Springs area is of high cultural and heritage significance and value, it is inappropriate to set revised closure objectives that omit these specific values, in the absence of appropriate stakeholder consultation.	Rio Tinto is committed to ongoing consultation with its stakeholders. During 2017 we were not able to consult with Eastern Guruma representatives regarding this closure plan for various reasons. During future updates to this plan we commit to consulting with Eastern Guruma and our other stakeholders on all relevant aspects of the closure plan. A heritage related objective has been proposed and included in the revised closure plan; this will be discussed with Eastern Guruma representatives during the next closure plan update to ensure it is appropriate.	Traditional Owners have been consulted during the preparation of the 2022 BSP ERD, the supporting SCHMPs and will be provided this MCP prior to submission to the EPA. Refer to Traditional Owner closure consultation in the Closure Consultation Register (Appendix 4)
The description of landforms is confusing as it alludes to managing only those landforms present at the end of mining (e.g. does not address or plan for any landforms that may be present during mining - see closure related data comments) and combines too many landforms with multiple potential issues into one simplified objective.	Rio Tinto assumes DWER is referring to Section 12.1 of the Silvergrass Closure plan. This section describes pre-mining habitats present in the area prior to mining disturbance and is not intended to describe mining landforms. Post mining and post closure landforms are discussed in Section 3 and Section 20 - 22 of the plan. The multiple landforms comment is addressed below.	Section 9.1 “Closure Works Program” summarises the closure implementation strategies by landform domain class across the Brockman Operation. Rio Tinto acknowledges the complexity that a consolidated Brockman Operation MCP creates. Rio Tinto will continue to evaluate future alternative means of communicating large, multi-pit development projects and update future MCPs as appropriate.
There are too many issues associated with "Landforms" to be encompassed as one objective. In accordance with the *Guidelines for preparing mine closure plans* (DMP 2015) objectives should be separated to address specific individual environmental factors and circumstances.	Noted. At this stage of planning objectives are largely considered at the whole of mine level. In future updates to this plan, Rio Tinto agrees that it will refine its objectives to the individual domain level where appropriate. It should be noted that the post closure landform for Silvergrass East is proposed to consist predominantly of backfilled mine pits (to varying levels) and a single external waste dump.	The Brockman Operation MCP (this document) merges all operations across Brockman 4, Brockman 2 Nammuldi and Silvergrass and has been prepared to meet the requirements of the DMIRS 2020 Statutory Guidelines for the Preparation of Mine Closure Plans. Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion.

Agency Comments	Rio Tinto Response to Comment	
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It may be more appropriate for "landform objective" to have multiple completion criteria and performance indicators which demonstrate all aspects of the objective have been satisfied (e.g. a landform which is safe, stable, non-eroding and non-polluting) addressing each relevant risk (e.g. seepage, erosion, hydrology, cover systems and groundwater/surface water quality).	Noted. At this stage of planning objectives are largely considered at the whole of mine level. In future updates to this plan, Rio Tinto agrees that it will refine its objectives to the individual domain level where appropriate and will consider recommendations regarding aspects of the criteria.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for current indicative completion criteria. Section 9.1 summarises the closure implementation strategies by landform domain class across the Brockman Operation.
It may be simpler to have a separate objective or completion criteria for each domain, depending on the type of landform (e.g. pit voids; waste rock landforms, Caves Creek diversion) and dependent on the risk that landform poses post closure (public safety and environmental risk). Each of these landforms is likely to have several different progress and performance indicators – appropriate to the developmental status of the project (e.g. geotechnical reports, rehabilitation reports, and surface and groundwater quality data).	Noted. At this stage of planning objectives are largely considered at the whole of mine level. In future updates to this plan, Rio Tinto agrees that it will refine its objectives to the individual domain level where appropriate.	The Brockman Operation MCP (this document) merges all operations across BS4, B2N, and SGE and has been prepared to meet the requirements of the DMIRS 2020 Statutory Guidelines for the Preparation of Mine Closure Plans. Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion. The applicability of more detailed closure criteria will continue to be evaluated during the life of operations for Brockman Operation.

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The non-polluting/non-contaminating aspect of the landforms has not been addressed – instead the focus is on achieving a "stable landform". Given the Silvergrass East deposit comprises mine pits, waste landforms, fibrous dumps and stockpiles; this is a serious oversight and could potentially impact water resources and ecological values in the area if not considered as part of the closure planning process.	While this closure plan outlines Rio Tinto's proposed plan to leave the Designated Hazardous Waste Dump, which will be used for the disposal of fibrous materials, as an external feature at closure, operational management practices will ensure the appropriate management and encapsulation of fibrous materials during operations. The closure plan also includes a standalone task (ID SV17) to ensure competent material is stockpiled during operations to ensure the long-term stability of this dump. As indicated in the closure plan, work on this task has commenced. It should also be noted that a separate objective exists for management of contamination namely '*Contaminated sites are appropriately managed in accordance with the Contaminated Sites Act 2003 (WA)*'. In addition, the interaction between hydrological function or water quality and key environmental values are specifically considered in the objectives relating to Caves Creek and the Themeda grassland.	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion.
The mine closure plan lists the indicative mining schedule for Silvergrass East, noting that the majority of waste dumps (including a hazardous waste dump) and below water table pits are still in the "proposed" stage. The revised objective for landforms is to demonstrate that ecological and hydrological factors have been adequately considered - however only the stability of these landforms is considered as an issue. Whilst it may be intended "stable" to incorporate "geochemically stable", the related performance indicators and verification tools do not address this factor.	In the 2012 Closure Plan, Rio Tinto committed to updating the closure plan on completion of geochemical testing for the site. As discussed in this 2017 Silvergrass East Closure Plan, this testing has been completed and the mine has a low geochemical risk profile. All waste materials are proposed to be returned to pit areas excluding a small designated hazardous waste dump containing fibres. Landform stability on this waste dump is proposed to be managed through a capping of rock armouring material, which will be subject to confirmation through rehabilitation research and trials. Inclusion of ecological factors will be reviewed and refined in future revisions of the criteria. Rio Tinto is currently in progress of a large rehabilitation data project which will enable review of rehabilitation data trends and analysis across our various mine sites. In order to maintain streamlined objectives across our operations our approach is to further refine this aspect consistently and ensure our monitoring programs are efficiently able to demonstrate progress towards criteria.	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion. No PAF material is anticipated to be mined at SGE. Fibrous material will be encapsulated as per the FMMP (Rio Tinto 2019b)

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There is no commitment to undertake ground or surface water monitoring to demonstrate that landforms will be non-polluting (pre or post-closure) which indicates a lack of consideration with all the aspects of ecology and hydrology.	Rio Tinto refers DWER to verification item #4 in relation to the objective '*Caves Creek functions similarly to the pre-mining state'*. This objective commits to surface and ground water monitoring.	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion.
The majority of landforms detailed in Table 1 are still in the "proposed" stage, it is inappropriate for it to be assumed that they will not present an issue and therefore exclude key aspects of their management from their mine closure obligations and commitments.	All conceptual landforms in the 'proposed stage' have been developed with consideration of their future composition and location within the project area. Placement of the landform has been done in such a way as to avoid significant impacts to the *Themeda grasslands*. Mineral waste risk assessments and conceptual rehabilitation designs are completed for all landforms. The management of closure section is undertaken in consideration of all current and proposed landforms. In addition, the closure objective relating to the *Themeda grasslands* has now been reinstated to provide assurance this will continue to be appropriately managed.	With the exception of the DHW Dump, all external WRLs at SGE are temporary and will be rehandled in full to backfill pit voids.
The objective for contaminated sites relies on adherence to the provisions of the *Contaminated Sites Act* but does not address the issue of identification and management of potential pollution/contamination from landforms through mining and prior closure.	Rio Tinto refers DWER to Section 14 of the Closure Plan. This details the Company's process with regards to the management of contaminated sites during operations and at closure. A register is maintained for each operation detailing potentially contaminating activities and known or suspected contaminated sites which have been formally reported. Table 19 also details closure measures pertaining to contaminated sites evaluation and clean up if required. The indicative completion criteria in relation to contaminated sites include the following: 'requirements have been met for the identification, recording, management and remediation of any contaminated sites.' In order to verify that this objective has been met, the following verifications are proposed: The site has been appropriately assessed for the presence of suspected or known contaminated sites. Suspected or known contaminated sites have been appropriately reported under the Contaminated Sites Act 2003. Appropriate management measures to address contamination have been implemented.	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion.

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	Process for transfer of residual liabilities (if any) is documented. Potential contamination from landforms i.e. from fibrous and/or potentially acid forming materials are managed and designed in accordance with the Company's Fibrous Materials Management Plan and the Spontaneous Combustion and Acid Rock Drainage Management Plan as discussed in Sections 10.4.2, 10.4.3 and 19.4 of the MCP.	
The closure plan should include a commitment to regularly update their hydrogeological models as data is collected; to monitor ground and surface water (throughout mining, prior to and post-closure); and to undertake ongoing characterisation of all mineral and waste (last conducted in 2014/15) – with the objective of demonstrating that all post-closure landforms will be safe, stable and "non-polluting". This would enable potential issues to be identified early on and schedule their waste management and closure implementation accordingly to prevent the issue of contamination/pollution in the long- term.	Rio Tinto is committed to undertaking regular review of key issues using a risk-based management approach. Material characterisation in relation to erodibility has been undertaken over a number of years based on the geological units found within waste materials. This information is transferrable across sites which have the same geologies and similar climatic patterns. This informs the Company's Landform Design Guidelines which specify design parameters for mining landforms across our operations. The AMD risk for the Silvergrass East deposit has been assessed to be low based on the analysis of 58,000 samples for sulfur, 128 acid base accounting samples and known geological risks in the Pilbara. Mine Geologists routinely assess waste material before it is sent to waste dumps using a variety of different methods which may include: visual inspections (i.e. for pyrite or asbestiform material), test work (i.e. for sulfur), geological models, drill holes and Pilbara wide known geological characteristics, the geologists are able to continually assess risk. The requirement to undertake this work is part of standard management procedures. The numerical groundwater model is updated on an annual basis. The model is calibrated with current and historical abstraction using operational borefields and proximal and regional groundwater monitoring infrastructure, to allow it to be as accurate as possible. The model outputs facilitate hydrogeological conceptualisation refinement as data is collected. The monitoring network across Silvergrass East comprises over 100 monitoring bores and vibrating wire piezometers;	As per 2018 response.

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	with water level readings collected daily through the use of in-bore logger units. All representative data is collated and included into the groundwater model calibration and validation process.	
Condition 10-1 (MS925) requires: • *Manage long-term hydrogeological impacts of mining the Marra Mamba and Bedded Brockman iron deposits;* • *Model the long-term hydrological impacts, particularly the water levels and quality both in the pit void and downstream of waste material landforms* *(10)Manage and monitor mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates.* In addition, Condition 29 imposed on the Silvergrass East mining tenement (L47/00647) states that: *"all waste dumps, tailing storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems".*	Noted. In relation to Condition 10.1 Rio Tinto refers DWER to Sections 11, 19.5 and 19.6 of the Closure Plan in relation to water management and modelling of hydrological impacts and to Sections 10.4, 19.2, 19.4 in relation to mineral waste characterisation and management. In relation to Condition 29 on L47/00647, Rio Tinto refers DWER to Section 13, 19.1 and 19.2 of the Closure Plan which outline rehabilitation including our process for identifying and prioritising areas for progressive rehabilitation. For information regarding compliance with Ministerial Statement 0925 conditions, Rio Tinto refers DWER to our 2017 Ministerial Statement Annual Compliance Report, as submitted to Stuart Cowie at DWER on the 30th April 2018.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion..

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Waste characterisation and inventory All waste dumps are proposed to be used to back-fill pit voids except for the designated hazardous waste dump. The location of the designated hazardous waste rock dump (WRD) outside of the 100- y e a r ARI flood plain extent of Caves Creek and on high ground to avoid interception of surface water flows from any significant catchments. The issue of erosion from 'temporary' WRDs during mining has not been addressed, nor has the possibility of changes to final closure design (e.g. permanent WRDs). It is possible that large scale erosion can occur from these dumps due to the physical characteristics of the waste material, negatively impacting the hydrology and water quality of Caves Creek through erosion and sedimentation. Management should be developed for these 'temporary' WRDs which address how these impacts will be managed prior to reclamation of this material into the pits (e.g. large rainfall events, erosion and surface water runoff).	Management of waste landforms during operations is completed in line with the current Management Plans and annual reviews for the site. Day to day management of the landforms to ensure any potential pollution (such as sediment) is subject to operational controls such as the existing sediment control bund around the perimeter of the disturbance footprint which prevents impact to the *Themeda grassland*. It is considered outside the scope of a closure plan to discuss all operational controls. The closure plan has submitted a change to the final landform design being the proposed permanent designated hazardous waste dump. The possibility of additional changes to landforms, the example being additional permanent waste dumps, is not addressed as it is not proposed. The final landform design has been developed in consideration of the ecological and hydrological values in the project area along with project approval obligations. Annual surface water management plans are prepared for our operations and consider water management requirements on all operational areas including active waste dumping areas. The company views management of these items as operational procedures.	No change.
Dewatering at Silvergrass is currently expected to lower groundwater levels in the deep aquifer by a depth of approximately 150 m and anticipated to take more than 500 years to recover to pre-mining levels. MS925 requires that the approved project does not cause long term impacts to the health and abundance of groundwater dependent vegetation communities in Duck and Caves Creeks as a result of dewatering and discharge. Whilst there are references to groundwater dependent vegetation throughout the plan, it is difficult to determine whether Ministerial requirements are being met including previous and/or revised closure commitments relating to groundwater dependent vegetation.	Rio Tinto is committed to meeting its closure obligations in relation to its operations, including Silvergrass East. Modelling in the 2012 Closure Plan previously predicted this recovery to take up to 125 years. The current modelling suggests as stated that it will take approximately 500 years to recover water levels to pre-mining levels. The current management tool for monitoring and ensuring compliance regarding groundwater dependant vegetation is via the approved Nammuldi-Silvergrass Monitoring and Management Plan - Groundwater Dependent Vegetation Monitoring and Management, as required by MS 925 Condition 6.2. The Closure Plan uses information that is generated as a result of this plan to guide closure strategies	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion.

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	to ensure the site can be effectively closed in accordance with existing closure conditions. It is not considered to be within the scope of a closure plan to report on compliance, as this is reported on through our Annual Ministerial Statement Annual Compliance Reporting process. Note the Caves Creek closure objective now includes as item 5 the following completion criteria reflecting the approval conditions; *Health and abundance of groundwater-dependant vegetation communities at Caves Creek (including Palm Springs but not the approved clearing envelope) is comparable to pre-mining conditions.*	
The use of riparian vegetation on Caves Creek in accordance with the Nammuldi Silvergrass Environmental Monitoring and Management Plan to ensure that any changes to groundwater dependent vegetation communities are monitored" however it appears that the terms of riparian and groundwater dependent vegetation are used interchangeably.	Riparian vegetation refers to vegetation associated with the banks of Creek and drainage lines. While groundwater dependent vegetation may occur within the riparian zone, they are not considered to mean the same thing. Rio Tinto will consider this in the next iteration of this Closure Plan to ensure terms are appropriately utilised.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion.
The Groundwater Dependent Vegetation Monitoring and Management Plan should be used as a measurement tool to verify the Caves Creek objective. The plan should include figures which clearly show areas of groundwater dependent vegetation in relation to predicted and observed groundwater drawdown.	Please refer to our response to item 12 which confirms our intent to utilise the management plan as a part of demonstrating this objective is met.	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion
Table 16: There is a commitment for a contamination sites evaluation and clean up (if required) for the mine services area only. A commitment to the undertaking of a contaminated sites valuation and clean-up of all areas of the Silvergrass East project area that may be subject to contamination (hydrocarbon leaks and/or chemical spills, ROM pads, crushers) is necessary.	As outlined in Section 14 of the Closure Plan, areas of potential contamination are identified during operations and recorded on a central register. Contaminated sites evaluation uses this information to identify areas where further investigation is warranted, including Preliminary Site Investigation and Sampling and if warranted, Detailed Site Investigation. This process covers sites in their entirety, not just the services areas, although this is typically where the risk of contamination is higher. Operational spills are managed in accordance with our hydrocarbon management procedure which requires spills to be contained, cleaned up and reported as they occur. Clean	Refer Section 8 “Closure Outcomes” and Section 8.2 “Completion Criteria” for further discussion.

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	up includes removal of contaminated material and surrounding soil to the bioremediation landfarm at Nammuldi.	
Table 3: The name of the Department of Lands needs updating.	Noted and will be updated in subsequent submissions.	Updated.
Post-Mining Land Use Section 6-2: Section 6.2 presents the current final end of land use as pastoral. It is then stated that the final land use will be determined prior to closure, during the final planning stage. Whilst considering alternative post mining land uses is an option, any proposed changes need to be consistent with current approved activities and should be negotiated with relevant stakeholders as soon as possible. MS925 requires all pits to be backfilled above groundwater level and this is not consistent with proposed alternative land uses to create pit lakes to provide a water source for cattle.	The current proposed final land use for the Silvergrass East mine site is pastoral. Ongoing consultation is proposed with stakeholders. Should any alternative options be considered that are not in alignment with approved activities they will be negotiated with regulators. Section 6.2 does discuss the potential to leave one or more selected pits as shallow permanent or occasional pit lakes to support pastoral activity should this be agreed and approved by stakeholders, pending suitable water quality. However, as described in Section 21, the current closure strategy is to backfill all below water table pits to at least 5m above the pre-mining water table levels (and to surface in the case of Pits 1 and 5) to prevent the formation of pit lakes.	Section 6 provides the latest updates for Post Mining Land Use across Brockman Operation operations
Completion Objectives: Closure objectives are proposed to be amended since the 2012 MCP. Specific objectives relating to the high-risk aspects of the site should be included. An objective relating to the absence of pit lakes post- closure should be considered, particularly as this factor is relevant to minimising impacts to groundwater post- mining. An objective relating to fibrous minerals should also be considered as these minerals require special management during operation/closure phases of the project to provide for a safe post-mining land use.	In response to DWERs feedback, Rio Tinto has revised its indicative closure objectives for the site, including reinstating the Themeda grassland objective, the addition of an objective related to cultural heritage and changes to the completion criteria associated with the Caves Creek objective. As discussed in item 33, the Rio Tinto's strategy is to backfill all below water table pits to at least 5m above the pre-mining water table levels (and to surface in the case of Pits 1 and 5) to prevent the formation of pit lakes in these locations as they are within the 1 in 100-year flood plain. Inclusion of an objective which prevents pit lakes across the site would	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion.

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	restrict the ability to consider alternative closure scenarios. This objective is therefore not proposed to be incorporated into the closure criteria. Fibrous minerals will be mined and appropriately encapsulated within an external waste dump well before closure. The objective 'Public safety hazards have been managed' has been revised to include reference to management of fibrous materials within one of the indicative completion criteria.	
Completion Criteria: The following should be considered in for the next revision of the MCP: Objective 3 - Final landform is stable and considers ecological and hydrological factors. • Completion criteria and verification methods relating to landform stability generally appear adequate. However, Criteria 2 for this objective should read "has been designed and constructed"; • All criteria for this objective relate to stability (linked to hydrological processes), and as such there are not completion criteria relating to ecological factors. This should be addressed in the next revision of the MCP. Objective 4 – Vegetation on rehabilitated land is self-- sustaining and compatible with the final land use. • Criteria 4 – Reference sites need to be established and agreed with stakeholders, linked to these criteria, and presented in a figure. Criteria 5 – requires re-wording to indicate reference to both the diversity and abundance of weed species in rehabilitated areas being the same as within the local area. A definition of "local" in this context should be provided. In addition to the above, should a separate objective relating to management of fibrous material not be developed, then specific criteria should be included within this section under one of the existing objectives, such as contaminated sites.	Rio Tinto thanks DWER for their extensive constructive feedback regarding completion criteria. Whilst closure objectives and completion criteria are necessarily driven by the specific circumstances of an operation, there are a number of common issues that arise across our extensive mining operations within the Pilbara. Rio Tinto has sought to take a consistent approach to common issues, where practicable to do so. In addition, particularly for sites where closure is still some way off, and closure conceptualisation will continue to evolve over a significant period of time, continuous refinement of the closure objectives has been considered a necessary part of the closure planning process. Through this refinement, approaches have been adopted to minimise unnecessary distinctions across sites, which generally have the same underlying key challenges and objectives. This has led to Rio Tinto gradually moving towards more consistent closure objectives and closure criteria and a reduction and streamlining of site-specific closure objectives. In response to DWERS comments, fibrous materials have been addressed – please refer to our response in item 34 and the enclosed revised closure plan. Objective 3 in relation to landform design and construction has been addressed, please refer to the enclosed revised closure plan. Rio Tinto acknowledges that ecological factors	Refer Section 8 "Closure Outcomes" and Section 8.2 "Completion Criteria" for further discussion.

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	of this objective may not have been specifically covered in the criteria and are somewhat linked to Objective 4 regarding vegetation. As criteria are subject to ongoing refinement ecological factors for this objective will be considered in the next compliance closure plan submission. The remaining objectives will be considered for revision in the next closure plan and will be subject to stakeholder consultation. Objective 4 Criteria – Noted. Fibrous material has been addressed above in item 24.	
Baseline Data: Climate – It is stated that rainfall intensity is considered in landform design however, frequency and duration of these events does not appear to have been covered. It would be beneficial to include relevant information on extreme rainfall events within this section, noting that the expectation is for landforms to be designed to remain stable in probable maximum precipitation and probable maximum flood events.	Final landforms are currently designed to 1:100-year ARI events and consider the extent and potential impact of more intense events including PMP / PMF. Where PMP / PMF risks are significant, appropriate controls will be implemented where practicable. This topic has previously been discussed with the DMIRS on several occasions. The Company requests further engagement to understand the regulators direction and reach an agreed approach.	Refer Sections 5.11 “Hydrology” for updates on baseline knowledge and management of key risks related to final landform flood modelling and assessment under different rainfall scenario outcomes.
Risk Assessment: The following information should be provided in support of the risk assessment to provide context and transparency on the risk assessment process undertaken: • Details of risk assessment attendees, dates conducted and context of the risk assessment; • Descriptors of likelihood and consequence and the overall risk matrix; • Summary table detailing inherent high-risk items, controls, residual risk rating, delegation of responsibility. The risk assessment in Appendix D does not detail the likelihood, consequence and risk rating for inherent and residual risks for each risk pathway. There are no descriptors/definitions of a number of headings in the risk assessment table: risk type; category; and subcategory. Tasks listed in Appendix E, to address knowledge gaps identified in the risk assessment, require prioritisation of tasks and timing of completion. These should be addressed in the next version of the MCP.	Rio Tinto maintains closure risk registers for all of its mine operations, which are based on a business wide approach to risk identification, ranking and management controls. The main driver for completing a closure risk assessment is to identify key issues which pose a risk to the closure strategies proposed and to identify gaps in existing knowledge which require further work. These are updated each time the closure plan is revised to ensure it remains appropriate for the current update to the closure plan. The risk evaluation scheme is in part driven by economic consequences which is considered commercially sensitive information. It is Rio Tinto’s view that the information presented in our closure plans currently, which is a summary of the risk assessment, is appropriate to providing assurance that key issues and gaps have been identified and plans are in place to manage these risks.	Section 7 – “Risk Assessment” summarises the outcomes of latest processes used for identifying closure risks across Brockman Operation areas. See Appendix 5 for the full closure risk assessment.

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	Rio Tinto is keen to engage with DWER to discuss this request in further detail and will consider this request for future updates to the closure plan.	
Management of Key Issues: Management of Surface Water – the MCP states that feasibility designs have been completed for the Caves Creek re-alignment, which is proposed to be constructed in 2022. DMIRS should be engaged at key stages during the development of the detailed design for this structure, with the detailed design report being presented to DMIRS (potentially via the MCP process) for review by a DMIRS Geotechnical Engineer prior to construction. Dimensions for the re-aligned channel, including a low flow channel, have also been provided however, it is unclear how these proposed widths and depths have been determined. This information should be provided within the next revision of the MCP. In addition, it is stated that rip rap will only be installed up to the 10yr Annual Recurrence Interval (ARI) flood event surface water level and that waste rock will be placed above this level to mitigate erosion risk. Further information should be included to demonstrate how the constructed channel would remain stable during extreme flood events (e.g. probably Maximum Flood event). Management of dewatering impacts – the MCP advises that, since the commencement of dewatering at Silvergrass, anticipated drawdown extent is now considered to be larger than initially thought. Further information on the current understanding of groundwater drawdown extent should be provided within the next revision of the MCP.	The approved 2012 closure plan detailed conceptual level information regarding the realignment and contained design parameters to support a 1 in 100-year flood event. The 2017 Closure plan has provided updated design information following completion of a feasibility level design. This demonstrates alignment with the closure plan guidelines to provide additional detail over time as scopes are further refined and additional information becomes available. Rio Tinto notes the request for engagement during key stages of the Caves Creek Realignment and for additional context regarding the design parameters. The topic of design parameters including PMP/PMF has previously been discussed with DMIRS on several occasions, most recently regarding the Channar Closure plan in January 2018. Rio Tinto requests further engagement to understand the regulators direction and reach an agreed approach. Further information will be presented in future revisions of the closure plan regarding the realignment and understanding of groundwater drawdown extents.	Refer Sections 5.11 “Hydrology” Rio Tinto has: - Committed to buttressing the SGE Pit 1 within the 1:10,000 AEP flood event. As a result of this modification, Rio Tinto does not expect that the Caves Creek flow regime will be impacted by mining at SGE Hydrology modelling has been undertaken across the entire Brockman Operation for 1:100, 1:1,000 and either 1:10,000 or PMP/PMF in line with guidance from DMIRS (Sept 2020)

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Closure Monitoring and Maintenance: The information provided within this section is very broad. While it is understood that the site is in its early stage of operations, the closure monitoring and maintenance section should be progressing towards including the information required in Section 4.13 of the 2015 MCP Guidelines, such as: • Monitoring framework for each completion criteria, monitoring methods and standards, considering implications on the broader environment and application of quality control in sampling, analysis and reporting; • Assessment of trends against predicted or expected; • Contingency strategies to address any issues with rehabilitation and closure works.	Noted. Rio Tinto will consider expansion of this section as the site approaches closure and final completion criteria are agreed which will define in more detail the monitoring required post closure. The young age of the operation means there is currently no rehabilitation monitoring data available at this point to review trends. Collection of data and analysis of trends is a part of the company's standard Rehabilitation Monitoring Procedure; however, it is noted that future iterations of the Closure Plan will incorporate rehabilitation data within Section 13 (Progressive Rehabilitation). In relation to rehabilitation and closure issues, a contingency is factored into the closure cost estimate for each site to cater for potential rework required in areas which do not perform as expected.	Refer Section 9.3 "Progressive Rehabilitation" and Appendix 22.
Section 24.1: This section states that post-closure monitoring will be conducted until it is demonstrated that closure objectives have been met and that the site is able to be relinquished, however, the 2015 MCP guideline requires post-closure monitoring to continue until agreed completion criteria have been met. Section 24.2.1 states that rehabilitation monitoring can provide vital information which can be used to set realistic and achievable completion criteria. However, development and refinement of completion criteria must occur throughout operations through trials and studies, and relevant learnings from other mine sites. Delaying refinement of closure criteria until rehabilitation has occurred would result in uncertainty for key stakeholders.	Rio Tinto notes that section 24.1 refers to closure objectives and has updated this section to include objectives and criteria. Section 24.2.1 contains general information regarding post closure rehabilitation monitoring. Rio Tinto agrees that development and refinement of completion criteria should occur throughout a project's lifespan. Conceptual completion criteria have been proposed for the project in Section 8 and discussion regarding continual refinement has been included. It should be noted that the Silvergrass East operation has only recently commenced with completion of the construction related rehabilitation earthworks currently underway. At the time of writing the closure plan, minimal rehabilitation has been able to occur as the site has been in the construction phase. Rio Tinto brings attention to sections 13, 19.1 and 19.2 in which progressive rehabilitation learnings are discussed including learnings from neighbouring sites at Nammuldi. As the site develops it is proposed that learnings from monitoring areas established during progressive rehabilitation opportunities will be further discussed and	Refer to Sections 8 "Closure Outcomes and Criteria" and 10 "Closure Monitoring and Maintenance" for updated discussion.

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DWER correspondence March 2018 (DWERA-000564)	**Rio Tinto response May 2018** (RTIO-HSE-0324153)	**Reference in the Brockman Operation MCP**
	included in this section and aid the refinement of completion criteria.	
Based on Proponent responses and revision to the MCP, DWER approved (2018-1527149018676) the revised 2017 Silvergrass East MCP (RTIO-HSE-0293538, v2 2018), noting the MCP was to be reviewed and submitted in 2020. **The Brockman Syncline Proposal was referred to EPA via section 38 (s38) of the EP Act in August 2019. As a result, Rio Tinto sought approval to defer submission of the March 2020 MCP in lieu of the development of the Brockman Operation MCP to support the Part IV assessment and ultimately supersede the B2N MCP.**		

Appendix 2: Post-Closure Landform and Landform Design Criteria

RioTinto

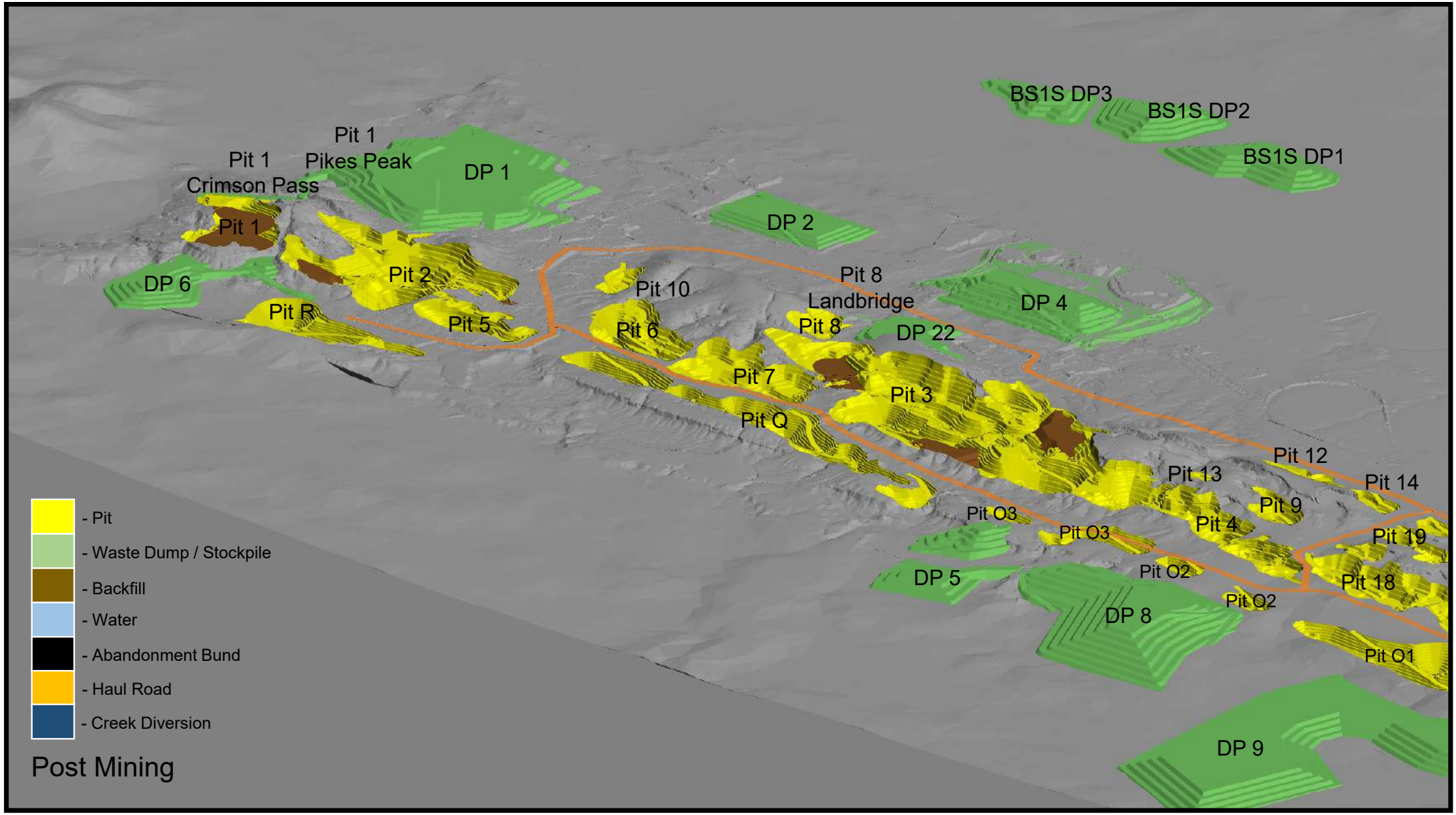
Brockman Operation Post-mining and Post-closure Landform Design

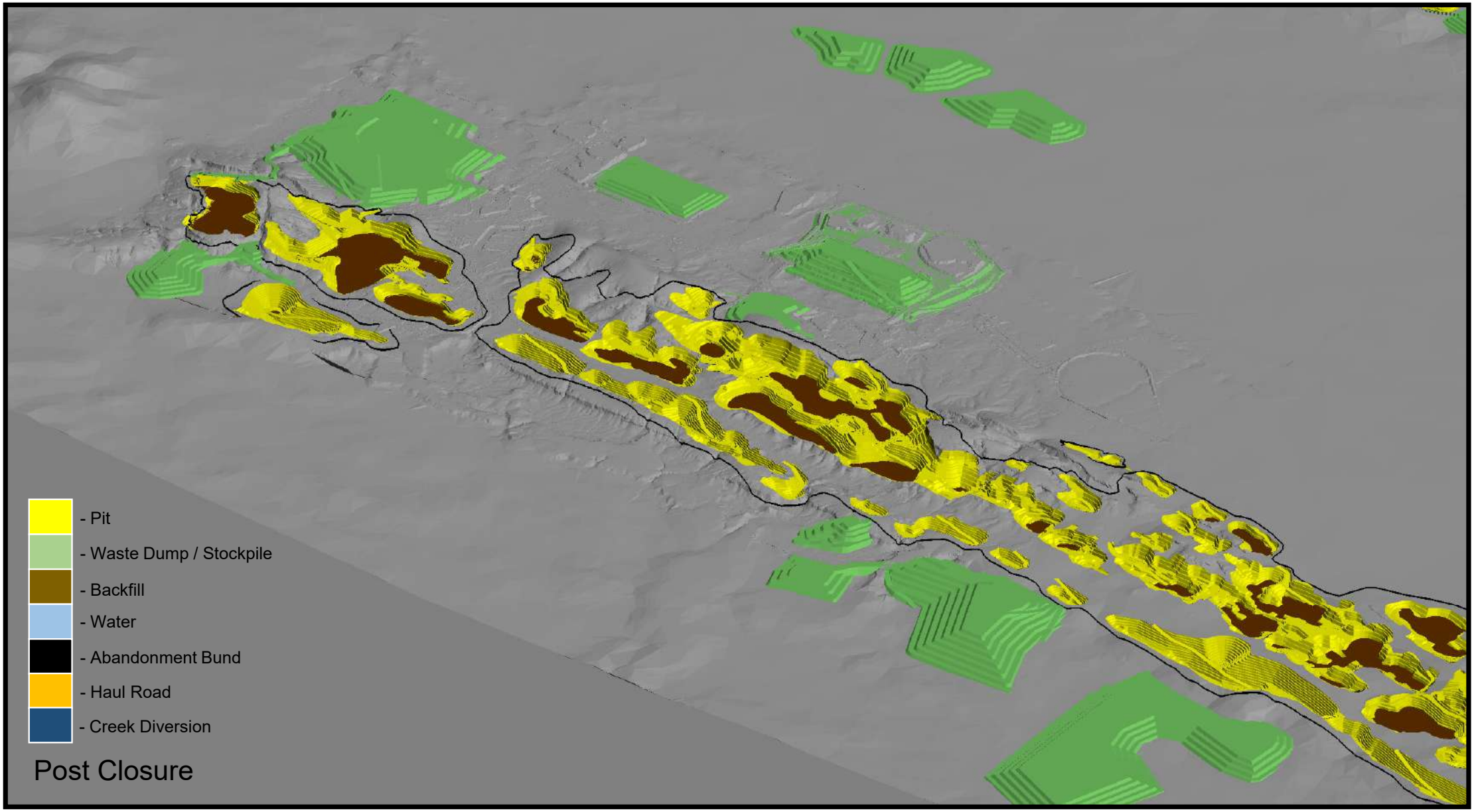
Technical Service – Mine Engineering

2022



BS4 Main


BS1S DP3
BS1S DP2
BS1S DP1
Pit 1
Pit 1
Pikes Peak
Crimson Pass
DP 1
Pit 1
DP 2
DP 6
Pit 2
Pit 10
Pit 8
Landbridge
DP 4
Pit R
Pit 5
Pit 6
Pit 8
DP 22
Pit 7
Pit 3
Pit Q
Pit 12
Pit 13
Pit 14
Pit O3
Pit 9
Pit O3
Pit 4
Pit 19
DP 5
Pit O2
Pit 18
Pit O2
DP 8
Pit O1
DP 9
- Pit
- Waste Dump / Stockpile
- Backfill
- Water
- Abandonment Bund
- Haul Road
- Creek Diversion
Post Mining


- Pit
- Waste Dump / Stockpile
- Backfill
- Water
- Abandonment Bund
- Haul Road
- Creek Diversion
Post Closure

[DP1 Low grade ore (LGO), waste]

Waste volume	101.5 Mm^3 – LGO: 37.6Mm^3, Waste: 63.4Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	46%
	Medium	49%
	High	5%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	Mm^3
	WFSF ☐	-
Overall height (m)	90m	
Topsoil required (Mm^3)	0.543Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	Waste 37° LGO 37°	Waste 15° LGO 12°
Lift height (m)	20m to 560mRL, 15m above	Waste: 20m to 560mRL. 15m above, LGO: 5m
Berm width (m)	Waste: 40m+ to 560mRL. 32m above, LGO: 65m	Waste: 16m+ to 560mRL. 13m above, LGO: 10m
Berm slope (deg)	0°	-10°
Footprint (ha)	270	275

Comments

DP1 is a mix of low grade concentrate (LGC) material, waste and LGO. LGC will be reclaimed prior to closure and therefore has no rehabilitation design.

Waste material will be dumped in separate cells (LGO is separated). Fibrous material will be encapsulated in cells within the dump with the exact location and geometry recorded. These cells will be dumped and encapsulated with inert material such that they are not exposed during final (post-closure) landform shaping.

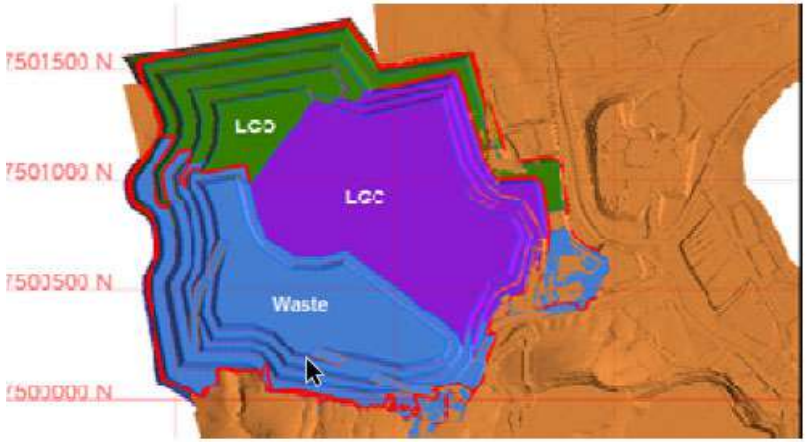
The dump has been designed as per erodibility class of material. Design is indicative and refinements will be made (ie ramp removal from designs). The final design will also revaluate the intersection with Pit 2's ZOI.

Based on the predominance of moderate to high erodibility material, the rehabilitation specifications for this waste dump were recently modified to reduce the proposed final lift heights to 15m. The sequencing of LGO material has influenced the 5m lifts.

The waste portion of DP1 has been redesigned to stay outside of the 100 year flood plain. The rehabilitation design was also updated to ensure it did not encroach on the 100 year flood plain.

The bottom lift of the Waste dump has been rehabilitated in 2019 as part of the progressive rehabilitation program in Brockman 4.

Construction Design



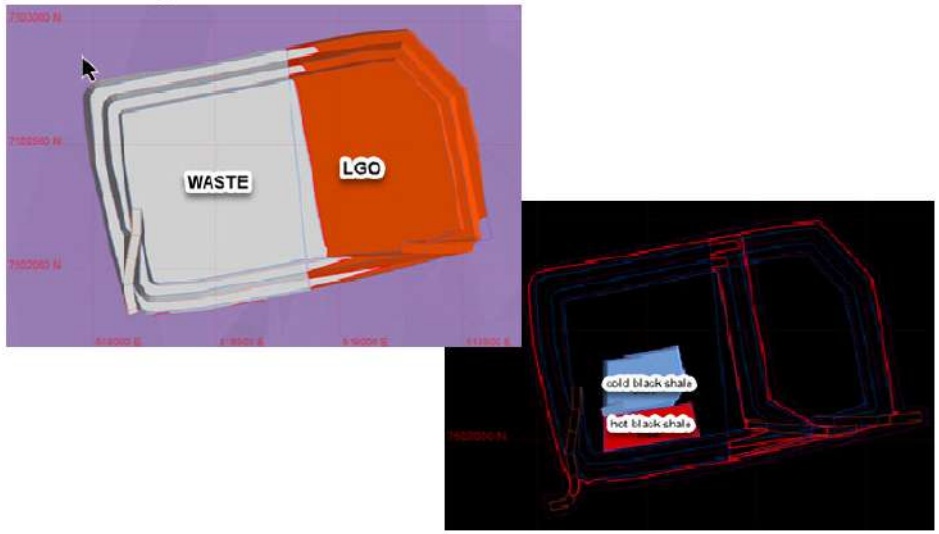
Rehabilitation Design



[DP2 waste PAF material, low grade ore]

Waste volume	16.2 Mm3	
Erodibility ranking	Low/Medium or High	
	Low	39%
	Medium	55%
	High	7%
Classification	Inert ☒	Capping required at closure:
	PAF ☒	0 Mm^3
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	40m	
Topsoil required (Mm^3)	0.340Mm^3	

Construction Design



Rehabilitation Design

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	37°	20°
Lift height (m)	20m	10m
Berm width (m)	40m	TBC
Berm slope (deg)	0°	-10°
Footprint (ha)	146	~148

Waste dumps DP2 is a designated PAF dump. DP2 extends into Cheela Plains; however an appropriate standoff will be adopted to ensure PAF cells are not located on Cheela Plains.
DP2 will encapsulate 1 Mm^3 of PAF material (0.84 Mm3 cold black shale, 0.16 Mm3 hot black shale). PAF material will not be stored under waste dump slopes. The PAF cells and the dump will be covered with a store and release cover, as stipulated in Section 18.1
Adequate material for store/release cover is available and will be separately stockpiled for application at completion of the landform Waste material will be dumped in separate cells (LGO is separated from waste).
Please note that the rehabilitation design will be refined as the dump approaches rehabilitation.

[DP4 low grade ore and waste]

Waste volume	36.4 Mm3	
Erodibility ranking	Low/Medium or High	
	Low	46%
	Medium	50%
	High	4%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	40m	
Topsoil required (Mm^3)	0.464Mm^3	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	37°	14°
Lift height (m)	20m	10m
Berm width (m)	40m	Various
Berm slope (deg)	0°	-10°
Footprint (ha)	220	~222

Waste material will be dumped in separate cells (LGO is separated from waste). LGO will be factored in to future design reiterations.
Fibrous material will be encapsulated in cells within the dump with the exact location and geometry recorded. These cells will be dumped and encapsulated with inert material such that they are not exposed during final (post-closure) landform shaping.
Adequate topsoil and material for cover is available and will be separately stockpiled for application at completion of the landform.
The bottom lift of the Waste and LGO dump has been rehabilitated in 2019 as part of the progressive rehabilitation program in Brockman 4.
Detailed rehabilitation designs are currently being developed to support progressive rehabilitation of several faces of the dump.

Construction Design



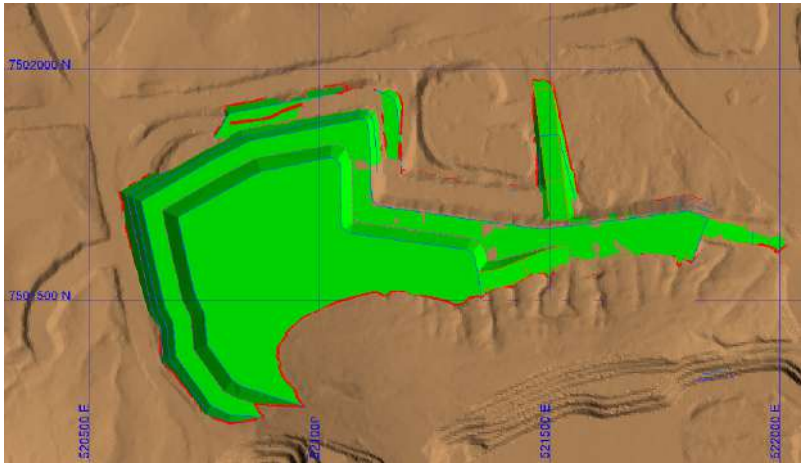
Rehabilitation Design



[DP22 LGO]

Waste volume	6.3 Mm3	
Erodibility ranking	Low/Medium or High	
	Low	92%
	Medium	3%
	High	5%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	60m	
Topsoil required (Mm^3)	$0.16Mm^3$	

Construction Design



Rehabilitation Design

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	
Lift height (m)	20m	
Berm width (m)	40m	
Berm slope (deg)	0°	
Footprint (ha)	77.8	~80

DP22 is designed as LGO dump. Source of the waste is mixed from Brockman Pits.
Adequate topsoil and material for cover is available and will be separately stockpiled for application at completion of the landform.
There has no rehabilitation design provided for this dump at the moment. LGO material was previously planned to be reclaimed at the end of the mine life.
Topsoil material requirements are only rough estimation based the dump/stockpile footprint.

[DP5 North waste]

Waste volume	33.4 Mm3	
Erodibility ranking	Low/Medium or High	
	Low	47%
	Medium	17%
	High	36%
Classification	Inert ☒	Dump to be reclaimed at closure
	PAF ☐	-
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	85m	
Topsoil required (Mm^3)	0.388Mm^3	

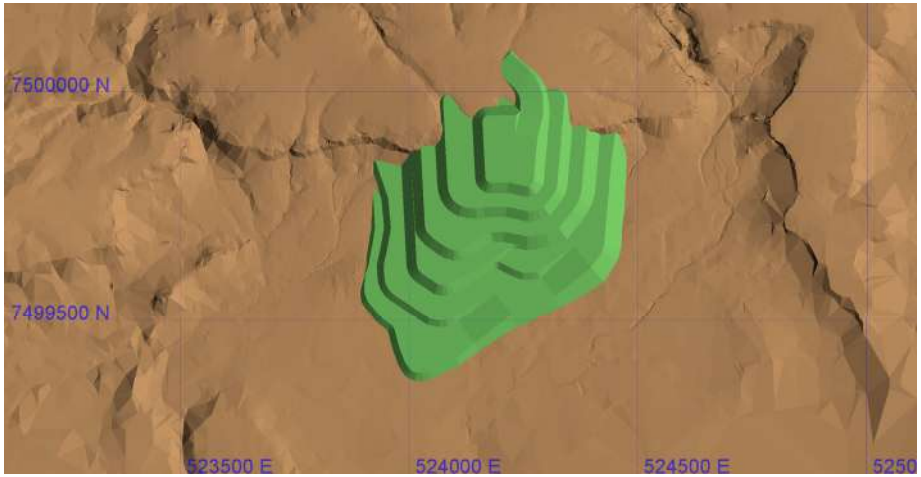
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	To be reclaimed at closure
Lift height (m)	15m	
Berm width (m)	50m	
Berm slope (deg)	0°	
Footprint (ha)	188	

DP5 is designed as waste dump. Source of the waste is mixed from Brockman Pits and Marra Mamba Pits.

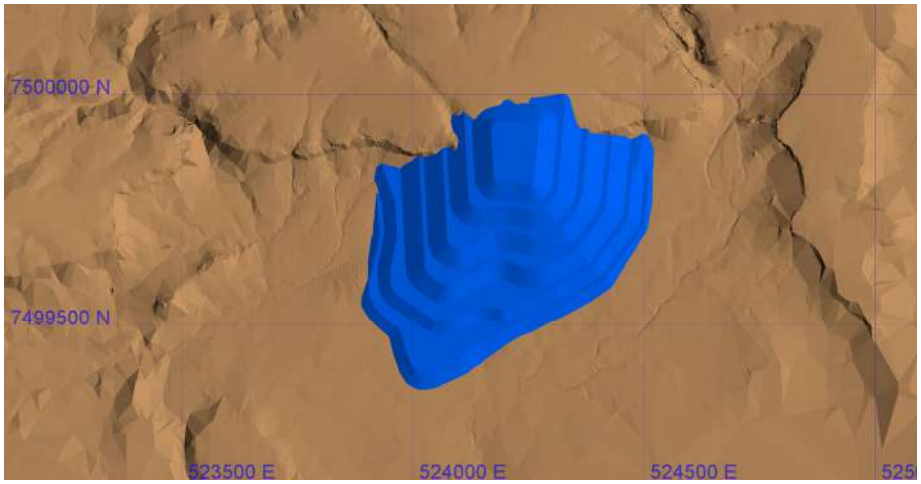
DP5 north is planned to be fully reclaimed at the end of its life. In case of change in strategy the dump is required to be capped up to 0.5m to ensure all erodible material is encapsulated.

Adequate topsoil and material for cover is available and will be separately stockpiled for application at completion of the landform.

Construction Design



Rehabilitation Design



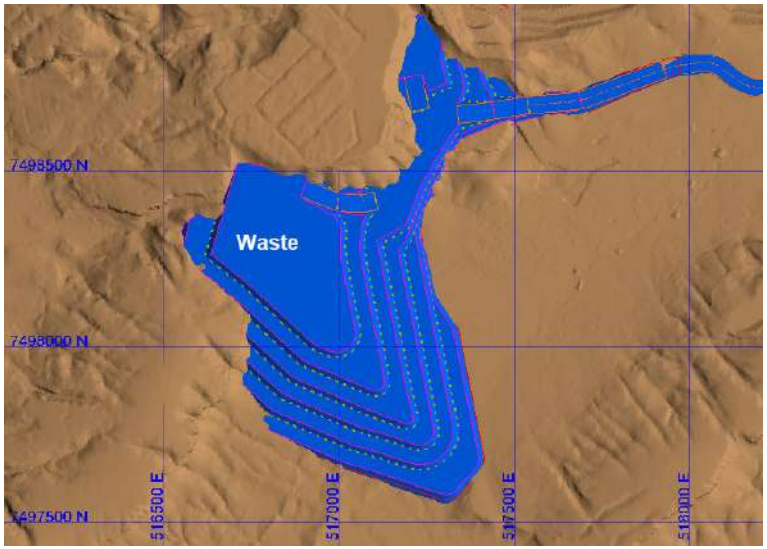
[DP6 waste]

Waste volume	14.8 Mm3	
Erodibility ranking	Low/Medium or High	
	Low	43%
	Medium	6%
	High	51%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	50m	
Topsoil required (Mm^3)	0.268Mm^3	

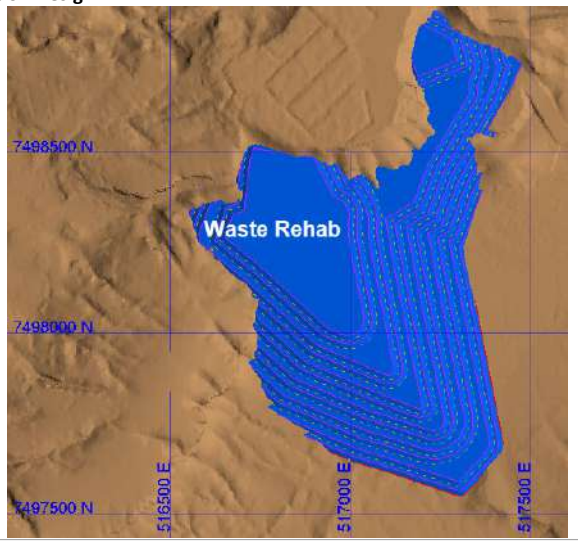
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	20°
Lift height (m)	10m	5m
Berm width (m)	50m	Various (Minimum 10m)
Berm slope (deg)	0°	0°
Footprint (ha)	133	~134

DP6 is designed as waste dump. Source of the waste is mixed from Brockman Pits and Marra Mamba Pits.
Fibrous material will be encapsulated in cells within the dump with the exact location and geometry recorded. Similar approach as implemented on DP1 and DP4 waste dump regarding handling fibrous material will be implemented in DP6. These fibrous cells will be dumped and encapsulated with inert material such that they are not exposed during final (post-closure) landform shaping.
Adequate topsoil and material for cover is available and will be separately stockpiled for application at completion of the landform.

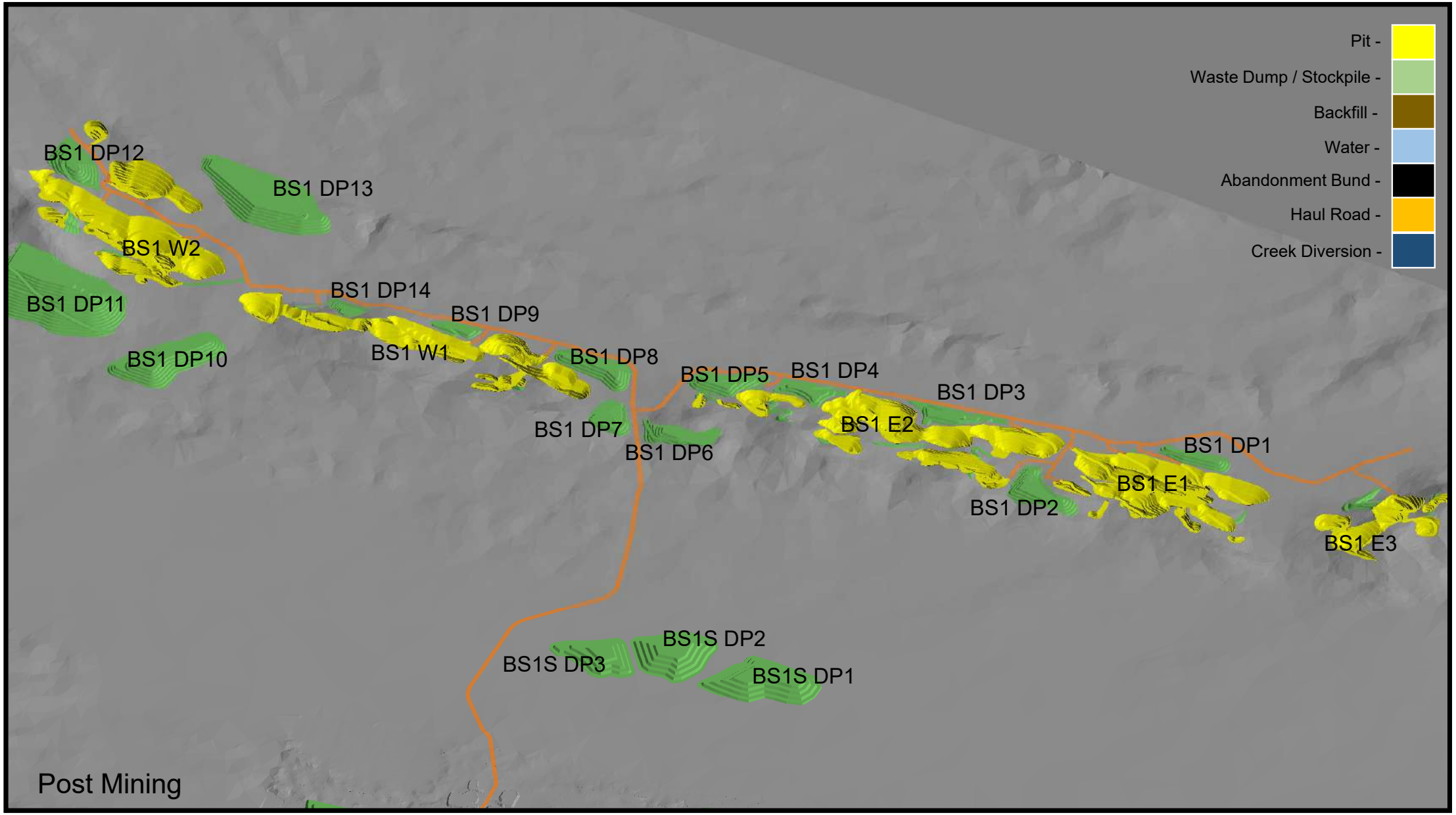
Construction Design

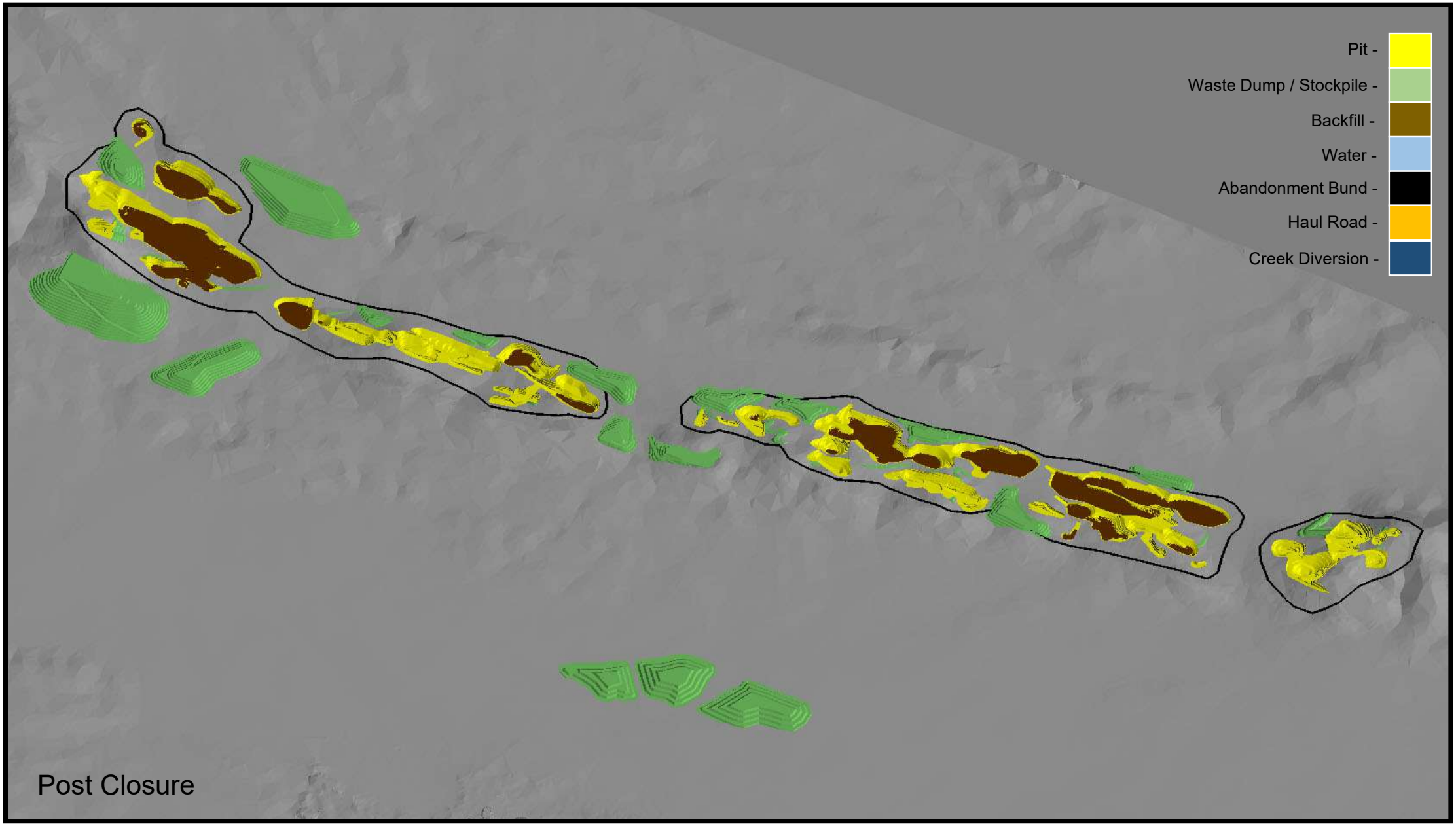


Rehabilitation Design

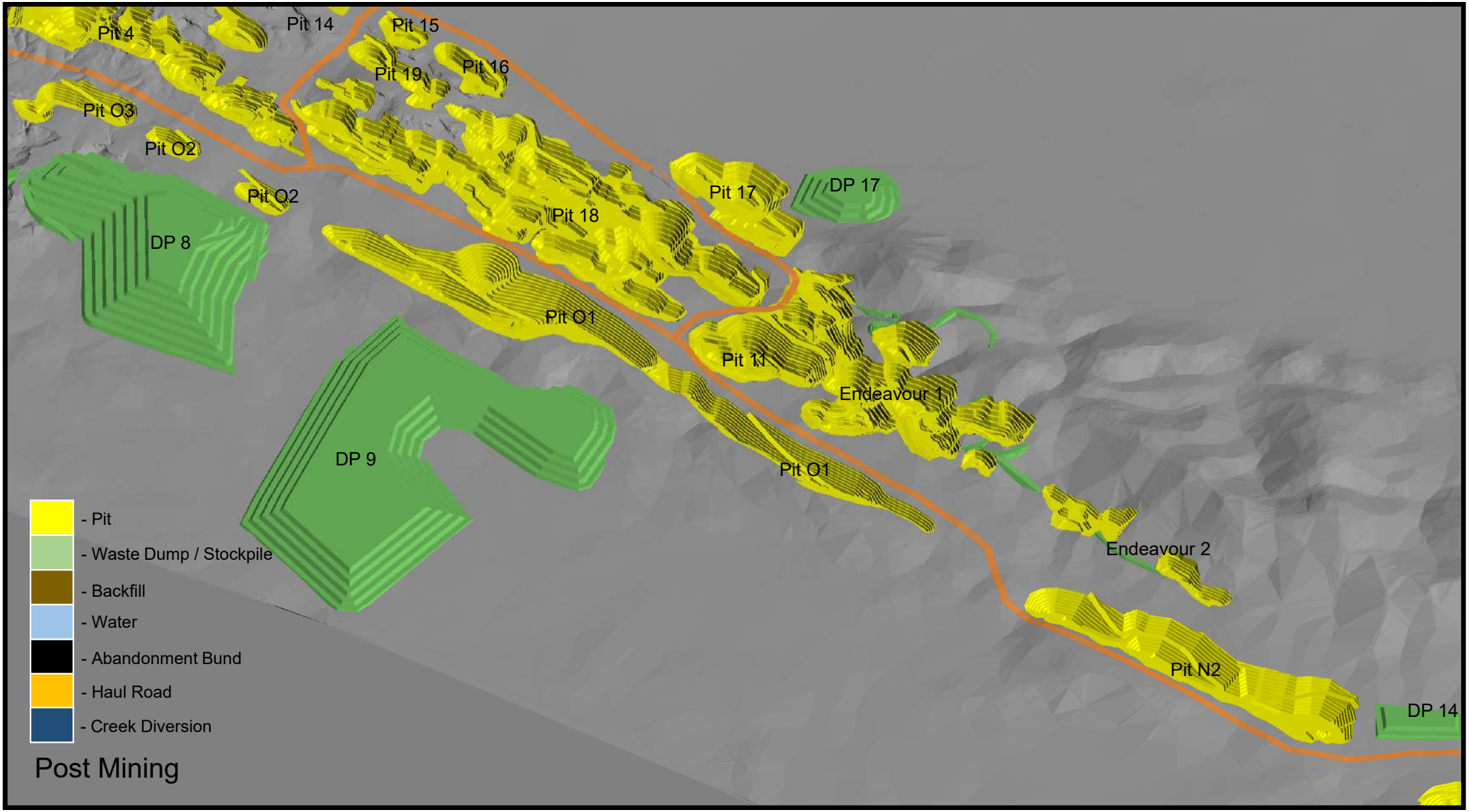


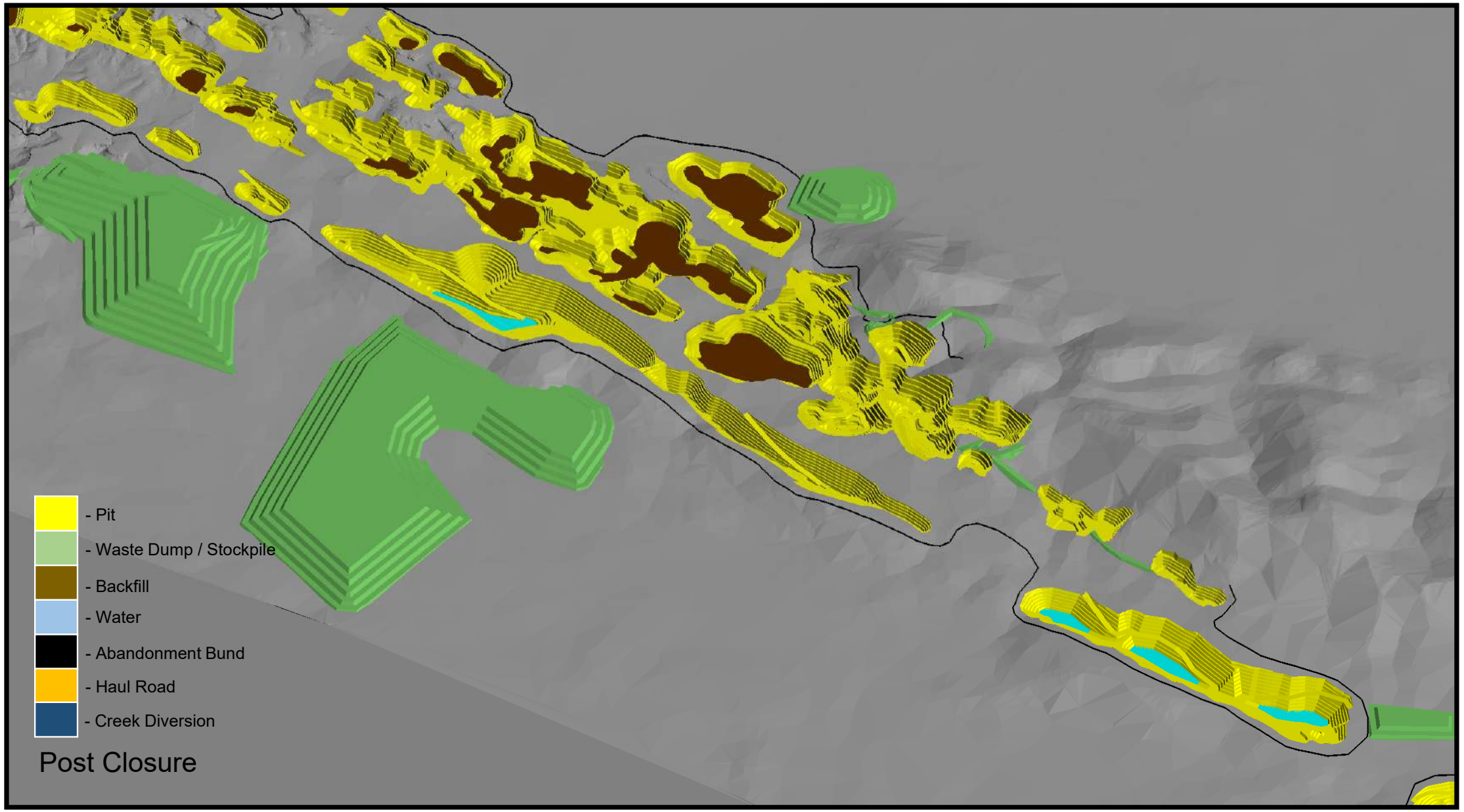
BS1


Pit -
Waste Dump / Stockpile -
Backfill -
Water -
Abandonment Bund -
Haul Road -
Creek Diversion -
BS1 DP12
BS1 DP13
BS1 W2
BS1 DP11
BS1 DP14
BS1 DP9
BS1 DP10
BS1 W1
BS1 DP8
BS1 DP5
BS1 DP4
BS1 DP3
BS1 DP7
BS1 E2
BS1 DP6
BS1 DP1
BS1 E1
BS1 DP2
BS1 E3
BS1S DP2
BS1S DP3
BS1S DP1
Post Mining


Pit -
Waste Dump / Stockpile -
Backfill -
Water -
Abandonment Bund -
Haul Road -
Creek Diversion -
Post Closure

BS4 Main, BS4 MM, Endeavour, BS4 MN & BS3


Pit 4
Pit 14
Pit 15
Pit 19
Pit 16
Pit O3
Pit O2
Pit O2
DP 8
Pit 18
Pit 17
DP 17
Pit O1
Pit 11
Endeavour 1
DP 9
Pit O1
Endeavour 2
Pit N2
DP 14
- Pit
- Waste Dump / Stockpile
- Backfill
- Water
- Abandonment Bund
- Haul Road
- Creek Diversion
Post Mining


- Pit
- Waste Dump / Stockpile
- Backfill
- Water
- Abandonment Bund
- Haul Road
- Creek Diversion
Post Closure

[DP8 LGO]

Waste volume	43.8 Mm^3 – LGO: 35.2Mm^3, Waste: 16.7Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	71%
	Medium	8%
	High	21%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	90m	
Topsoil required (Mm^3)	0.86Mm^3	

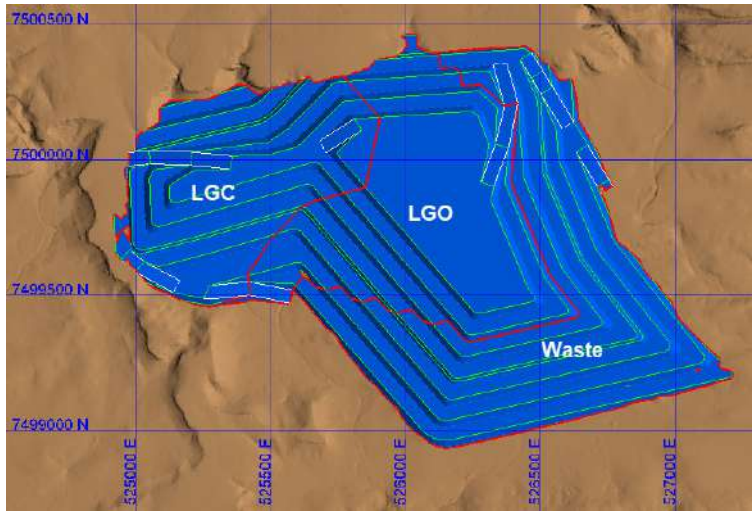
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	
Lift height (m)	15m	
Berm width (m)	40m	
Berm slope (deg)	0°	
Footprint (ha)	425	~430

DP8 is designed as waste, LGO and LGC dump. Source of the waste is mixed from Brockman Pits and Marra Mamba Pits.

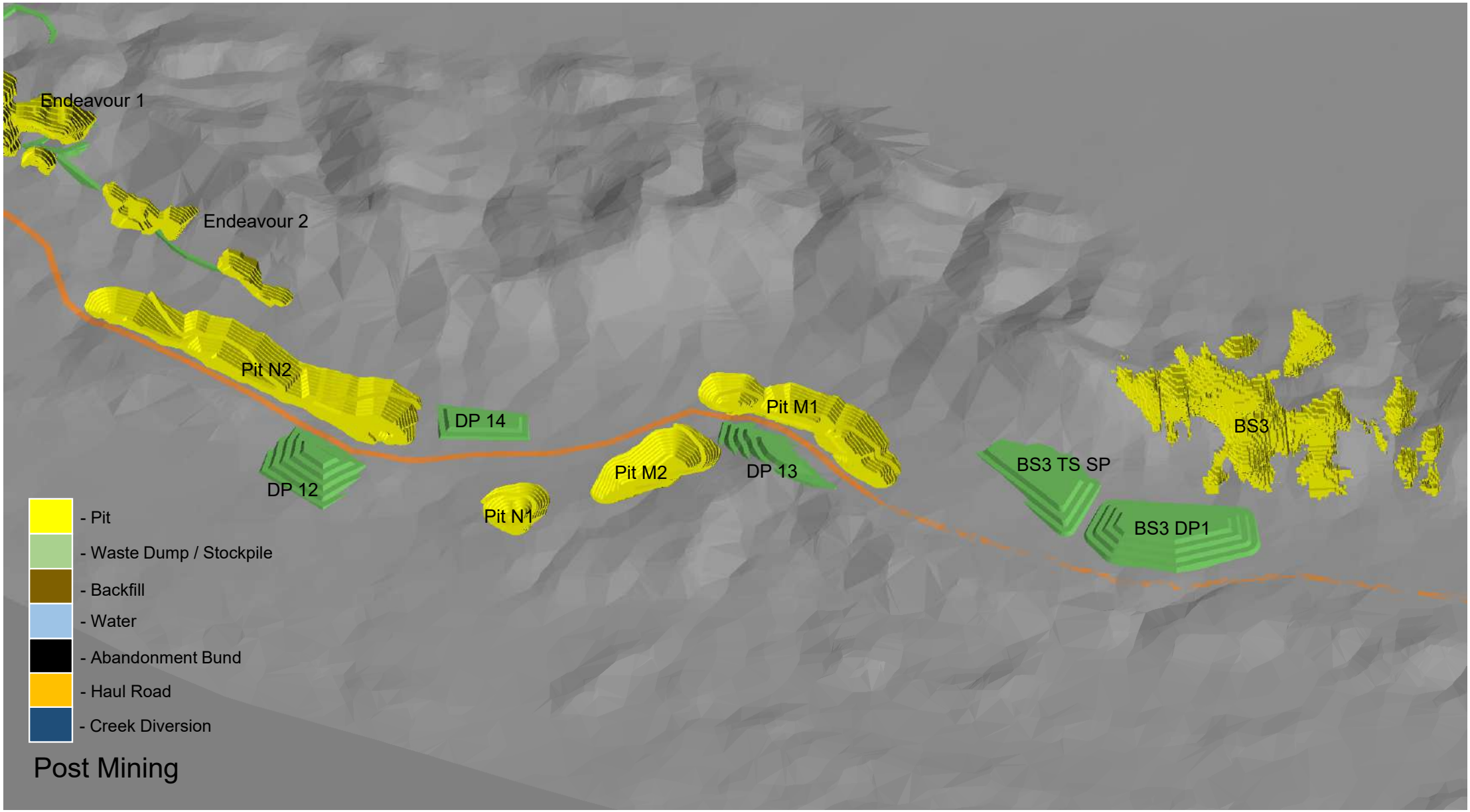
Conceptual design only - no formal design review has been completed

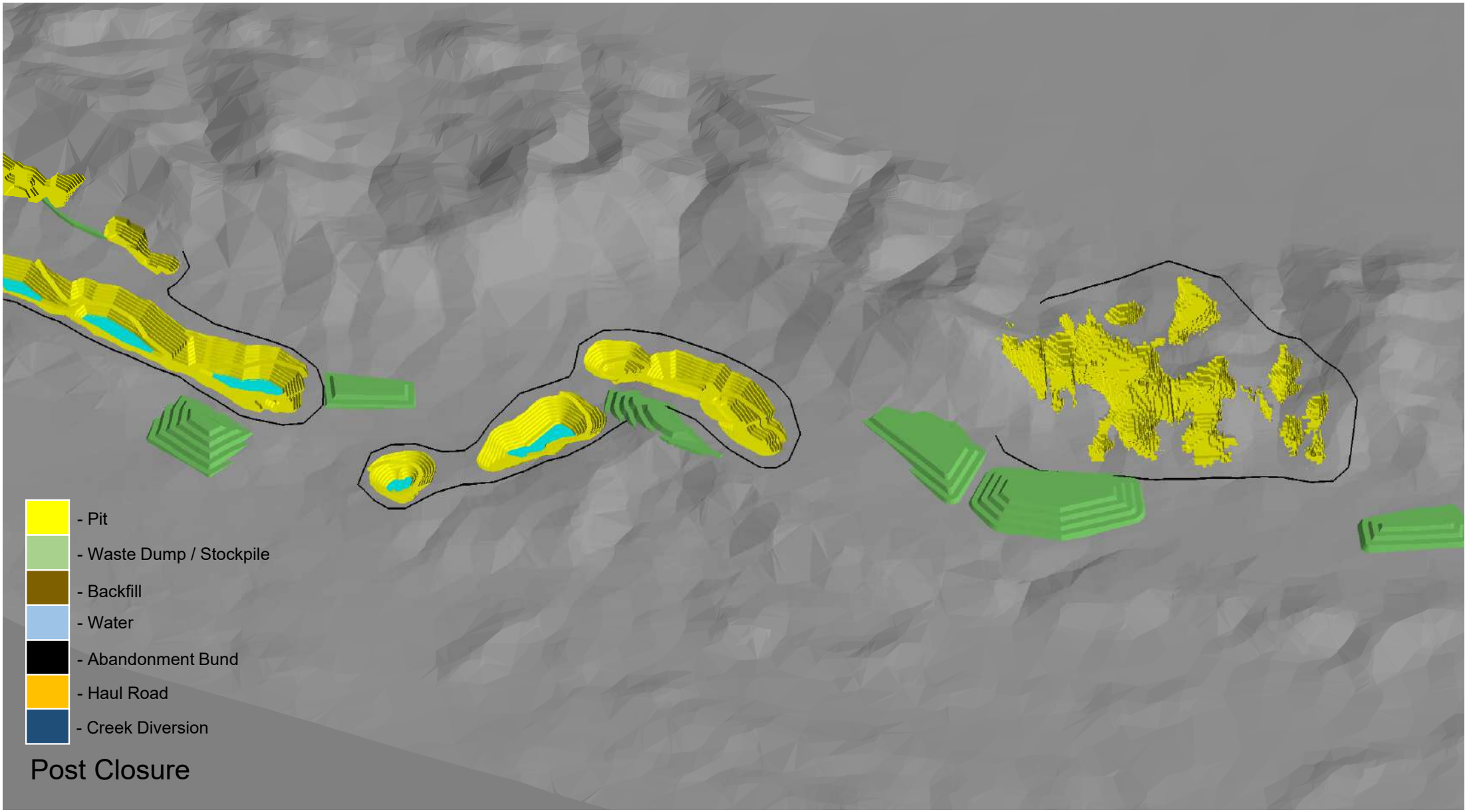
There has no rehabilitation design available for this dump at the moment.
Topsoil material requirements are only rough estimation based the dump/stockpile footprint.

Construction Design

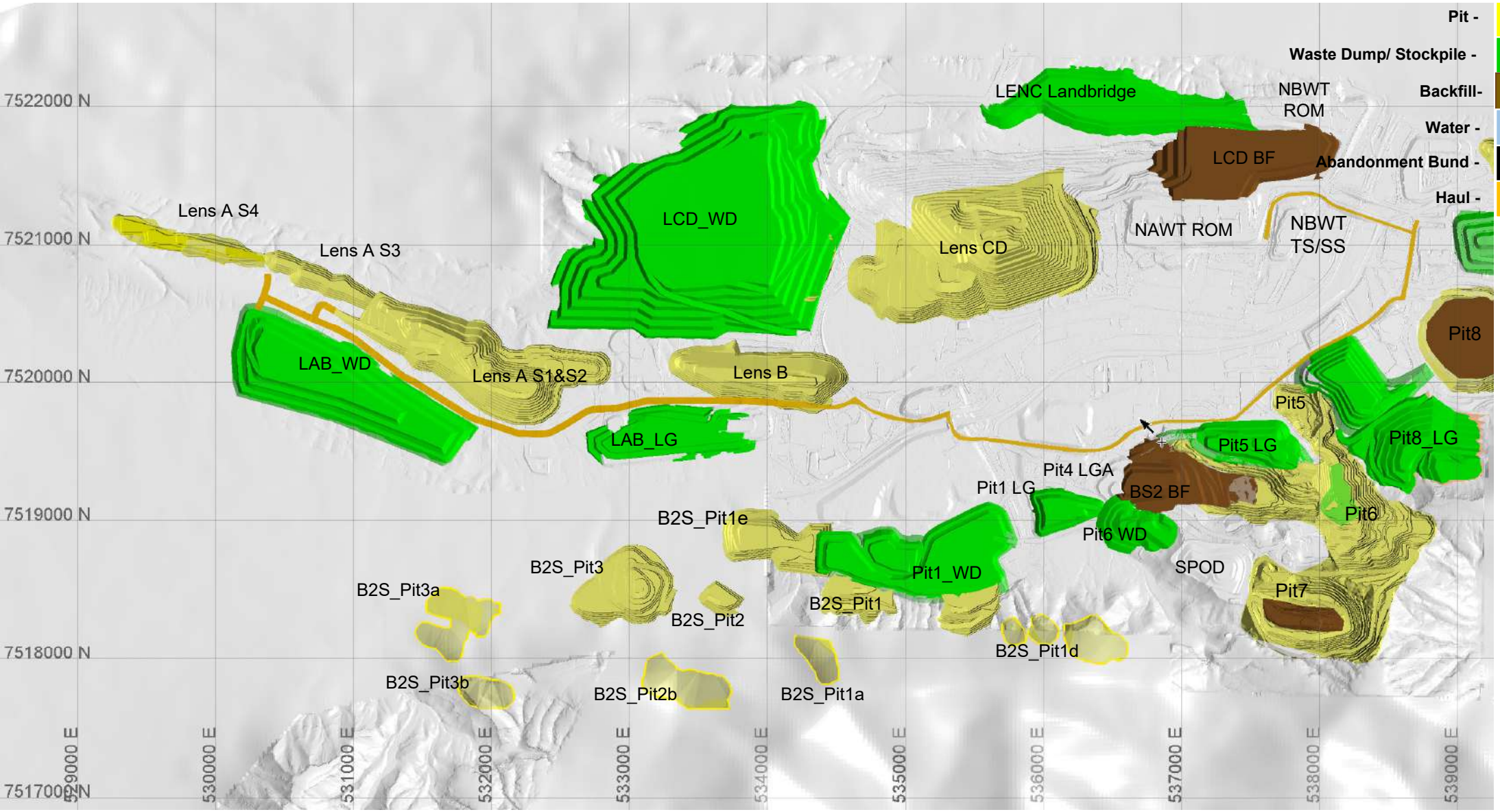


Rehabilitation Design

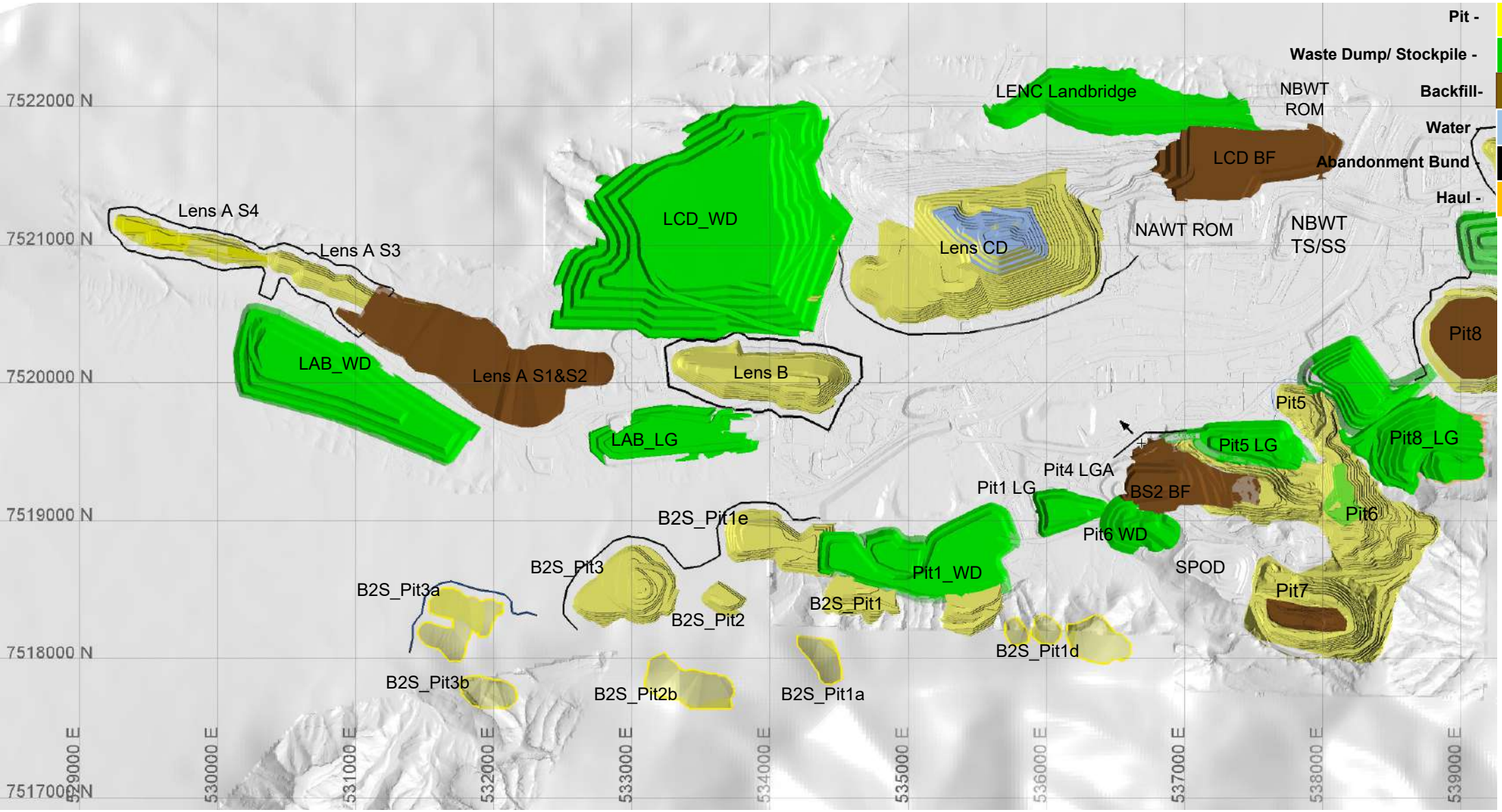

Endeavour 1
Endeavour 2
Pit N2
DP 14
DP 12
Pit N1
Pit M2
Pit M1
DP 13
BS3 TS SP
BS3
BS3 DP1
- Pit
- Waste Dump / Stockpile
- Backfill
- Water
- Abandonment Bund
- Haul Road
- Creek Diversion
Post Mining


- Pit
- Waste Dump / Stockpile
- Backfill
- Water
- Abandonment Bund
- Haul Road
- Creek Diversion
Post Closure

Len AB and Len CD
BS2 and BS2S


Pit -
Waste Dump/ Stockpile -
Backfill-
Water -
Abandonment Bund -
Haul -
7522000 N
7521000 N
7520000 N
7519000 N
7518000 N
7517000 N
529000 E
530000 E
531000 E
532000 E
533000 E
534000 E
535000 E
536000 E
537000 E
538000 E
539000 E
LENC Landbridge
NBWT ROM
LCD BF
LCD_WD
Lens A S4
Lens A S3
Lens CD
NAWT ROM
NBWT TS/SS
Pit8
LAB_WD
Lens A S1&S2
Lens B
Pit5
Pit8_LG
LAB_LG
Pit5 LG
Pit4 LGA
Pit1 LG
BS2 BF
Pit6
B2S_Pit1e
Pit6 WD
B2S_Pit3
Pit1_WD
SPOD
B2S_Pit3a
Pit7
B2S_Pit1
B2S_Pit2
B2S_Pit1d
B2S_Pit3b
B2S_Pit2b
B2S_Pit1a

Post Mining



Post Closure

Pit1_wd (pit1_wd_us115)

Waste volume	20Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	50%
	Medium	33%
	High	17%
Classification	Inert ☒	Capping required at closure: ~0.5Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	30m	
Topsoil required (Mm^3)	~0.1Mm^3	

Construction Design



	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	37°	20°
Lift height (m)	15	15
Berm width (m)	35	15
Berm slope (deg)	0°	°
Footprint (ha)	49	49

Rehabilitation Design



Comments

- **Pit 1 backfill and external dump**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

Pit1 LG (Pit1_lg_dump_us102)

Waste volume	5Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	50%
	Medium	33%
	High	17%
Classification	Inert ☒	Capping required at closure: ~0.1Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	20m	
Topsoil required (Mm^3)	~0.05Mm^3	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	36°	20°
Lift height (m)	10	10
Berm width (m)	30	10
Berm slope (deg)	0°	°
Footprint (ha)	7	7

Comments

- **LG stockpile to rehabbed at closure**
- **elevates sulphur LG stockpile**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

Construction Design



Rehabilitation Design



BS2_BF (bs2_bf_cs302)

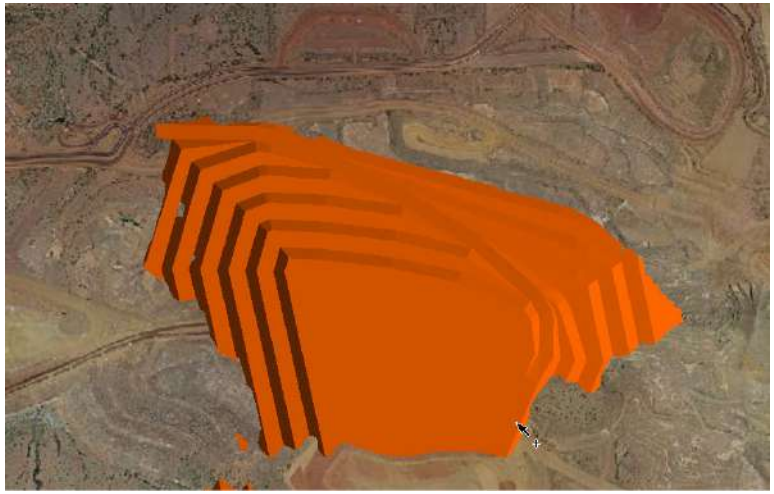
Waste volume	42Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	48%
	Medium	50%
	High	2%
Classification	Inert ☒	Capping required at closure: ~0.8Mm^3
	PAF ☒	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	125m	
Topsoil required (Mm^3)	0.2Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	°
Lift height (m)	20	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	80	

Comments

- **Conceptual design only - design to be amended based on 2016 LoM schedule requirements**
- **No formal design review complete**
- **Extended BF to incorporate existing PAF storage facility**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

Construction Design



Rehabilitation Design

Under review.

Pit6_WD

Waste volume	0Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	%
	Medium	100%
	High	%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	Mm^3
	WFSF ☐	-
Overall height (m)	10m	
Topsoil required (Mm^3)	0 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	°	20°
Lift height (m)		10-20
Berm width (m)	-	10
Berm slope (deg)	°	1°
Footprint (ha)	15	

Comments

- Rehabilitation completed 2017?

Construction Design



Rehabilitation Design



SPOD WD

Waste volume	0Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	%
	Medium	100%
	High	%
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	Mm^3
	WFSF ☐	-
Overall height (m)	10m	
Topsoil required (Mm^3)	0 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	°	20°
Lift height (m)		10-15
Berm width (m)	-	15
Berm slope (deg)	°	1°
Footprint (ha)	23	

Comments

- Rehabilitation completed 2018?

Construction Design

Rehabilitation Design



Pit5_lg (pit5_lg_us104 / pit5_lgr_u02)

Waste volume	5Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	48%
	Medium	50%
	High	2%
Classification	Inert ☒	Capping required at closure: ~0.1Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	30m	
Topsoil required (Mm^3)	~0.1Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	25°
Lift height (m)	20	20
Berm width (m)	40	10
Berm slope (deg)	0°	0°
Footprint (ha)	18	18

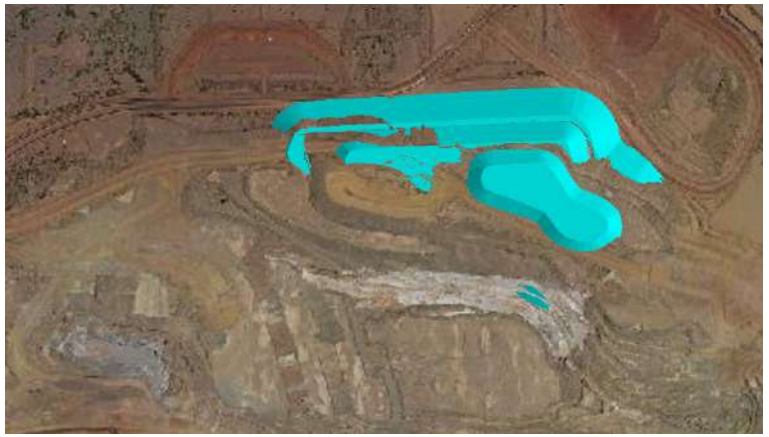
Comments

- **LG stockpile to be rehabbed at closure**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

Construction Design



Rehabilitation Design



Pit8_LGO (pit08_lgo_us204 / pit08_lgo_r_us203)

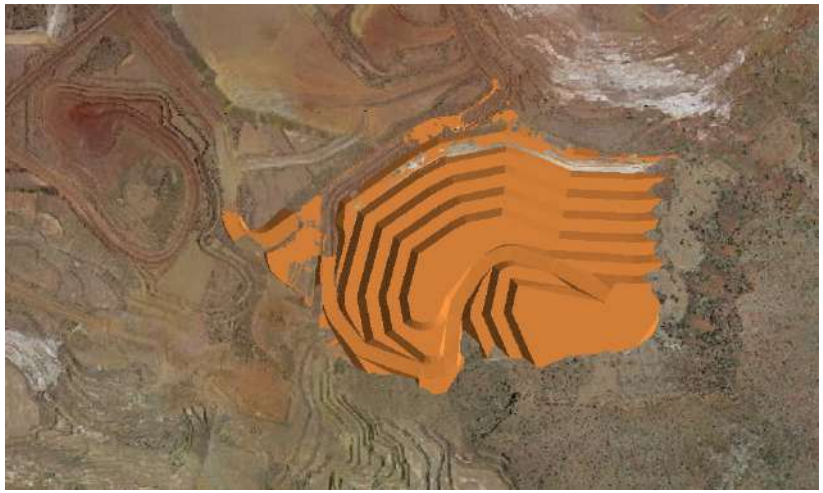
Waste volume	15Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	48%
	Medium	50%
	High	2%
Classification	Inert ☒	Capping required at closure: ~0.6Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	98m	
Topsoil required (Mm^3)	~0.2Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	20°
Lift height (m)	20	20
Berm width (m)	40	10
Berm slope (deg)	0°	0°
Footprint (ha)	52	52

Comments

- **LG stockpile to be rehabbed at closure**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

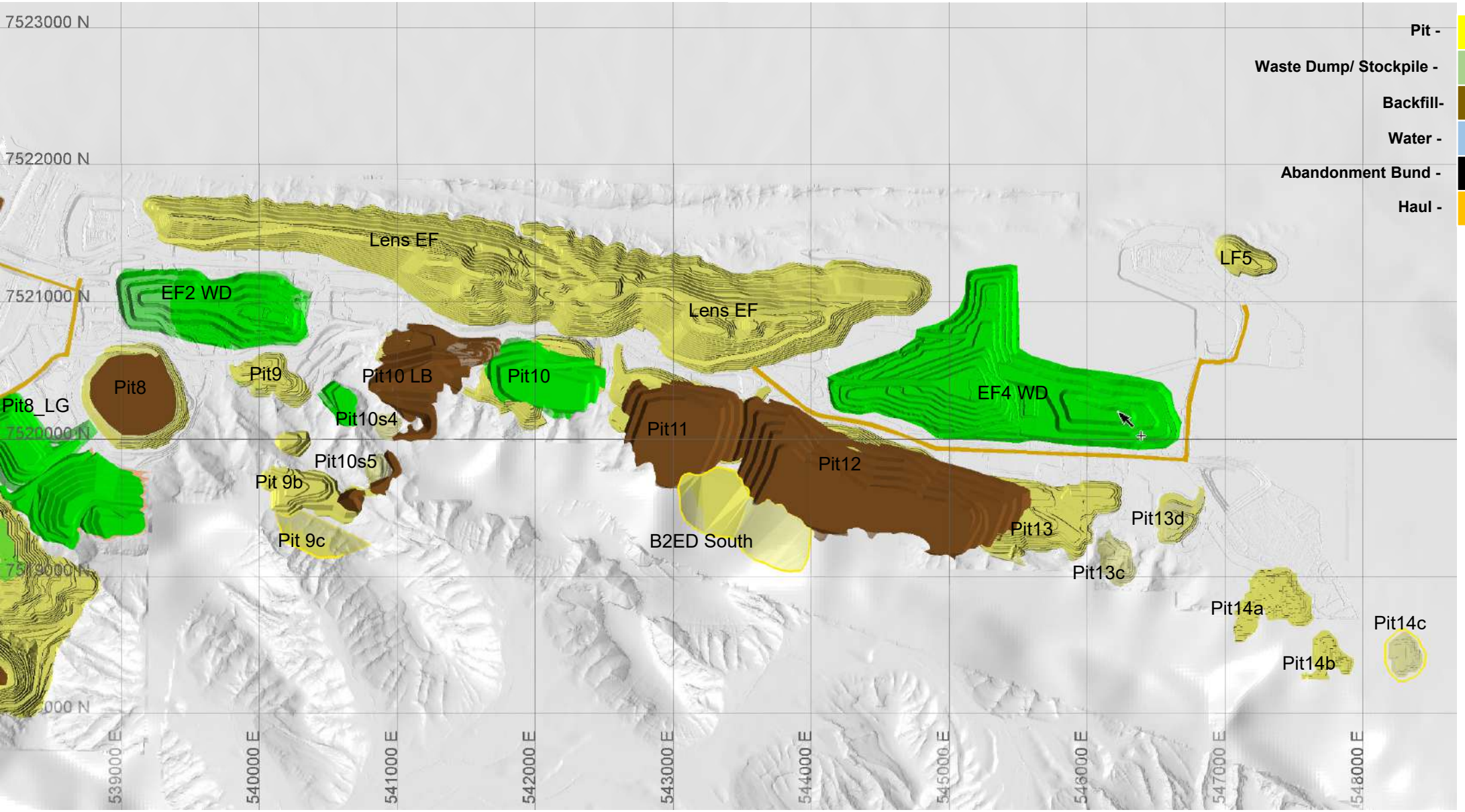
Construction Design



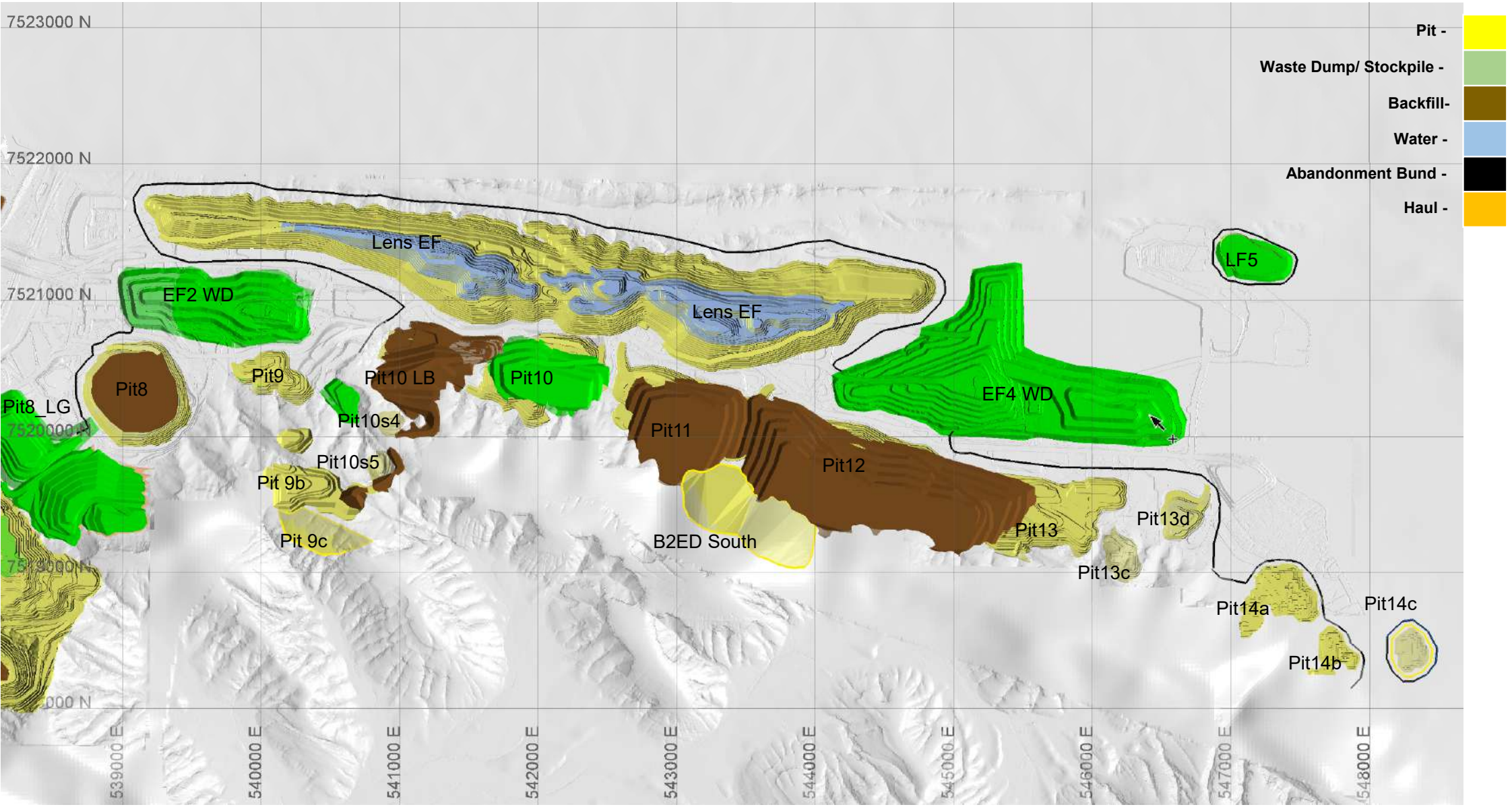
Rehabilitation Design



LEF, B2ED


7523000 N
7522000 N
7521000 N
7520000 N
539000 E
540000 E
541000 E
542000 E
543000 E
544000 E
545000 E
546000 E
547000 E
548000 E
Pit -
Waste Dump/ Stockpile -
Backfill-
Water -
Abandonment Bund -
Haul -
Lens EF
Lens EF
LF5
EF2 WD
EF4 WD
Pit8
Pit8_LG
Pit9
Pit10 LB
Pit10
Pit10s4
Pit10s5
Pit 9b
Pit 9c
Pit11
Pit12
B2ED South
Pit13
Pit13d
Pit13c
Pit14a
Pit14c
Pit14b

Post Mining



Post Closure

LEFBWT_LGP

Waste volume	30Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	5%
	Medium	13%
	High	82%
Classification	Inert ☒	Capping required at closure:~0.4Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	50m from pit floor	
Topsoil required (Mm^3)	~0.1Mm^3	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	36°	20°
Lift height (m)	20	15
Berm width (m)	40	10
Berm slope (deg)	0°	°
Footprint (ha)	35	35

Comments

- **Conceptual design only - no formal design review has been completed**
- **LG / Blend stockpile for LEF mining, backfill of Pit 10 S2.**
- **Stockpiles remaining at closure to be rehabbed**
- **Rehab design to be completed as part of formal design process**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

Construction Design



Rehabilitation Design

Under review.

EF6_WD (Comp_mat_c)

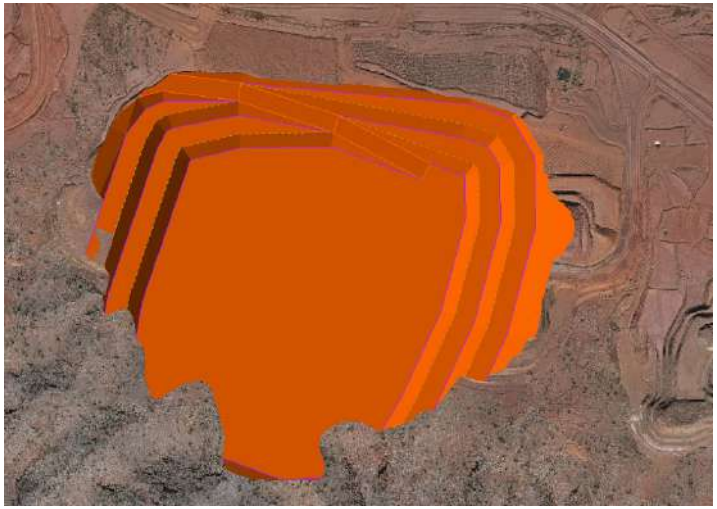
Waste volume	30Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	100%
	Medium	%
	High	%
Classification	Inert ☒	Capping required at closure:Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	45m	
Topsoil required (Mm^3)	~0.1Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	36°	°
Lift height (m)	20	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	51	

Comments

- **Conceptual design only - no formal design review has been completed**
- **Backfill of Pit 11**
- **Competent material stockpile for use at closure (capping/wrapping etc)**
- **Stockpile to be reclaimed at closure**
- **Topsoil material requirements are only rough estimation based the dump footprint after competent material being reclaimed.**

Construction Design



Rehabilitation Design

Under review.

EF5 (EF5_wd_c)

Waste volume	83Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	2%
	Medium	13%
	High	85%
Classification	Inert ☒	Capping required at closure: ~1.4Mm^3
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	100m	
Topsoil required (Mm^3)	~0.3Mm^3	

Construction Design



	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	36°	°
Lift height (m)	20	
Berm width (m)	20	
Berm slope (deg)	0°	°
Footprint (ha)	139	

Rehabilitation Design

Under review.

Comments

- **Conceptual design only - no formal design review has been completed**
- **Backfill of Pit 12 and partial backfill of Pit 13.**
- **Rehab design to be completed as part of formal design process**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

LEF4_US105 and LEF4 EXT US104 WD

Waste volume	65.4Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	2%
	Medium	13%
	High	85%
Classification	Inert ☒	Capping required at closure: ~1.9Mm^3
	PAF ☐	-
	Fibrous minerals ☒	~0.75Mm^3
	WFSF ☐	-
Overall height (m)	60m	
Topsoil required (Mm^3)	~0.4Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	20°
Lift height (m)	10	10
Berm width (m)	22-32	18-20
Berm slope (deg)	0°	0°
Footprint (ha)	190	190

Comments

- **Waste dump will receive PH and DH waste, encapsulation to follow FMMP guidelines.**
- **Rehab design requires updated, based latest as-built design update.**
- **The amount of Fibrous minerals dumped into LEF4_WD needs to be validated based on survey data**
- **Capping and Topsoil material requirements are only rough estimation based the dump/stockpile footprint.**

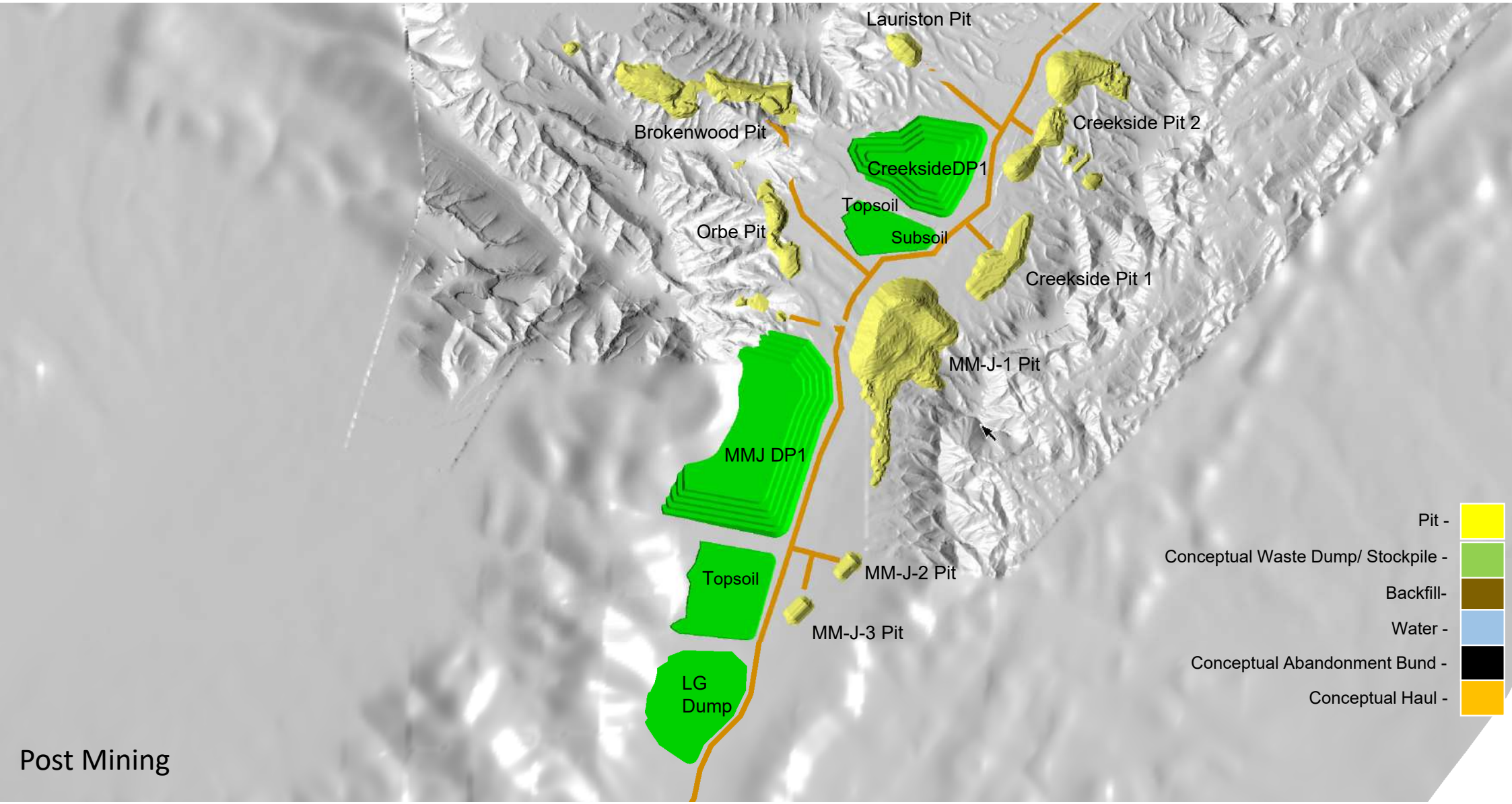
Construction Design

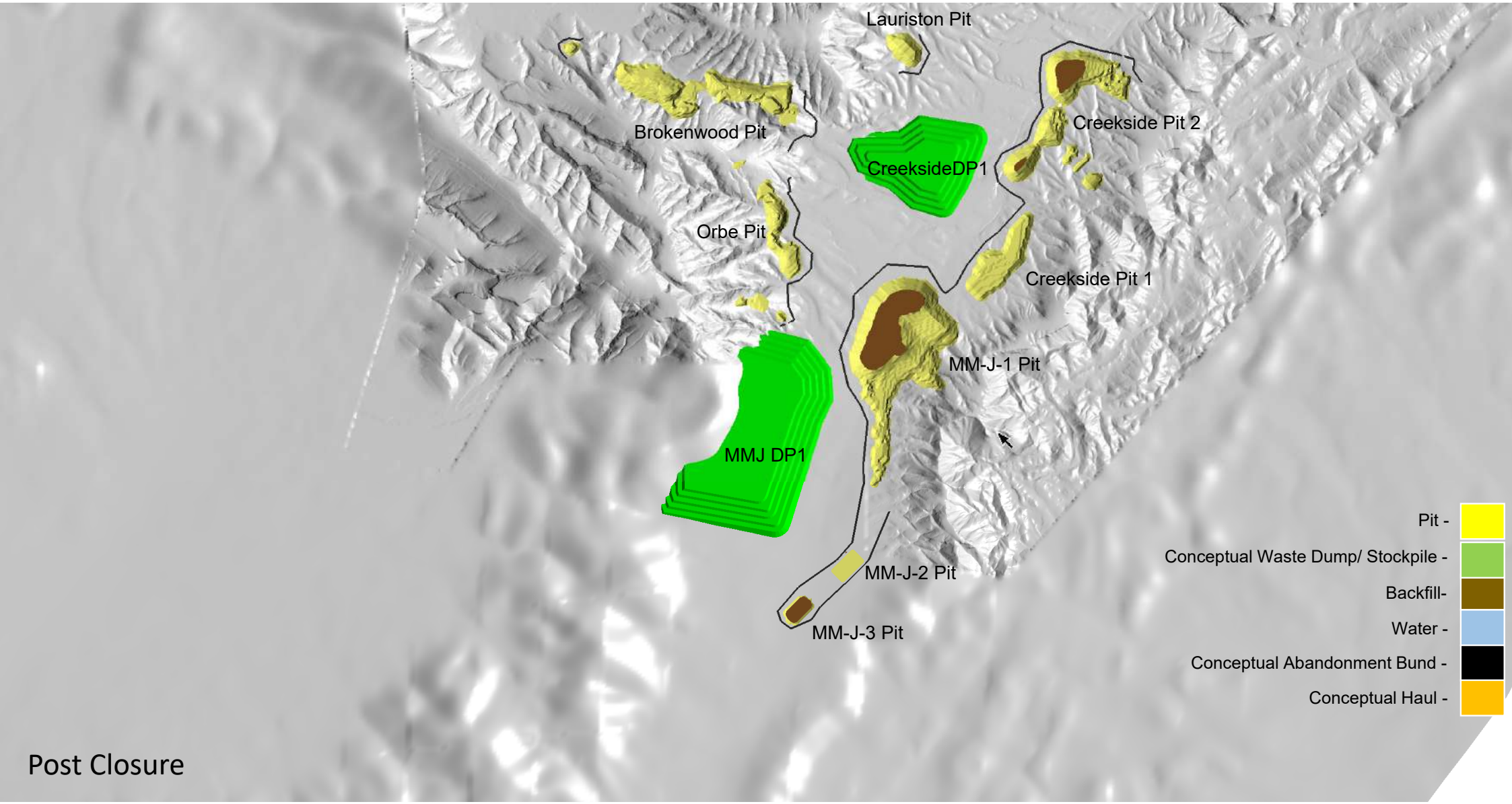


Rehabilitation Design (requires update)



BS3 ext, Creekside, Orbe, Lauriston, Brokenwood

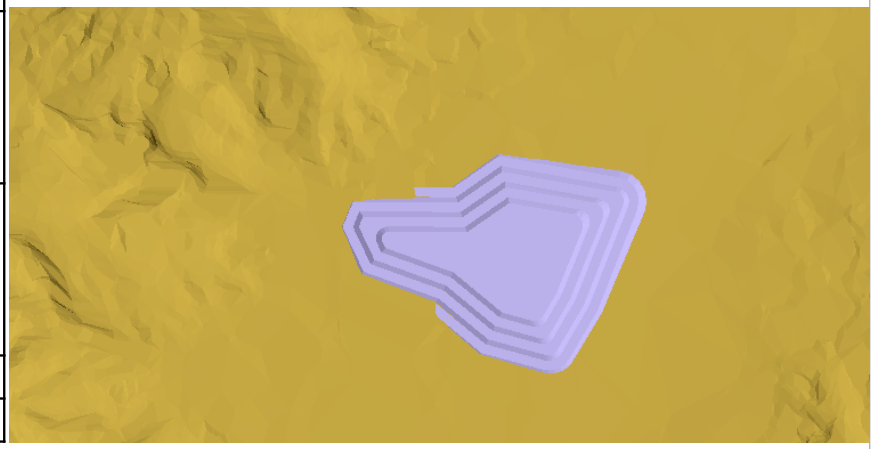

Lauriston Pit
Brokenwood Pit
Creekside Pit 2
CreeksideDP1
Topsoil
Subsoil
Orbe Pit
Creekside Pit 1
MM-J-1 Pit
MMJ DP1
Topsoil
MM-J-2 Pit
MM-J-3 Pit
LG
Dump
Pit -
Conceptual Waste Dump/ Stockpile -
Backfill-
Water -
Conceptual Abandonment Bund -
Conceptual Haul -
Post Mining


Lauriston Pit
Brokenwood Pit
CreeksideDP1
Creekside Pit 2
Orbe Pit
Creekside Pit 1
MM-J-1 Pit
MMJ DP1
MM-J-2 Pit
MM-J-3 Pit
Pit -
Conceptual Waste Dump/ Stockpile -
Backfill-
Water -
Conceptual Abandonment Bund -
Conceptual Haul -
Post Closure

BS3EXT : CREEKSIDE_DP1

Waste volume (Mm^3)	27.67	
Erodibility ranking	Low/Medium or High	
	Low	3.7 %
	Medium	29.6 %
	High	66.7 %
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	75	
Topsoil required (Mm^3)	0.17 Mm^3	

Construction Design



	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	°
Lift height (m)	15	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	78.36	

Rehabilitation Design

Comments

Waste landform is a conceptual design.

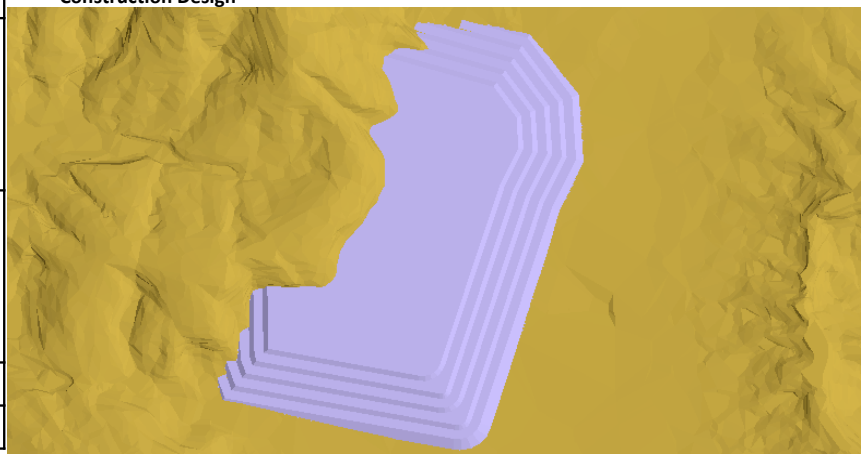
Rehabilitation design is not available, further details of designs will be done in PFS/FS study.

Estimated required topsoil volume is based on construction surface area and assumption of 200mm thickness topsoil layer.

BS3EXT : MMJ_DP1

Waste volume (Mm^3)	87.97	
Erodibility ranking	Low/Medium or High	
	Low	3.7 %
	Medium	29.6 %
	High	66.7 %
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	95	
Topsoil required (Mm^3)	0.35 Mm^3	

Construction Design



	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	°
Lift height (m)	15	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	166.79	

Rehabilitation Design

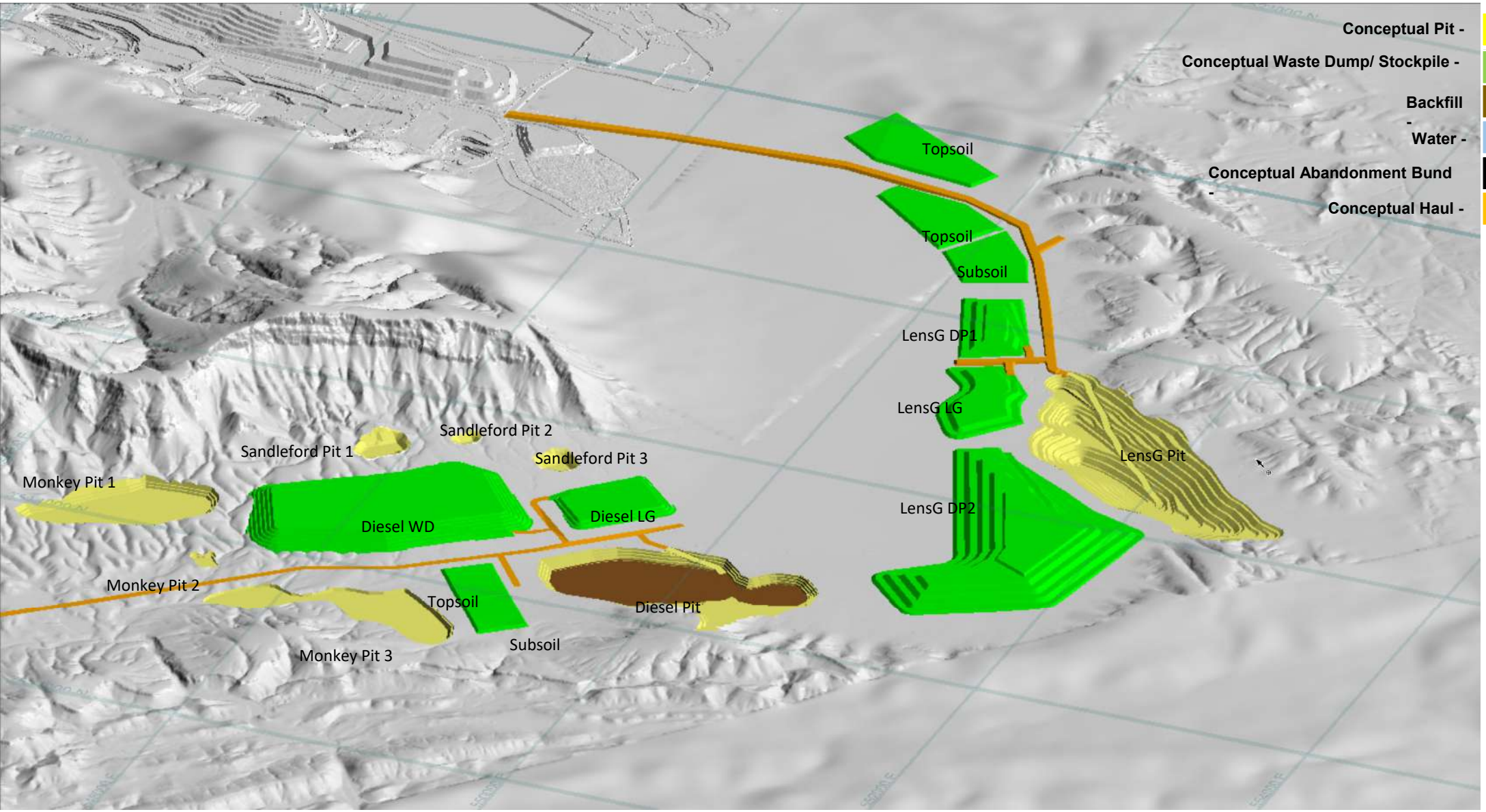
Comments

Waste landform is a conceptual design.

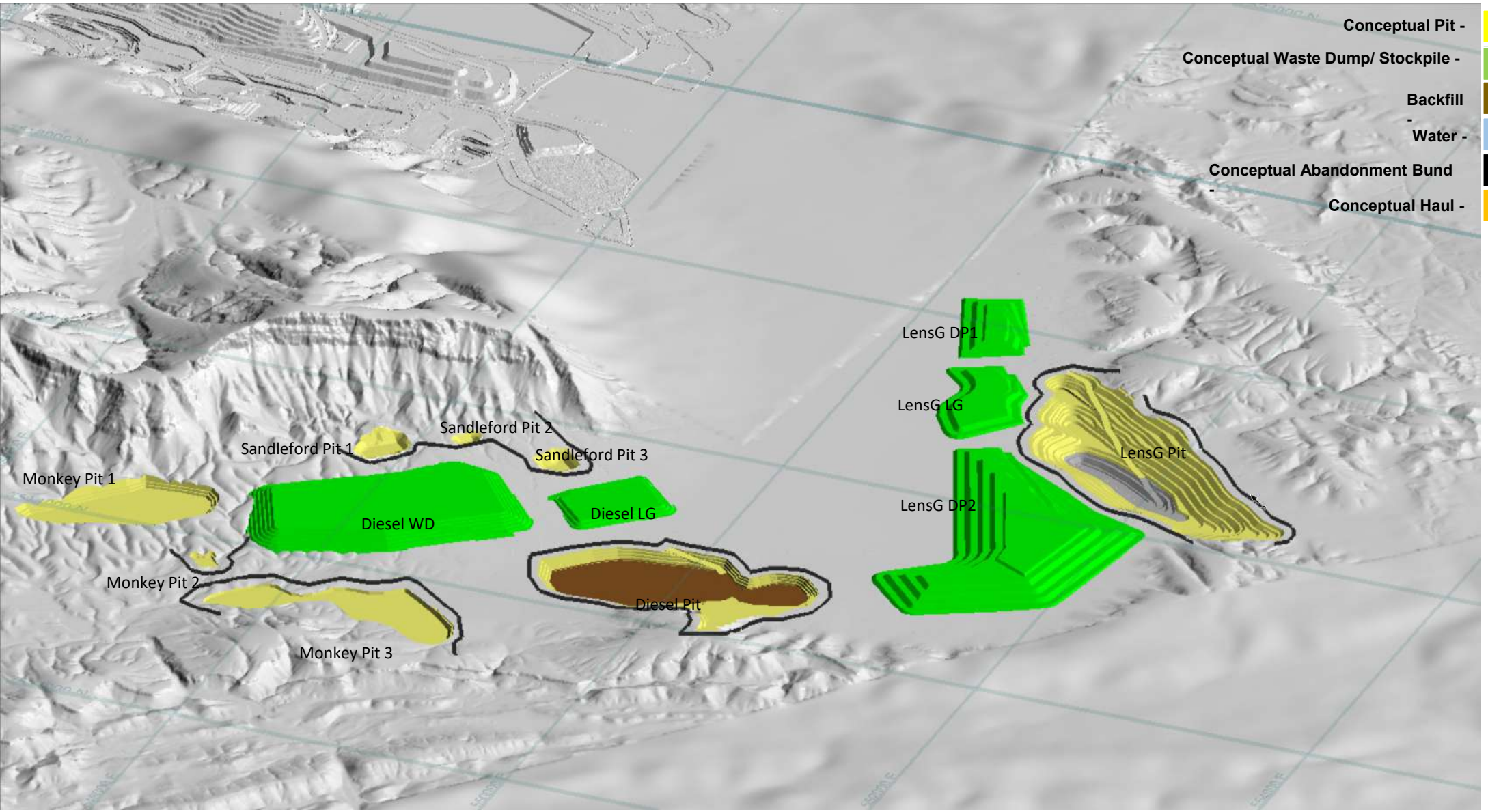
Rehabilitation design is not available, further details of designs will be done in PFS/FS study.

Estimated required topsoil volume is based on construction surface area and assumption of 200mm thickness topsoil layer.

BS3 ext, Diesel, Monkey and Sandleford

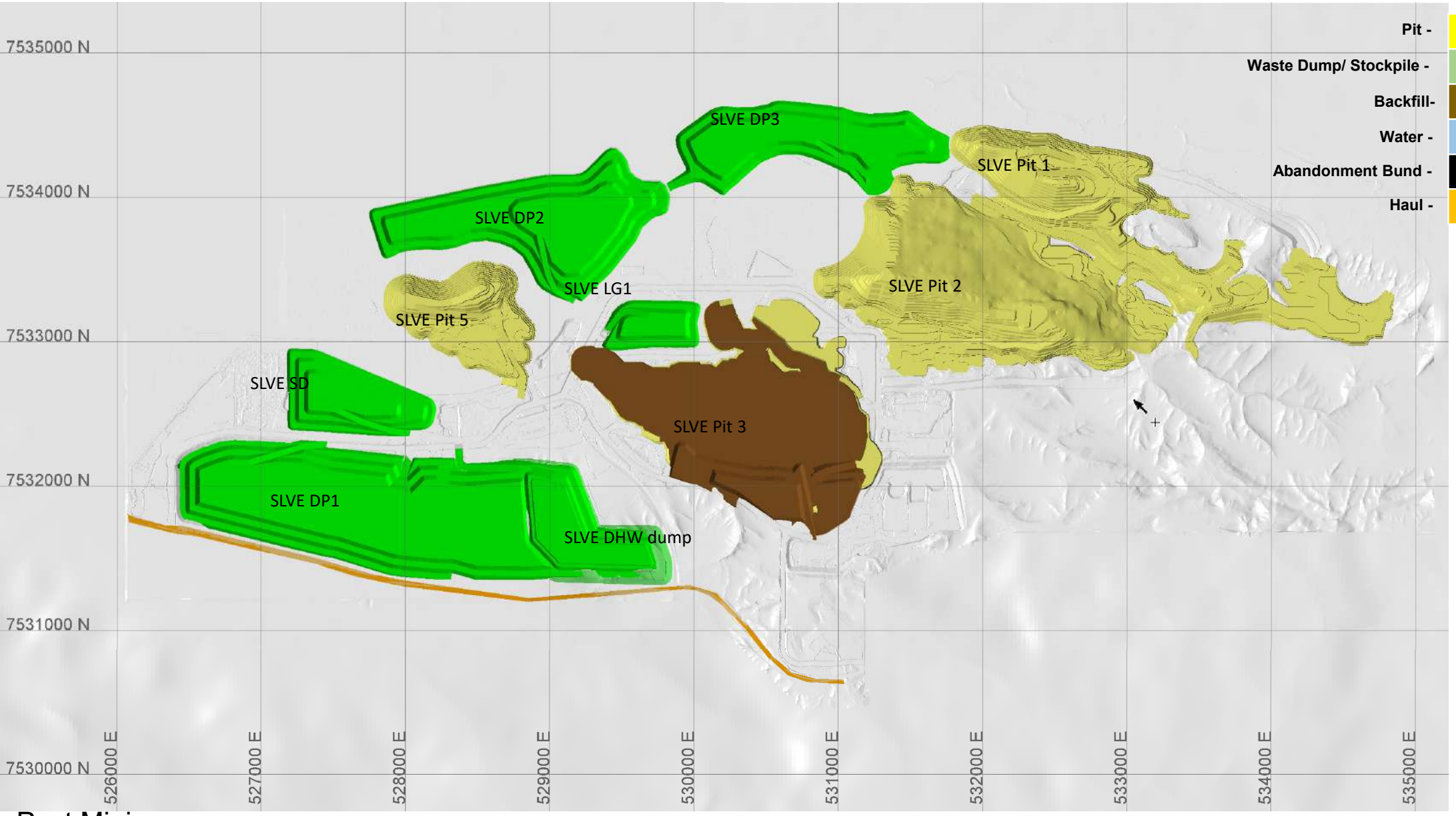

Conceptual Pit -
Conceptual Waste Dump/ Stockpile -
Backfill -
Water -
Conceptual Abandonment Bund -
Conceptual Haul -
Topsoil
Topsoil
Subsoil
LensG DP1
LensG LG
LensG Pit
LensG DP2
Sandleford Pit 2
Sandleford Pit 1
Sandleford Pit 3
Monkey Pit 1
Diesel WD
Diesel LG
Monkey Pit 2
Topsoil
Diesel Pit
Subsoil
Monkey Pit 3

Post Mining

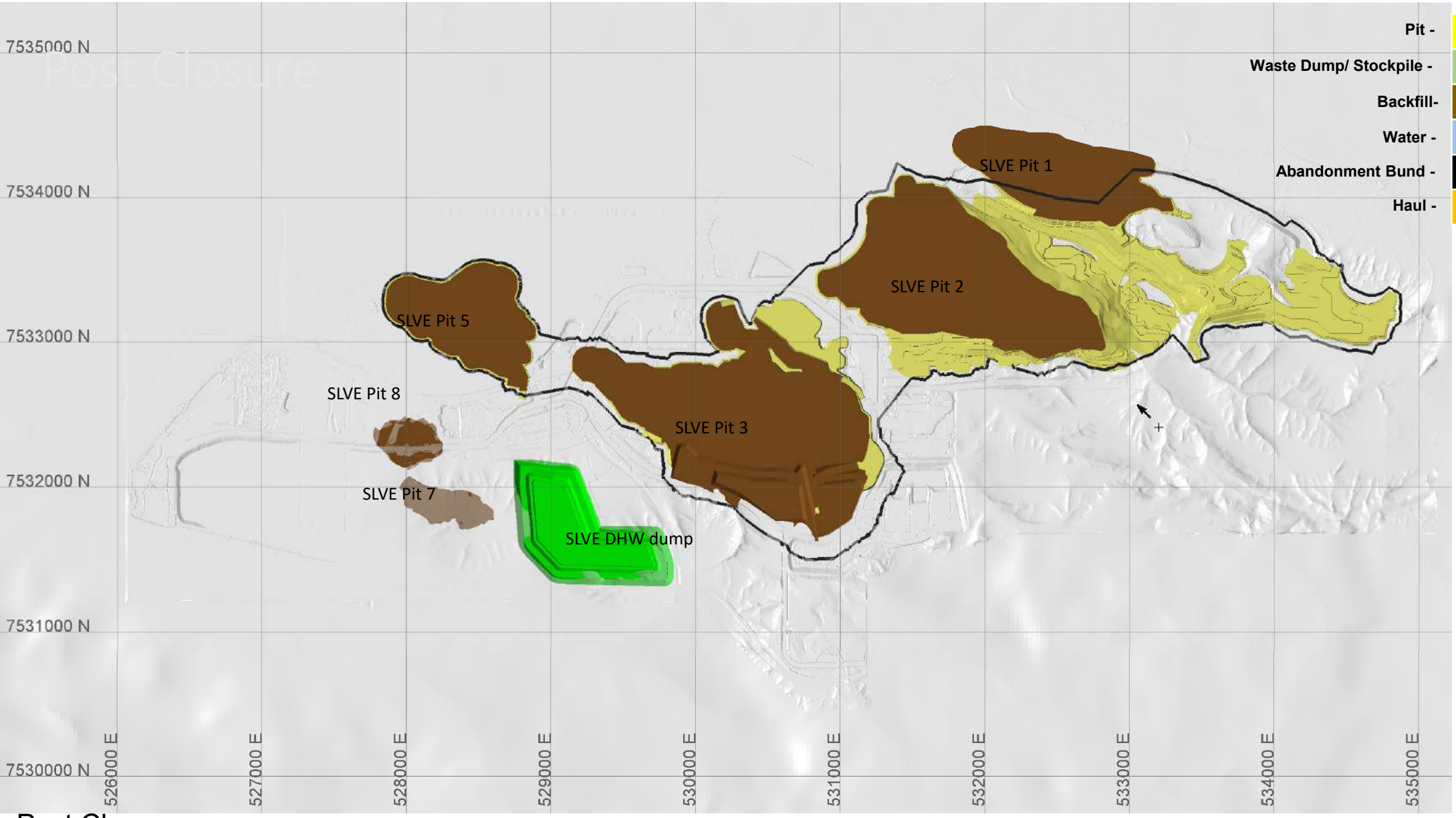


Post Closure

Silvergrass East


Pit -
Waste Dump/ Stockpile -
Backfill-
Water -
Abandonment Bund -
Haul -
SLVE DP3
SLVE Pit 1
SLVE DP2
SLVE LG1
SLVE Pit 2
SLVE Pit 5
SLVE SD
SLVE Pit 3
SLVE DP1
SLVE DHW dump
7535000 N
7534000 N
7533000 N
7532000 N
7531000 N
7530000 N
526000 E
527000 E
528000 E
529000 E
530000 E
531000 E
532000 E
533000 E
534000 E
535000 E

Post Mining



Post Closure

SLVE_DHW_wd (slve_dhw_uf04_ext)

Waste volume	9.7Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	66%
	Medium	32%
	High	3%
Classification	Inert ☐	Capping required at closure: ~0.7Mm^3
	PAF ☐	-
	Fibrous minerals ☒	9 Mm^3
	WFSF ☐	-
Overall height (m)	42m	
Topsoil required (Mm^3)	~0.2Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	20°
Lift height (m)	15	15
Berm width (m)	40	10
Berm slope (deg)	0°	0°
Footprint (ha)	67	67

Comments

- **Used for dumping Designated Hazardous material (Fibre = '3') material**
- **Inert material for capping**
- **Capping and Topsoil material requirements are only rough estimates based the dump/stockpile footprint.**

Construction Design



Rehabilitation Design



LG1

Waste volume	4.8Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	71%
	Medium	8%
	High	21%
Classification	Inert ☒	Capping required at closure: No
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	35m	
Topsoil required (Mm^3)	~0.1Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	°
Lift height (m)	20	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	26	

Comments

- **Conceptual design only - no formal design review has been completed**
- **Stockpile to be reclaimed at closure**
- **Topsoil material requirements are only rough estimate based the dump/stockpile footprint dump/stockpile being reclaimed**

Construction Design



Rehabilitation Design

SD

Waste volume	14.3Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	24%
	Medium	0%
	High	76%
Classification	Inert ☒	Capping required at closure: NO
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	50m	
Topsoil required (Mm^3)	~0.1Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	°
Lift height (m)	20	
Berm width (m)	35	
Berm slope (deg)	0°	°
Footprint (ha)	50	

Comments

- **Conceptual design only - no formal design review has been completed**
- **Waste Dump to be reclaimed at closure**
- **Topsoil material requirements are only rough estimation based the dump/stockpile footprint dump/stockpile being reclaimed**

Construction Design

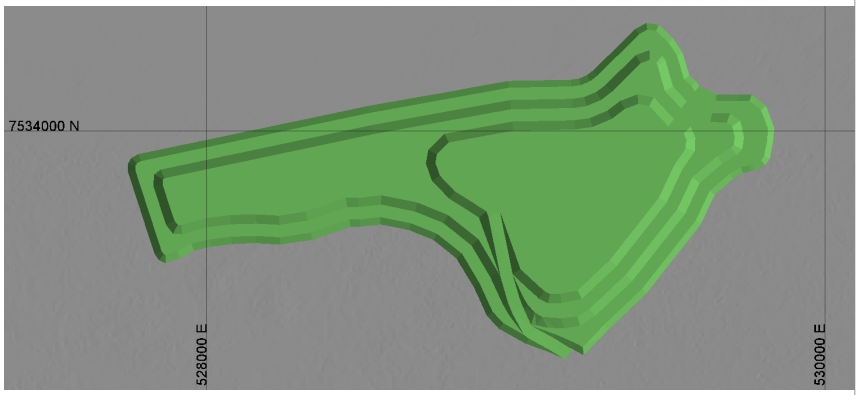


Rehabilitation Design

NORTH WEST DUMP DP2

Waste volume	37Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	71%
	Medium	8%
	High	21%
Classification	Inert ☒	Capping required at closure: NO
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	60m	
Topsoil required (Mm^3)	~0.2Mm^3	

Construction Design



	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	°
Lift height (m)	20	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	57	

Rehabilitation Design

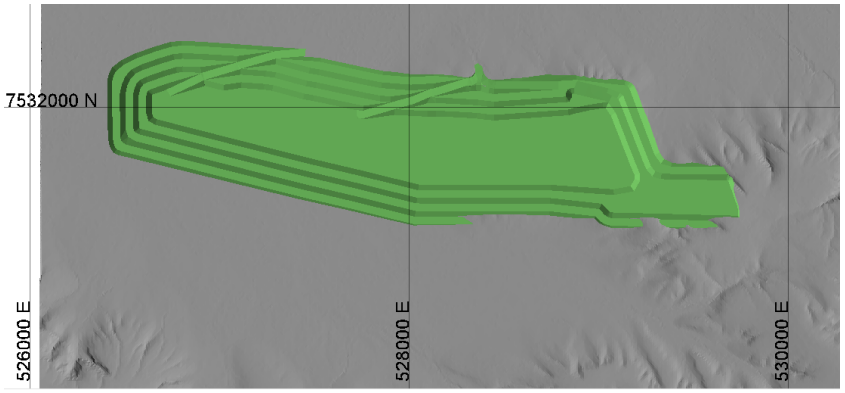
Comments

- **Conceptual design only - no formal design review has been completed**
- **Dump to be reclaimed at closure**
- **Topsoil material requirements are only rough estimation based on the dump footprint being reclaimed**

SOUTH WEST DUMP DP1

Waste volume	87Mm^3	
Erodibility ranking	Low/Medium or High	
	Low	71%
	Medium	8%
	High	21%
Classification	Inert ☒	Capping required at closure: NO
	PAF ☐	-
	Fibrous minerals ☐	Mm^3
	WFSF ☐	-
Overall height (m)	70m	
Topsoil required (Mm^3)	~0.2Mm^3	

Construction Design



	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	34°	°
Lift height (m)	20	
Berm width (m)	40	
Berm slope (deg)	0°	°
Footprint (ha)	57	

Rehabilitation Design

Comments

- **Conceptual design only - no formal design review has been completed**
- **Dump to be reclaimed at closure**
- **Topsoil material requirements are only rough estimation based on the dump footprint being reclaimed**

Appendix 3: Brockman Operation Closure Legal Obligations Register

Ministerial Statement 131 (Brockman No.2 Detrital Iron Ore Mine)	
Condition No.	**Closure conditions**
Key Characteristics table - Closure	Partial backfill of mine voids (Pits 1, 4, 4 Extension, 5 and 6). Establish protective bunds around mine voids. Remove infrastructure not required for future use. Rip, spread topsoil and if necessary, seed waste dumps, hardstand and road areas.
1	In implementing the proposal, the proponent shall fulfil the commitments (which are not inconsistent with the conditions or procedures contained in this statement) made, in the Consultative Environmental Review and in correspondence from the proponent, as consolidated on 21 March 1991. - (Refer **Conditions relevant to closure** section below).
4	Within 12 months of the commencement of production, the proponent shall prepare and subsequently implement a rehabilitation plan which shall include, but not be limited to, the following: a) details of topsoil conservation; b) objectives for establishing self-sustaining indigenous vegetation following site rehabilitation; c) initial development of completion criteria for rehabilitation success; d) a monitoring programme for rehabilitated and control areas and related studies; and e) provision for annual review and modification in accordance with the results of the monitoring-programme and related studies: In consultation with the Department of Mines, to the satisfaction of the Environmental Protection Authority. At least 12 months prior to the completion of mining, the proponent shall prepare final completion criteria to the satisfaction of the Environmental Protection Authority on advice of the Department of Mines.
5	The proponent shall be responsible for final decommissioning and removal of the plant and installations and rehabilitating the site and its environs, to the satisfaction of the Environmental Protection Authority. At least six months prior to decommissioning, the proponent shall prepare and subsequently implement a final decommissioning and rehabilitation plan to the satisfaction of the Environmental Protection Authority.
6	At least 12 months prior to the completion of mining, the proponent shall develop detailed plans for the retention or alternatively the decommissioning and rehabilitation of the rail spur, to the satisfaction of the Environmental Protection Authority.
Commitment No.	**Conditions relevant to closure**
1	A continuous programme will be carried out to determine the effectiveness of measures taken for protection and rehabilitation of the environment. A brief annual report and a more comprehensive triennial report of the effectiveness of measures to protect and rehabilitate the environment will be provided.
2	Areas disturbed in project construction and operations will be stabilised as soon as practicable and appropriate erosion control works installed wherever necessary.
5	Wherever practicable topsoil will be removed from larger building sites, borrow areas and other disturbed areas for use in rehabilitation works.
6	Rehabilitation methods will be determined on a site-specific basis following assessment of each disturbed area. Consultation will take place with appropriate officers of the Environmental Protection Authority and/or the Department of Mines during the formulation of programmes for rehabilitation of areas affected by mining or construction.
7	All rehabilitation sites will be periodically assessed for establishment of vegetation.
9	Mine pits and waste dumps will be suitably rehabilitated as final profiles are determined. Rehabilitation works of pits, dumps, construction areas, etc. will be carried out at the earliest opportunity after the use of any particular area or dump is no longer required. The actual timing may depend upon seasonal or other conditions

	outside Hamersley's control, but Hamersley undertakes that work required under the rehabilitation programme will be carried out within 12 months of an area no longer being required for mining or construction. After the initial stockpiling of overburden in surface dumps, overburden removed during subsequent mining operations will be backfilled into mined out areas.
10	The following general principles will apply to the flora and fauna management programme: a) Clearing of native vegetation will be kept to a minimum at any one point in time. b) Rehabilitation of disturbed and mined areas will be kept to a minimum at any one point in time. c) Rehabilitation of disturbed and mined areas will commence as soon as practicable after disturbance (See commitment 2,6 & 9 above). d) The removed vegetation and topsoil will be re-spread as soon as practicable to minimise the loss of seed and propagules (See commitment 5). e) Where appropriate, areas already disturbed will be used for the development of access trucks and haulage roads. f) The use of off-road vehicles will be restricted to main access roads and tracks. g) {7) Firearms and domestic pets will not be allowed in the project area.
11	Areas disturbed in project construction and operations will be stabilised as soon as practicable and appropriate erosion control works installed wherever necessary.

Ministerial Statement 867 (Brockman 2 Detrital Iron Ore Mine Extension Phase 2B)

Condition No.	Closure conditions
7-1	The proponent shall ensure that run-off and/or seepage from the mineral waste dump and waste material landforms does not impact the quality of groundwater and surface water within or adjacent to the proposal area to the extent that it exceeds the trigger values for a slightly to moderately disturbed ecosystem provided for in Table 3.4.2 of Chapter 3 of the Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, Australian Water Quality Guidelines for Fresh and Marine Waters and its updates, taking into consideration natural background water quality.
7-2	The proponent shall monitor the quality of groundwater and surface water within the proposal area including around the edge of the BS2 pit and the waste material landform to ensure that the requirements of condition 7-1 are met. This monitoring is to be carried out using methods consistent with Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, Australian Guidelines for Water Quality Monitoring and Reporting (and its updates) and to the satisfaction of the CEO.
7-6	In the event that monitoring required by condition 7-2 indicates that the requirements of condition 7-1 are not being met, the proponent shall: a) report such findings to the CEO within 21 days of the decline in water quality being identified; b) provide evidence which allows determination of the root cause of the decline in water quality; and c) if determined to be a result of activities undertaken in implementing theproposal, state the actions and associated timelines proposed to be taken to remediate the water quality.
7-7	The proponent shall on approval of the CEO, implement the actions identified in 7-6(3) and continue to implement such actions until the CEO determines that the remedial actions may cease.
8-5	The proponent shall manage all material with the potential to generate Acid and Metalliferous Drainage including selenium so that the quality of surface water or groundwater does not exceed the trigger values for a slightly to moderately disturbed ecosystem provided for in Table 3.4.2 of Chapter 3 of the Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, Australian Water Quality Guidelines for Fresh and Marine Waters and its updates.
9-1	The proponent shall undertake progressive rehabilitation of disturbed areas including the waste material landform over the life of the proposal to achieve the following outcomes:

	a) The waste material landform facility shall be non-polluting and shall be constructed so that its stability, surface drainage, resistance to erosion and ability to support local native vegetation, are similar to undisturbed natural analogue landforms as demonstrated by Ecosystem Function Analysis or other methodology acceptable to the CEO; b) Waste material landforms and other areas disturbed through implementation of the proposal (excluding mine pits), shall be progressively rehabilitated with vegetation composed of native plant species of local provenance; c) The percentage cover and species diversity of living self-sustaining native vegetation in all rehabilitation areas shall be comparable to that of undisturbed natural analogue sites as demonstrated by Ecosystem Function Analysis or other methodology acceptable to the CEO; d) No new species of weeds (including both declared weeds and environmental weeds) shall establish in the area as a result of the implementation of the proposal; and e) The coverage of weeds (including both declared weeds and environmental weeds) within rehabilitated areas shall be no greater than the average of three reference sites on nearby land, with the reference sites to be chosen in consultation with the Department of Environment and Conservation and the Department of Mines and Petroleum.
9-2	Rehabilitation activities shall continue until such time as the requirements of condition 9-1 are met, and are demonstrated by inspections, monitoring and reports to be met, for a minimum of five years following mine completion to the satisfaction of the CEO, on advice of the Department of Mines and Petroleum.
9-3	Within two years of the end of productive mining in the BS2 pit, the proponent shall backfill the BS2 pit with inert waste to sufficient depth to ensure that, following mine closure and backfilling, the groundwater water table would permanently remain at least 3 metres below the lowest point of the pit floor.
9-4	The proponent shall undertake monitoring to ensure that the requirements of condition 9-3 are adhered to until such time as the watertable remains constant for 3 years after backfilling. Note: Watertable refers to the upper surface of groundwater below which soil is saturated with water that fills all voids and interstices, and where the pressure of water in the soil equates to atmospheric pressure. Constant refers to invariable or unchanging.
9-5	Should the backfilling of the pit not ensure that the watertable remains at least 3 metres below the backfilled level of the BS2 and provide a sufficient capillary break to maintain groundwater quality and prevent the upward movement of salts; metals or other mobile elements (whichever is the greater); the proponent shall remediate and monitor to the satisfaction of the CEO.
9-6	The proponent shall ensure that all waste material used for the encapsulation of potential acid forming (PAF) material and the construction of the store and release cover is of appropriate physical and chemical nature to the satisfaction of the CEO on advice from the Department of Mines and Petroleum.
9-7	The proponent shall prevent the leaching of soluble constituents from pit walls at levels that may cause environmental harm as defined in Section 3A (2) of the Environmental Protection Act 1986.
9-8	At the completion of mining of the BS2 pit the proponent shall encapsulate PAF material within a waste material landform consisting of: a) an inert waste rock layer overlaid on the uppermost PAF layer of a minimum of 2 metres; b) a thick store and release cover of a minimum of 4 metres constructed on top of the 2 metre layer of inert waste rock; and c) topsoil spread of a minimum of 0.3 metres on top of the store and releasecover.
9-9	The proponent shall ensure that an adequate capillary break is installed under the waste dump as outlined in Figure 1 to prevent upward movement of groundwater coming into contact with material with potential to produce acid, metalliferous or seleniferous drainage.
9-10	The proponent shall undertake monitoring to ensure that the requirements of condition 9-9 are met.
9-11	In the event that monitoring required by condition 9-10 indicates that the requirements of condition 9-9 are not being met, the proponent shall:

	a) report such findings to the CEO within 21 days; b) prepare mitigation strategies on advice from the Department of Mines and Petroleum to the satisfaction of the CEO; and c) implement the mitigation strategies.
9-12	The proponent shall ensure that vegetation species for rehabilitation planting on the store and release cover are to be native to the proposal area with root penetration of less than 5 metres.
9-13	The proponent shall monitor progressively the rehabilitation for the store and release cover against the criteria developed pursuant to condition 9-1 with appropriately timed surveys as agreed with the Department of Environment and Conservation, until the completion criteria are met. The surveys shall be conducted annually unless otherwise agreed by the CEO, on advice from the Department of Environment and Conservation and the Department of Mines and Petroleum.
9-14	The proponent shall include the results of the rehabilitation monitoring required pursuant to condition 9-2 in the compliance assessment report referred to in condition 4-6 commencing no less than 15 months from the date rehabilitation was commenced. The report shall address the following: a) The progress made towards meeting the completion criteria developed pursuant to condition 9-1(3); and b) Contingency management measures in the event that the completion criteria required by condition 9 - 1(3) are unlikely to be met.
9-15	The proponent shall make the monitoring reports required by condition 9-2 publicly available in a manner approved by the CEO.
10-1	Within six months of the date of the Ministerial Statement being issued, the proponent shall submit to the Office of the Environmental Protection Authority a detailed and project-specific Mine Plan and Preliminary Closure Strategy to the requirements of the CEO on advice of the Department of Mines and Petroleum and Department of Environment and Conservation.
10-2	The Mine Plan and Preliminary Closure Strategy shall include detailed results of geochemical and geophysical characterisation of materials, in particular the potential for acid drainage, metalliferous drainage, and of the occurrence of dispersive materials. Testing for materials with potential to cause acid and/or metalliferous drainage including selenium shall include static and kinetic testing carried out using techniques and timeframes consistent with national and international standards (Leading Practice Sustainable Development Program for the Mining Industry – Managing Acid and Metalliferous Drainage 2009 – Department of Industry, Tourism and Resources; The Global Acid Rock Drainage Guide 2009 – International Network for Acid Prevention).
10-3	The Mine Plan and Preliminary Closure Strategy shall provide detailed technical information on proposed management measures to prevent contamination, environmental harm or human health impacts during implementation of the proposal and after mine completion and closure.
10-4	The Mine Plan and Preliminary Closure Strategy shall include maps and diagrams showing the proposed placement, dimensions, design and proposed methods of construction and closure of waste disposal facilities, mine pits and evaporation pond.
10-5	The Mine Plan and Preliminary Closure Strategy shall demonstrate that waste disposal facilities will be located, designed and constructed to ensure that they are non-polluting and so that their final shape, height, stability and ability to support native vegetation are comparable to natural landforms in the area. The Mine Plan and Preliminary Closure Strategy shall describe remedial options available to deliver condition 7-1 if condition 7-6 is triggered.
10-6	The proponent shall implement the Mine Plan and Preliminary Closure Strategy referred to in condition 10-1.
10-7	The Mine Plan and Preliminary Closure Strategy shall be reviewed on a 3 year basis and incorporate new knowledge as the mine develops. The revised Mine Plan and Closure Strategy should be submitted in accordance with relevant Western Australian Government closure guidelines and updates.

Ministerial Statement 925 (Nammuldi-Silvergrass Expansion)

Condition No.	Closure conditions
6-1	The proponent shall ensure that dewatering and discharge do not cause long term impacts on the health and abundance of groundwater-dependent vegetation

	communities in Duck and Caves creeks beyond the approved clearing envelope as shown in Figure 3 and delineated by the coordinates specified in Schedule 2.
7-1	The proponent shall ensure that the discharge of surplus water from the Nammuldi or Silvergrass sites as a result of mining does not cause long term impacts on the environmental and conservation values of Duck Creek.
10-1	Within six months following commissioning of the first Silvergrass pit or a new Nammuldi pit, whichever occurs first, the proponent shall prepare a Closure, 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.
10-2	**The Closure, Decommissioning and Rehabilitation Plan required by Condition 10-1 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.**
10-3	The Closure, Decommissioning and Rehabilitation Plan required by Condition 10-1 shall set out procedures to: a) manage long-term hydrogeological impacts of mining the Marra Mamba and Bedded Brockman iron deposits; b) model the long-term hydrological impacts, particularly the water levels and quality both in the pit void and downstream of waste material landforms; c) identify pits to be backfilled; d) manage over the long-term the surface water systems affected by the open pits; e) progressively rehabilitate all disturbed areas to a standard suitable for the agreed end land use(s), with consideration and incorporation of: i) the characteristics of the pre-mining ecosystems within the project area (through research and baseline surveys); ii) the performance of previously rehabilitated areas within the mining lease; iii) the performance of rehabilitation areas at the proponent's other operations in the Pilbara; and iv) best practice rehabilitation techniques used elsewhere in the mining industry; f) develop and identify completion criteria; g) monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria; h) report on the rehabilitation and monitoring results; i) 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; j) manage and monitor mineral waste including physical characteristics and acid or neutral metalliferous drainage using national and international standards and updates; and k) (11) close the mine in a manner which does not result in unacceptable liability to the State.
10-4	Within 12 months following commissioning of the first Silvergrass pit or a new Nammuldi pit, whichever occurs first, the proponent shall implement the Closure, Decommissioning and Rehabilitation Plan required by Condition 10-1 and any subsequent approved revisions until otherwise agreed by the CEO.
Attachment 1 to Ministerial Statement 925: Table 2	Mining up to 150 metres below the water table. All pits to be backfilled above the post-mining water table levels.
Attachment 1 to Ministerial Statement 925: Table 2	Permanent realignment of up to a 3 kilometre length of Caves Creek.

Ministerial Statement 1000 (Brockman Syncline 4 Iron Ore – Revised Proposal)	
Condition No.	**Closure conditions**
6-1	The proponent shall ensure that the proposal is decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State of Western Australia, through the implementation of the Mine Closure Plan required by condition 6-2.
6-2	The proponent shall prepare the Brockman Syncline 4 Mine Closure 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.
6-3	The proponent shall review and revise the Brockman Syncline 4 Mine Closure Plan required by condition 6-2 at intervals not exceeding three years, or as otherwise specified by the CEO.
6-4	The proponent shall implement the latest revision of the Brockman Syncline 4 Mine Closure Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 6-2.
Commitment No.	**Closure commitments**
Schedule 1, Table 2	Mine pits are to be backfilled so that the final surface levels are at a higher elevation than the pre-mining groundwater level to prevent the formation of pit lakes.

Iron Ore (Hamersley Range) Agreement Act 1963 (WA)	
Clause No.	**Closure obligations**
10I(2)	On or before the 1st day of October, 1990 (or thereafter within such extended time as the Minister may allow as hereinafter provided) the Company shall submit to the Minister to the fullest extent reasonably practicable its detailed proposals (which proposals shall include plans where practicable and specifications where reasonably required by the Minister) with respect to the mining of iron ore from the Brockman No. 2 Detritals Deposit and the transportation of iron ore mined to the Company's Paraburdoo Dampier railway which proposals shall make provision for the necessary workforce and associated population required to enable the Company to mine and recover iron ore from the Brockman No. 2 Detritals Deposit and shall include the location, area, layout, design, quantities, materials and time programme for the commencement and completion of construction or the provision (as the case may be) of each of the following matters, namely a) the mining and recovery of iron ore including mining crushing screening handling transport and storage of iron ore and plant facilities; b) roads; c) housing and accommodation for the persons engaged in the development and/or mining of the Brockman No. 2 Detritals Deposit and associated activities including the provision of utilities, services and associated facilities; d) water supply; e) power supply; f) iron ore transportation; g) airstrip and other airport facilities and services; h) any other works, services or facilities desired by the Company; i) use of local labour professional services manufacturers suppliers contractors and materials and measures to be taken with respect to the engagement and training of employees by the Company its agents and contractors; j) any leases licences or other tenures of land required from the State; and 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.
10I(3)	The proposals pursuant to sub clause (2) of this clause may with the approval of the Minister or if so required by him be submitted separately and in any order as to the matter or matters mentioned in one or more of paragraphs (a) to (k) of that subclause.

10I(4)	On receipt of the said proposals the Minister shall subject to the Environmental Protection Act 1986 — (a) approve of the said proposals either wholly or in part without qualification or reservation; or (b) defer consideration of or decision upon the same until such time as the Company submits a further proposal or proposals in respect of some other of the matters mentioned in sub clause (2) of this clause not covered by the said proposals; or (c) require as a condition precedent to the giving of his approval to the said proposals that the Company makes such alteration thereto or complies with such conditions in respect hereto as he (having regard to the circumstances including the overall development of and the use of other parties as well as the Company of all or any of the facilities proposed to be provided) thinks reasonable and in such a case the Minister shall disclose his reasons for such conditions PROVIDED ALWAYS that where implementation of any proposals hereunder has been approved pursuant to the Environmental Protection Act 1986 subject to conditions or procedures, any approval or decision of the Minister under this clause shall if the case so requires incorporate a requirement that the Company make such alterations to the proposals as may be necessary to make them accord with those conditions or procedures.
10I(5)	The Minister shall within two months after receipt of the said proposals or, if applicable, within two months of service on him of an authority under section 45(7) of the Environmental Protection Act 1986 give notice to the Company of his decision in respect of the same.
10I(6)	If the decision of the Minister is as mentioned in either of paragraphs (b) or (c) of sub clause (4) of this clause the Minister shall afford the Company full opportunity to consult with him and should it so desire to submit new or revised proposals either generally or in respect to some particular matter.
10I(7)	If the decision of the Minister is as mentioned in either of paragraphs (b) or (c) of sub clause (4) of this clause and the Company considers that the decision is unreasonable the Company within two months after receipt of the notice mentioned in sub clause (5) of this clause may elect to refer to arbitration in the manner hereinafter provided the question of the reasonableness of the decision PROVIDED THAT any requirement of the Minister pursuant to the proviso to sub clause (4) of this clause shall not be referable to arbitration hereunder.
10I(9)	The Company shall implement the proposals as approved by the Minister or an award made on arbitration (except where the proposals are withdrawn) as the case may be in accordance with the terms thereof and in such implementation shall comply with all requirements in connection with the protection of the environment 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.
11(d)	The parties hereto covenant and agree with each other.... that on the cessation or determination of this Agreement — (i) except as otherwise agreed by the Minister the rights of the Company to in or under this Agreement and the rights of the Company or of any assignee of the Company or any mortgagee to in or under the mineral lease and any other lease license easement or right granted hereunder or pursuant hereto shall thereupon cease and determine but without prejudice to the liability of either of the parties hereto in respect of any antecedent breach or default under this Agreement or in respect of any indemnity given hereunder AND the Company will without further consideration but otherwise at the request and cost of the State transfer or surrender to the State or the Crown all land the subject of any Crown Grant issued under the Land Act pursuant to this Agreement; (ii) the Company shall forthwith pay to the State all moneys which may then have become payable or accrued due.
11(e)	The parties hereto covenant and agree with each other.... that on the cessation or determination of any lease license or easement granted hereunder by the State to the Company or (except as otherwise agreed by the Minister) to an associated company or other assignee of the Company under clause 20 hereof of land for the Company's wharf for any installation within the harbour for the Company's railway or for housing at the port or port townsite the improvements and things erected on the relevant land and provided for in connection therewith shall remain or become the absolute property of the State without compensation and freed and discharged from all mortgages and encumbrances and the Company will do and execute such documents and things (including surrenders) as the State may reasonably require to give effect to this provision. In the event of the Company immediately prior to such expiration or determination or subsequent thereto deciding to remove its locomotives rolling stock plant equipment and removable buildings or any of them from any land it shall not do so without first notifying the State in writing of its decision and thereby granting to the State the right or option exercisable within three months thereafter to purchase at valuation in situ the said plant equipment and removable buildings or any of them. Such valuation shall be mutually agreed or in default of agreement shall be made by such competent valuer as the parties may appoint or falling agreement as to such appointment then by two competent valuers one to be appointed by each party or by an umpire appointed by such valuers should they fail to agree.

Mining Act 1978 – Tenement Conditions

Tenement No. M47/369	
Condition No.	**Closure conditions**
4-1	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the

	termination of exploration program.
5-2	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
8-1	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman 2 Mine Operations Notice of Intent - Purpose - to establish borrow pits along the Brockman Access Road and obtain road base material for improvement works, M47/369, M47/370, M47/371 and M47/372" (NOI 5193A)" dated 31 October 2005 and retained on Department of Industry and Resources File No. E0264/200501. • Letter titled "Notice of Intent for Mining Leases M47/369, M47/370, M47/371 and M37/372 Supplementary Information" (NOI 5193B) written by Ben Von Perger for Peter Landman, dated 1 December 2005 and retained on Department of Industry and Resources File No. E0264/200501. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
10-1	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
11-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
12-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
13-1	At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Director, Environment Division, DoIR.
Tenement No. M47/370	
Condition No.	**Closure conditions**
4-1	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.
5-2	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
8-1	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman 2 Mine Operations Notice of Intent - Purpose - to establish borrow pits along the Brockman Access Road and obtain road base material for improvement works, M47/369, M47/370, M47/371 and M47/372" (NOI 5193A)" dated 31 October 2005 and retained on Department of Industry and Resources File No. E0264/200501. • Letter titled "Notice of Intent for Mining Leases M47/369, M47/370, M47/371 and M37/372 Supplementary Information" (NOI 5193B) written by Ben Von Perger for Peter Landman, dated 1 December 2005 and retained on Department of Industry and Resources File No. E0264/200501. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
10-1	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.

11-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
12-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
13-1	At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Director, Environment Division, DoIR.
Tenement No. M47/371	
Condition No.	**Closure conditions**
4-1	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.
5-2	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
8-1	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman 2 Mine Operations Notice of Intent - Purpose - to establish borrow pits along the Brockman Access Road and obtain road base material for improvement works, M47/369, M47/370, M47/371 and M47/372" (NOI 5193A)" dated 31 October 2005 and retained on Department of Industry and Resources File No. E0264/200501. • Letter titled "Notice of Intent for Mining Leases M47/369, M47/370, M47/371 and M37/372 Supplementary Information" (NOI 5193B) written by Ben Von Perger for Peter Landman, dated 1 December 2005 and retained on Department of Industry and Resources File No. E0264/200501. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
10-1	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
11-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
12-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
13-1	At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Director, Environment Division, DoIR.
Tenement No. M47/372	
Condition No.	**Closure conditions**
4-1	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.
5-2	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
8-1	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman 2 Mine Operations Notice of Intent - Purpose - to establish borrow pits along the Brockman Access Road and obtain road base material for

	improvement works, M47/369, M47/370, M47/371 and M47/372" (NOI 5193A)" dated 31 October 2005 and retained on Department of Industry and Resources File No. E0264/200501. • Letter titled "Notice of Intent for Mining Leases M47/369, M47/370, M47/371 and M37/372 Supplementary Information" (NOI 5193B) written by Ben Von Perger for Peter Landman, dated 1 December 2005 and retained on Department of Industry and Resources File No. E0264/200501. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
10-1	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
11-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
12-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
13-1	At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Director, Environment Division, DoIR.
Tenement No. G47/01225	
Condition No.	**Closure conditions**
6-2	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman Syncline 4 Project, Rail Spur Line Construction and Fibre Optic Cable Installation Mining Proposal L47/141, L47/153 and G47/1225" (MP 5901)" dated 4 December 2007, signed by Alistair Conn and retained on Department of Mines and Petroleum File No. E0024/200502; • (Reg ID 36008) "Brockman 2 to Brockman 4 Access Road Upgrade" dated 27 June 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-36008 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
Tenement No. G47/01227	
Condition No.	**Closure conditions**
6-2	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman Syncline 4 Exploration Camp - Laying of pipeline to a water bore - Letter of Intent, G47/1227 and L47/153" (MP 5887) dated 23 November 2007 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303; • (Reg. ID: 30308) "Brockman Syncline 4 Project - Upgrade to Airstrip - Mining Proposal - L47/153, L47/185 and G47/1227 - 30 March 2011 (Revised 31 May 2011)" dated 30 March 2011 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum file No. EARS-MP-30308. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
10-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
11-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. G47/01232	
Condition No.	**Closure conditions**
5-6	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman 4 Project - Construction Camp/Permanent Accomodation Village Mining Proposal - G47/1232 (MP 5829)" dated 27 September 2007, signed by Aidan Kelly and retained on Department of Industry and Resources File No. E0025/200501. • "Addendum to Mining Proposal No. 5829: Brockman 4 Project - Construction Camp/Permanent Accommodation Village Mining Proposal General Purpose Lease 47/1232" (MP 5967) dated 6 February 2008 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303; • "Addendum to Mining Proposal No. 5829/5967: Brockman 4 Project - Cpnstruction Camp/Permanent Accommodation Village Mining Proposal General

	Purpose lease 47/1232" (Reg ID 21849) dated 19 May 2009, signed by Alistair Conn and retained on Department of Mines and Petroleum File No. E0024/200503. • (Reg ID: 31367) "Brockman 4 Project Operations Village Upgrade Mining Proposal G47/1232" dated 22 June 2011 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-31367; • (Reg. ID 34097) "Addendum to Mining Proposal Reg. ID 5829/5967: Mining Proposal - Brockman 4 construction camp/permanent village Mining Proposal General Purpose Lease 47/1232" dated 13 February 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum file No. EARS-MP-34097; • (Reg ID 35781) "Brockman 4 Project Construction Camp Expansion" dated 12 June 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-35781 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
10-1	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
11-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
13-2	At the completion of operations, or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or an alternative agreed outcome to the satisfaction of an Environmental Officer, DMP.
Tenement No. G47/1242	
Condition No.	**Closure conditions**
8-4	The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled: • (Reg ID: 38119) "Nammuldi BWT Project-Mining Proposal- G47/1243-3, L47/140 & L47/160" dated 3 April 2013 signed by Alistair Conn, and retained on Department of Mines and Petroleum file no.EARS-MP38119; • (MP Reg ID 41939) "Nammuldi - Silvergrass Overland Conveyor and Infrastructure Corridor (Revised Version)" dated 22 October 2013 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-41939 • (MP Reg ID:60240)"Letter Of Intent - Modification To The Approved Alignment Of The 33kv Powerline And Overland Conveyor As Presented In The Approved Mining Proposal "Nammuldi - Silvergrass Overland Conveyor And Infrastructure Corridor (Revised Version) G47/1242 and G47/1243" dated 4 August 2016 signed by Alistair Conn, and retained on Department of Mines and Petroleum file no. EARS-MP-60240 as Doc ID 4424999; • (MP Reg ID 64371) "Silvergrass 33kV Powerline (Line 4) L47/140 and G47/1242" dated 27 February 2017 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-63471 as Doc ID 4839664 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
11-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
12-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP.
13-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
16-1	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence or be within the zone of pit instability.
17-1	On the completion of operations or progressively when possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.
19-1	All activities being carried out in such a manner so as to not have a detrimental effect on the natural water flow through the lease and surrounding areas to the satisfaction of the Environmental Officer, DMP.
22-1	At the time of decommissioning of the tailings storage facility and prior to rehabilitation, a further review report by a geotechnical or engineering specialist will be

	required by the Executive Director, Environment Division, DMP. This report should review the status of the structure and its contained tailings, examine and address the implications of the physical and chemical characteristics of the materials, and present and review the results of all monitoring. The rehabilitation stabilisation works proposed and any on-going remedial requirements should also be addressed.
25-2	Piezometers to be installed at the strategic locations in the Stage 1 embankment, as approved by the designer, to monitor the phreatic surface movements and - are to be operational early in construction of the embankment, remain operational, and be capable of reflecting the phreatic water profile through the embankment for life of the WFSF.
31-1	During operation, erosion resistance testing shall be undertaken where relevant to determine the resistance to varying rated of flow for the materials to be used for final rehabilitation of the WFSF and to maintain erosion of interim slopes to acceptable levels.
Tenement No. G47/01243	
Condition No.	**Closure conditions**
2-1	The Lessee notifying the holder of any underlying pastoral or grazing lease by telephone or in person, or by registered post if contact cannot be made, prior to undertaking airborne geophysical surveys or any ground disturbing activities utilising equipment such as scrapers, graders, bulldozers, backhoes, drilling rigs; water carting equipment or other mechanised equipment.
6-3	The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled: • (Reg ID:38119) "Nammuldi BWT Project- Mining Proposal - G47/1243-3, L47/140 & L47/160" dated 3 April 2013 signed by Alistair Conn, and retained on Department of Mines and Petroleum file no.EARS- MP-38119; • (MP Reg ID 41939) "Nammuldi - Silvergrass Overland Conveyor and Infrastructure Corridor (Revised Version)" dated 22 October 2013 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-41939 • (MP Reg ID:60240) "Letter Of Intent - Modification To The Approved Alignment Of The 33kv Powerline And Overland Conveyor As Presented In The Approved Mining Proposal "Nammuldi - Silvergrass Overland Conveyor And Infrastructure Corridor (Revised Version) G47/1242 and G47/1243"" dated 4 August 2016 signed by Alistair Conn, and retained on Department of Mines and Petroleum file no. [EARS-MP-60240] as Doc ID [4424999]. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
8-1	The development and operation of the project being carried out in such a manner so as to create the minimum practicable disturbance to the existing vegetation and natural landform.
9-1	All topsoil and vegetation being removed ahead of all mining operations being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
10-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP.
11-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
12-1	The lessee taking all reasonable measures to prevent or minimise the generation of dust from all materials handling operations, stockpiles, open areas and transport activities.
13-1	Where saline water is used for dust suppression, all reasonable measures being taken to avoid any detrimental effects to surrounding vegetation and topsoil stockpiles.
14-1	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence and zone of pit instability.
15-1	On the completion of operations or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. G47/001269 - Pending	
Tenement No. L47/00139	
Condition No.	**Closure conditions**
12-1	The licensee notifying the holder of any underlying pastoral or grazing lease by telephone or in person, or by registered post if contact cannot be made, prior to undertaking airborne geophysical surveys or any ground disturbing activities utilising equipment such as scrapers, graders, bulldozers, backhoes, drilling rigs; water carting equipment or other mechanised equipment.
18-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and

	• on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.
19-4	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman Syncline 4 Powerline and Crest Rail Siding Laydown Area - Letter of Intent, L47/139" (MP 5886) dated 23 November 2007, signed by Alistair Conn and retained on Department of Industry and Resources File No. E0025/200502 • "Re: Brockman Syncline 4 Project - Construction of 220Kv Powerline on L47/139 - Mining Proposal" (MP 5996) dated 13 March 2008 signed by Alistair Conn and retained on department of Industry and Resources File No. E2779/200303 • "Rosella Rail Siding to Brockman 2 Project Rail Upgrade Mining Proposal: Rail Infrastructure (L47/178), Construction of Crest rail siding and Fibre Optic Cable Installation (L47/151), Realignment of Nammuldi Rail Junction and Fibre Optic Cable Installation (L47/207), Powerline and Haul Road realignment (L47/139)" (MP 5889) dated 26 November 2007 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303; • (MP Reg ID 85102) "NBWT Access Road to Lens EF Facilities" dated 30 January 2020 signed by Sean Savage and retained on Department of Mines, Industry Regulation and Safety File No. EARS-MP-85102 as Doc ID 7141381 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
Tenement No. L47/00140	
Condition No.	**Closure conditions**
15-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.
16-2	The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled: • (Reg ID: 38119) "Nammuldi BWT Project-Mining Proposal- G47/1243-3,l47/140 & l47/160" dated 3 April 2013 signed bu Alistair Conn, and retained on Department of Mines and Petroleum file no EARS- MP-38119; • (MP Reg ID 64371) "Silvergrass 33kV Powerline (Line 4) L47/140 and G47/1242" dated 27 February 2017 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-63471 as Doc ID 4839664 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
19-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
20-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP
24-1	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence and zone of pit instability.
25-1	On the completion of operations or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. L47/00141	
Condition No.	**Closure conditions**
6-1	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Inspector.
18-1	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the District Inspector of Mines; and

	• on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Inspector and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
19-7	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Programme of Work for Hamersley Iron Pty Ltd on Miscellaneous Licences 47/141 and 47/153 (EXP 6514)" dated 4 April 2007 signed by John Carlisle, and retained on Department of Industry and Resources file T3906/200401; • "Brockman Syncline 4 Project 33kV Powerline Mining Proposal" (Reg ID 19471) dated 21 October 2008, signed by Alistair Conn and retained on Department of Industry and Resources File No. E0024/200502; • "Brockman Syncline 4 Project, Rail Spur Line Construction and Fibre Optic Cable Installation Mining Proposal L47/141, L47/153 and G47/1225" (MP 5901) dated 4 December 2007, signed by Alistair Conn and retained on Department of Mines and Petroleum File No. E0024/200502; • (Reg. ID 32690) "Brockman Fuel Hub Facility Project" dated 7 October 2011 signed by Genevieve Thompson and retained on Department of Mines and Petroleum file No. EARS-MP-32690; • (Reg ID 36008) "Brockman 2 to Brockman 4 Access Road Upgrade" dated 27 June 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-36008; • (Reg ID 36008) "Letter: Mining Proposal Reg ID 36008 - Brockman 2 to Brockman 4 access road project - Miscellaneous Licences 47/141 and 47/153 and General Purpose Lease 47/1225" dated 6 September 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-36008; • (Reg ID 48165) "Mining Proposal (RTIO-HSE0221613) Southern Rail Capacity Enhancement Project Rail Passing Track Miscellaneous Licence 47/141 Hamersley Iron Pty Ltd May 2014" dated 23 May 2014 signed by Shreya Shah and retained on Department of Mines and Petroleum File No. EARS-MP-48165 as Doc ID 2932238; • (MP Reg ID 53685) "Modification to the Proposed Disturbance as presented in the Approved Mining Proposal "Brockman 2 to Brockman 4 Access Road Upgrade on G47/1225, L47/141 and L47/153" (Reg ID 36008) dated 16 January 2015 signed by Pia Motteram - Government Approvals and retained on Department of Mines and Petroleum File No. EARS-MP-53685 as Doc ID 3376595 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
24	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
25	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP.
29	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence and zone of pit instability, to the satisfaction of the Executive Director, Environment Division, DMP.
30	On the completion of operations or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. L47/00151	
Condition No.	**Closure conditions**
9-2	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Rosella Rail Siding to Brockman 2 Project Rail Upgrade Mining Proposal: Rail Infrastructure (L47/178), Construction of Crest rail siding and Fibre Optic Cable Installation (L47/151), Realignment of Nammuldi Rail Junction and Fibre Optic Cable Installation (L47/207), Powerline and Haul Road realignment (L47/139)" (MP 5889) dated 26 November 2007 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303; • (MP Reg ID 52815) "Rio Tinto Iron Ore Mining Proposal (RTIO-HSE-0238486) Rail Operations Maintenance of rail Infrastructure Borrow pits L47/151, L47/178, L47/223, L47/49, L47/50" dated 6 October 2014 signed by Fiona Hambidge and retained on Department of Mines and Petroleum File No. EARS-MP-528A5 as Doc ID 3199305 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.

Tenement No. L47/00152	
Condition No.	**Closure conditions**
4-1	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Inspector.
12-1	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the District Inspector of Mines; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Inspector and properly maintain same until the Inspector advises regrowth is self supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.
Tenement No. L47/00153	
Condition No.	**Closure conditions**
6-1	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Inspector.
13-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
14-9	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Programme of Work for Hamersley Iron Pty Ltd on Miscellaneous Licences 47/141 and 47/153 (EXP 6514)" dated 4 April 2007 signed by John Carlisle, and retained on Department of Industry and Resources file T3906/200401; • "Addendum to Mining Proposal Nos 5901 and 5968 - Brockman Syncline 4 Project - Construction of Rail Spur Line and Airstrip Extension Mining Proposals - L47/153" dated 28 July 2008 signed by Alistair Conn and retained on Department of Industry and Resources File No. E0024/200502 • "Brockman Syncline 4 Exploration Camp - Laying of pipeline to a water bore - Letter of Intent, G47/1227 and L47/153" (MP 5887) dated 23 November 2007 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303 • "Brockman Syncline 4 Project 33kV Powerline Mining Proposal" (Reg ID 19471) dated 21 October 2008 signed by Alistair Conn and retained on Department of Industry and Resources File No. E0024/200502 • "Brockman Syncline 4 Project, Rail Spur Line Construction and Fibre Optic Cable Installation Mining Proposal L47/141, L47/153 and G47/1225" (MP 5901) dated 4 December 2007, signed by Alistair Conn and retained on Department of Mines and Petroleum File No. E0024/200502 • "Widening of Existing Road that Links The Brockman Syncline 4 Project Airstrip to the Camp - L47/153" Reg ID 20780 dated 11 November 2008 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. E0024/200502; • "Mining Proposal: Brockman 4 Project - Addendum to MP 5968 - Additional Airstrip Clearing - L47/153" (Reg ID 27076) dated 25 May 2010 signed by Jeremy English and retained on Department of Mines and Petroleum File No. E0202/201001; • "Mining Proposal: Brockman 4 Project - Airstrip Upgrade on L47/153 and L47/185" (Reg ID 29059) dated 10 December 2010 signed by Jeremy English and retained on Department of Mines and Petroleum File No. E0422/201001; • (Reg. ID: 30308) "Brockman Syncline 4 Project - Upgrade to Airstrip - Mining Proposal - L47/153, L47/185 and G47/1227 - 30 March 2011 (Revised 31 May 2011)" dated 30 March 2011 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum file No. EARS-MP-30308; • (Reg ID 36008) "Brockman 2 to Brockman 4 Access Road Upgrade" dated 27 June 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-36008; • (Reg ID 36008) "Letter: Mining Proposal Reg ID 36008 - Brockman 2 to Brockman 4 access road project - Miscellaneous Licences 47/141 and 47/153 and General Purpose Lease 47/1225" dated 6 September 2012 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum File No. EARS-MP-36008 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
19-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
20-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment

	Division, DMP.
Tenement No. L47/00159	
Condition No.	**Closure conditions**
6-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.
7-1	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Brockman 2 Project-Construction of Runway End SafetyArea-L47/159(Reg ID20982) " dated 16 December 2008 signed by Alister Conn and retained on Department of Mines and Petroleum File No. E2780/200303 . Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
9-1	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
Tenement No. L47/00160	
Condition No.	**Closure conditions**
11-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Inspector and properly maintain same until the Inspector advises regrowth is self supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.
12-2	The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled: • (Reg. ID 33319) "Brockman 2 - Widening of Existing Access Track to Communication Tower - L47/160" dated 29 November 2011 signed by Genevieve Thompson and retained on Department of Mines and Petroleum file No. EARS-MP-33319; • (Reg ID 38119) "Nammuldi BWT Project-Mining Proposal-G47/1243-3, L47/140 and L47/160" dated 3 April 2013 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-38119 Where a difference exists between the above document and the following conditions, then the following conditions shall prevail.
15-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
16-1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP.
26-1	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence and zone of pit instability.
27-1	On the completion of operations or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.

Tenement No. L47/00161	
Condition No.	**Closure conditions**
13-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
14-2	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Addendum to Mining Proposal No. 5902: Brockman Syncline 4 Project, White Quartz Road Upgrade Mining Proposal - L47/161" dated 4 June 2008, signed by Alistair Conn and retained on Department of Industry and Resources File No. E0024/200502 • "Brockman Syncline 4 Project, White Quartz Road Upgrade Mining Proposal L47/161" (MP 5902) dated 4 December 2007, signed by Alistair Conn and retained on Department of Mines and Petroleum File No. E0024/200502 • Brockman Syncline 4 Project, Addendum to White Quartz Road Upgrade Mining Proposal (MP # 5902) - Addition Borrows Pits L47/161 Reg ID 20821, dated 18 November 2008 signed by Alister Conn and retained on Department of Mines and Petroleum File No. E0024/200502. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
23-1	All topsoil and vegetation being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
Tenement No. L47/00178	
Condition No.	**Closure conditions**
14-4	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Rosella Rail Siding to Brockman 2 Project Rail Upgrade Mining Proposal: Rail Infrastructure (L47/178), Construction of Crest rail siding and Fibre Optic Cable Installation (L47/151), Realignment of Nammuldi Rail Junction and Fibre Optic Cable Installation (L47/207), Powerline and Haul Road realignment (L47/139)" (MP 5889) dated 26 November 2007 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303; • "Wackilina Drainage Upgrade L47/178, Addendum to MP 5889: Rosella Rail Siding to Brockman 2 - Rail Upgrade MP" (Reg ID 20994) dated 18 December 2008 signed by Genevieve Thompson, and email from Genevieve Thompson, dated 18 February 2009 with a subject heading of "Response to DMP Queries: Wackilina Drainage Upgrade on L47/178 (Reg ID 20994)" both retained on Department of Mines and Petroleum File No. E0030/200402; • (MP Reg ID 52815) "Rio Tinto Iron Ore Mining Proposal (RTIO-HSE-0238486) Rail Operations Maintenance of rail Infrastructure Borrow pits L47/151, L47/178, L47/223, L47/49, L47/50" dated 6 October 2014 signed by Fiona Hambidge and retained on Department of Mines and Petroleum File No. EARS-MP-528A5 as Doc ID 3199305; • (MP Reg ID 85102) “NBWT Access Road to Lens EF Facilities” dated 30 January 2020 signed by Sean Savage and retained on Department of Mines, Industry Regulation and Safety File No. EARS-MP-85102 as Doc ID 7141381 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
Tenement No. L47/00184	
Condition No.	**Closure conditions**
13-1	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Industry and Resources and properly maintain same until the Environmental Officer advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
Tenement No. L47/00185	
Condition No.	**Closure conditions**
5-2	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Mining Proposal: Brockman 4 project - Airstrip Upgrade on L47/153 and L47/185" (Reg ID 29059) dated 10 December 2010 signed by Jeremy English and retained on Department of Mines and Petroleum File No. E0422/201001;

	• (Reg. ID: 30308) "Brockman Syncline 4 Project - Upgrade to Airstrip - Mining Proposal - L47/153, L47/185 and G47/1227 - 30 March 2011 (Revised 31 May 2011)" dated 30 March 2011 signed by Grant O'Donoghue and retained on Department of Mines and Petroleum file No. EARS-MP-30308. Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
8-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
10-1	All rubbish and scrap is to be progressively disposed of in a suitable manner, to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. L47/00207	
Condition No.	**Closure conditions**
9-1	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Environmental Officer, Department of Industry and Resources.
18-1	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the District Inspector of Mines; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Industry and Resources and properly maintain same until the Environmental Officer advises regrowth is self supporting; unless the Mining Registrar or Minister responsible for the Mining Act 1978 orders or consents otherwise.
19-1	The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled: • "Rosella Rail Siding to Brockman 2 Project Rail Upgrade Mining Proposal: Rail Infrastructure (L47/178), Construction of Crest rail siding and Fibre Optic Cable Installation (L47/151), Realignment of Nammuldi Rail Junction and Fibre Optic Cable Installation (L47/207), Powerline and Haul Road realignment (L47/139)" (MP 5889) dated 26 November 2007 signed by Alistair Conn and retained on Department of Industry and Resources File No. E2779/200303 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
Tenement No. L47/00647	
Condition No.	**Closure conditions**
3-1	Where surface disturbance activities are proposed on the licence which are not associated with development or construction proposals, the prior written approval of the Environmental Officer, DMP must be obtained before the use of drilling rigs, scrapers, graders, bulldozers, backhoes or other mechanised equipment for the proposed surface disturbance activities. Following approval, all topsoil being removed ahead of operations and separately stockpiled for replacement after backfilling and/or completion of operations.
4-1	The Licensee notifying the holder of any underlying pastoral or grazing lease by telephone or in person, or by registered post if contact cannot be made, prior to undertaking airborne geophysical surveys or any ground disturbing activities utilising equipment such as scrapers, graders, bulldozers, backhoes, drilling rigs; water carting equipment or other mechanised equipment.
9-1	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Environmental Officer, DMP.
21-1	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the Environmental Officer, Department of Mines and Petroleum; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Mines and Petroleum and properly maintain same until the Environmental Officer advises regrowth is self supporting; unless the Minister responsible for the Mining Act 1978 orders or consents otherwise.
22-4	The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled:

	• (Reg ID 48689) "Mining Proposal (RTIO-HSE-0225489) Nammuldi - Silvergrass Overland Conveyor and Infrastructure Corridor L47/647 Hamersley Iron Pty Ltd" dated July 2014 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-48689 as Doc ID 3009215; • (MP Reg ID 53319) "Letter of Intent - Modification to the Layout as presented in the Approved Mining Proposal "Nammuldi - Silvergrass Overland Conveyor and Infrastructure Corridor L47/647" (Reg ID 48689)" dated 3 December 2014 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-53349 as Doc ID 3307930 and 3307929 . • (MP Reg ID 63707) "Letter of Intent - Establishment of Temporary High Grade Ore Stockpiles within the Approved Mine Servicesd Facilities Area - L47/647 (Nammuldi-Silvergrass Overland Conveyor and Infrastructure Corridor)" dated 21 December 2016 signed by Alistair Conn and retained on Department of Mines and Petroleum File No. EARS-MP-63707 as Doc ID 4721633 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
25-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
29-1	On the completion of operations or progressively when possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. L47/00855	
Condition No.	**Closure conditions**
12-1	The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled: • (MP Reg ID 85102) “NBWT Access Road to Lens EF Facilities” dated 30 January 2020 signed by Sean Savage and retained on Department of Mines, Industry Regulation and Safety File No. EARS-MP-85102 as Doc ID 7141381 Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.
15-1	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
16-1	All rubbish and scrap is to be progressively disposed of in a suitable manner.
19-1	On the completion of operations or progressively when possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Resource and Environmental Compliance, Department of Mines, Industry Regulation and Safety.
Tenement No. L47/00880 - Pending	
Tenement No. L47/00948 - Pending	
Tenement No. L47/00958 - Pending	
Tenement No. L47/00959 - Pending	
Tenement No. L47/00961 - Pending	

Mining Act 1978 – Associated Mining Proposal Closure Related Commitments

NOI 5193A	
Section No.	**Closure Related Commitment**
4.7	• All areas disturbed will be rehabilitated upon completion of activates • Borrow pits will be self-draining on closure.
4.9	• Upon completion of activities, all exhausted borrow pits will be rehabilitated in accordance with the current Pilbara Iron Standards
NOI 5193B	
Section No.	**Closure Related Commitment**
N/A	• Hamersley Iron will, as part of the rehabilitation of the proposed borrow pits, construct diversion bund structures on the upslope side of the borrow pits (if they are located on sloping grounds) in order to prevent any cross-land water flows from entering the rehabilitated borrow pits

MP5829	
Section No.	**Closure Related Commitment**
9.2	• Rehabilitation and re-shaping shall endure that natural drainage is re-installed, and compacted areas will be ripped along the contour. Topsoil and vegetation will be respread over areas requiring rehabilitation in accordance with the soil management procedure. • Rehabilitated areas will be monitored for erosion and vegetation growth.
9.3	• The rehabilitation of the camp will involve the removal of all infrastructure and services (to an acceptable standard as required by the EPA). The remaining disturbance footprint will be rehabilitated so as to form a safe, stable landform.
MP 5887	
Section No.	**Closure Related Commitment**
N/A	• All infrastructure, footings and services will be removed to a depth of 1m • Any contaminated materials will be removed and appropriately disposed • Earthen pads and structures will be re-profiled, stabilised and revegetated. • The site will be stabilised, respread, and stockpiled vegetation, topsoil and seeded with native species • Revegetation success will be monitored.
MP 5889	
Section No.	**Closure Related Commitment**
9.2	• Rehabilitation and re-shaping shall ensure that natural drainage is re-installed, and compacted areas will be ripped along the contour. • Topsoil and vegetation will be respread over areas requiring rehabilitation in accordance with the Soil Management Procedure • Rehabilitated areas will be monitored for erosion and vegetation regrowth.
9.3	• The rehabilitation of the railway will involve the removal of all infrastructure and services (to an acceptable standard as required by the EPA). The remaining disturbance footprint will be rehabilitated so as to form a safe, stable landform.
MP 5901	
Section No.	**Closure Related Commitment**
9.2	• Topsoil and vegetation will be respread over areas requiring rehabilitation in accordance with the Soil Management Procedure • Rehabilitated areas will be monitored for erosion and vegetation regrowth. • Areas which will be rehabilitated progressively will include the borrow pits, construction laydown areas, FOC corridor and access tracks.
9.3	• The rehabilitation of the rail spur will be carried out to a standard which is acceptable to the EPA. The remaining disturbance footprint will be rehabilitated so as to form a safe, stable landform.
MP 5902	
Section No.	**Closure Related Commitment**
9.2	• Rehabilitation of all non-permanent areas will be conducted progressively throughout the construction period. Rehabilitation re-shaping shall ensure that natural drainage is re-installed, that rock armouring for erosion protection shall be used where necessary and compacted areas will be ripped along the contour. • Topsoil and vegetation will be respread over areas requiring rehabilitation in accordance with the Soil Management Procedure (see Attachment 14). • Rehabilitated areas will be monitored for erosion and vegetation regrowth. • Areas which will be rehabilitated progressively will include the borrow pits, construction laydown areas, FOC corridor and access tracks.
9.3	• The rehabilitation of the WQR will involve the removal of all infrastructure and services (to an acceptable standard as required by the EPA). The remaining disturbance footprint will be rehabilitated so as to form a safe, stable landform.
Addendum to MP 5902	
Section No.	**Closure Related Commitment**
N/A	• Rehabilitation of the existing White Quartz Road (WQR) for sections that pass-through heritage sites to be undertaken in a progressive manner through construction of the WQR). • Rehabilitation and re-shaping of non-permanent areas will ensure that natural drainage is re-installed, and compacted areas will be ripped along the contour.

	• Topsoil and vegetation will be respread over areas requiring rehabilitation as outlined in the Soil Management Procedures
Addendum to MP 5901 and 5968	
Section No.	**Closure Related Commitment**
"Rehabilitation"	• The company will ensure that where the centreline of the railway is no longer required due to the rail realignment, rehabilitation will be carried out in accordance with the standards outlined in the CEMP. This includes ensuring that natural drainage is re-installed, compacted areas are ripped along the contour and the area is rehabilitated to form a safe, stable landform. • The stockpiled topsoil and vegetation will be respread over areas requiring rehabilitation.
RegID 19471	
Section No.	**Closure Related Commitment**
8.4	• Topsoil will be conserved and reused to establish vegetation on rehabilitated areas along with any cleared vegetation in the nearby borrow pits that have been used for construction along the rail alignment (in similar habitat) to assist with their rehabilitation. • Topsoil management will be carried out in accordance with Management Procedure 5.8 of the CEMP (see attachment 8) and the Company's Soil Management Procedure (see Attachment 15).
9.2	• If rehabilitation of the Powerline is the closure developed option, it will involve the decommissioning of the Powerline and the removal of all infrastructure and services (to an acceptable standard as required by the EPA). • Disturbance footprint will be rehabilitated as to form a safe, stable landform, and a self-sustaining system of native vegetation that is similar in diversity, density, and cover to pre-disturbance conditions and consistent with ongoing land use objectives. Upon completion of construction, compacted surfaces will be appropriately ripped to promote water penetration and the catchment of windblown seed. • Access tracks that are no longer required will be rehabilitated.
RegID 20780	
Section No.	**Closure Related Commitment**
"Rehabilitation"	• On rehabilitation of the project, the road will be rehabilitated. The company will ensure that the rehabilitation will be carried out in accordance with the standards outlined in the CEMP. This includes ensuring that natural drainage is re-installed, compacted areas are ripped along the contour and the area is rehabilitated to form a safe, stable landform. The stockpiled topsoil and vegetation will be respread over areas requiring rehabilitation.
RegID 20821	
Section No.	**Closure Related Commitment**
9.2	• Rehabilitation of all non-permanent areas will be conducted progressively throughout the construction period. This will include the borrow pits and any construction laydown areas that are no longer required • Rehabilitation and re-shaping shall ensure natural drainage is re-installed, compacted areas are ripped along the contour. Topsoil and vegetation will be respread over areas requiring rehabilitation in accordance with the soil management procedure • Rehabilitated areas will be monitored for erosion and vegetation growth
9.3	• Rehabilitation of the White Quartz Road will involve the removal of all infrastructure and services (to an acceptable standard as required by the EPA). The remaining disturbance footprint will be rehabilitated so as to form a safe, stable landform.
RegID 20982	
Section No.	**Closure Related Commitment**
"Rehabilitation and Closure"	• The rehabilitation of the airstrip and will include the removal of the perimeter fence and the re-shaping of the airstrip if required to re-instate natural drainage. All compacted areas will be ripped along the contour, and stockpiled topsoil and vegetation will be respread. Rehabilitated areas will be monitored for erosion and vegetation regrowth.
RegID 20994	
Section No.	**Closure Related Commitment**
"Rehabilitation"	• Rehabilitation and re-shaping will ensure that natural drainage is re-established, compacted areas are ripped along the contour, and the area is rehabilitated to form a safe, stable landform. • The stockpiled topsoil and vegetation will be respread over areas requiring rehabilitation.

RegID 21849	
Section No.	**Closure Related Commitment**
"Rehabilitation"	On rehabilitation of the Project, the Powerline infrastructure will be removed, and the remaining disturbance footprint will be rehabilitated. The company will ensure the rehabilitation will be carried out in accordance with the standards outlined in the CEMP. This includes ensuring that natural drainage is re-installed, compacted areas are ripped along contour, and the area is rehabilitated to form a safe, stable landform. The stockpiled topsoil and vegetation will be respread over areas requiring rehabilitation.
RegID 27076	
Section No.	**Closure Related Commitment**
	Rehabilitation re-shaping as a minimum shall ensure: • Natural drainage is re-instated. • The final profile of a constructed drainage line should consist of a flat base and sloped banks. • Rock armouring shall be used where necessary to prevent erosion. • Windrows should be constructed on the contour every 50m on steep sloping surfaces to prevent large sheet water flows. • Areas which are very compacted shall be ripped twice to a depth of 0.5m metres along the contour. A three-tyne attachment has been found to be most effective. • For roads and other access tracks, if a treatment such as a salt or acid base dust suppressant has been • used then clean fill may be required over the surface so that plant germination is not suppressed. • Roads should be ripped along the contours to minimise erosion potential • Rehabilitated areas will be inspected and approved as satisfactory prior to the demobilisation of the contractor. • Rehabilitated areas will be monitored for erosion, vegetation regrowth and weed establishment.
RegID 29059	
Section No.	**Closure Related Commitment**
"Rehabilitation and Closure"	• The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour. • If decommissioning is required all the infrastructure including the aerodrome and perimeter fence will be removed. Bituminised surfaces will be broken up and removed to an appropriate disposal site. • Rehabilitated areas will be monitored for erosion and vegetative growth.
RegID 30308	
Section No.	**Closure Related Commitment**
8.0	• The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour. • Borrow pits will be designed to be free draining through appropriate location in the landscape and implementation of drainage controls (such as upslope diversion banks) if necessary. Following rehabilitation, no ponding should occur within the borrow pit, with the pit floor constructed with a fall of approximately 1:300 where practicable. • During rehabilitation the pit walls of the borrow pit will be battered to an angle of approximately 18 degrees or less, and the final pit contours and any drainage control structures will be constructed to blend with the surrounding landscape. • Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow ripping along the contour perpendicular to water flow. Access roads will be ripped in the final stage of rehabilitation. • Historic disturbance on tenements will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation • Rehabilitated areas will be monitored in accordance with IEMS Vegetation Monitoring Procedure – Rehabilitation. Transects will be established within • rehabilitated areas and an associated control site to monitor parameters including species composition, number, and % cover. • If decommissioning is required all the infrastructure including the aerodrome and perimeter fence will be removed. Bituminised surfaces will be broken up and removed to an appropriate disposal site. • Rehabilitated areas will be monitored for erosion and vegetative growth.

RegID 31367	
Section No.	**Closure Related Commitment**
8.0	Progressive rehabilitation of borrow pits. • Borrow pits will be designed to be free draining through appropriate location in the landscape and implementation of drainage controls (such as upslope • diversion banks) if necessary. Following rehabilitation, no ponding should occur within the borrow pit, with the pit floor constructed with a fall of approximately 1:300 where practicable. • If required, appropriately sized diversion banks will be constructed on the upslope side of borrow pits. • During rehabilitation the pit walls of the borrow pit will be battered to an angle of approximately 18o or less, and the final pit contours and any drainage control structures will be constructed to blend with the surrounding landscape. • Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow ripping along the contour perpendicular to water flow. Access roads will be ripped in the final stage of rehabilitation. • Historic disturbance on tenements will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation • Rehabilitated areas will be monitored in accordance with IEMS Vegetation Monitoring Procedure – Rehabilitation. Transects will be established within rehabilitated areas and an associated control site to monitor parameters including species composition, number, and % cover. • If decommissioning is required, all infrastructure including accommodation units and other village facilities will be removed. • Bituminised surfaces will be broken up and removed to an appropriate disposal site. Disturbed areas will be shaped to re-establish the natural landform and drainage patterns, stockpiled topsoil and vegetation will be returned, and then areas will be ripped or scarified (dependent on degree of compaction) on the • contour. • Rehabilitated areas will be monitored for erosion and vegetative regrowth.
RegID 32690	
Section No.	**Closure Related Commitment**
8.0	• Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than 1 metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting. • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring. • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. • Completion criteria are agreed with stakeholders as closure approaches • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria. • Rehabilitation of borrow pits will be carried out in accordance with the Borrow Pit Specifications and Management Procedure, including the following management actions. • Borrow pits will be designed to be free draining through appropriate location in the landscape and implementation of drainage controls (such as upslope 21 diversion banks) if necessary. • Following rehabilitation, no ponding should occur within the borrow pit, with the pit floor constructed with a fall of approximately 1:300 where practicable. • If required, appropriately sized diversion banks will be constructed on the upslope side of borrow pits. • During rehabilitation the pit walls of the borrow pit will be battered to an angle of approximately 18o or less, and the final pit contours and any drainage control structures will be constructed to blend with the surrounding landscape. • Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow ripping along the contour perpendicular to water flow. Access roads will be ripped in the final stage of rehabilitation. • Historic disturbance on tenements will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation

	• Rehabilitated areas will be monitored in accordance with IEMS Vegetation Monitoring Procedure – Rehabilitation. Transects will be established within rehabilitated areas and an associated control site to monitor parameters including species composition, number, and % cover. • The final Rehabilitation and Closure Plan for the Brockman Syncline 4 Project will address options for closure of the Brockman fuel hub facility, including decommissioning and rehabilitation if no longer required for other projects or land users in the area. If decommissioning is required, all infrastructure including fuel storage tanks, administration buildings, unloading/loading facilities and other associated infrastructure will be removed. • Bituminised surfaces will be broken up and removed to an appropriate disposal site. Disturbed areas will be shaped to re-establish the natural landform and drainage patterns, stockpiled topsoil and vegetation will be returned, and then areas will be ripped or scarified (dependent on degree of compaction) on the contour. • Rehabilitated areas will be monitored for erosion and vegetative regrowth.
RegID 33319	
Section No.	**Closure Related Commitment**
"Decommissioning and Rehabilitation"	• Subject to stakeholder negotiation above ground installations are removed and materials recycled or reused where practicable • Infrastructure that is located more than 1 metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting. • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility • Rehabilitation is undertaken to make the land compatible with the agreed final land use • Considerations is given to the surface water drainage impacts and steps taken to ensure appropriate flow following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species • Completion criteria are agreed with stakeholders as closure approaches • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria.
RegID 35781	
Section No.	**Closure Related Commitment**
8.0	• Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than 1 metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting. • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring. General principles for rehabilitation include: o Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. o Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. o Consideration is given to the surface water drainage impacts, and steps o taken to ensure appropriate flows following closure. o Compacted soils are ripped in order to improve rehabilitation outcomes. o Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. o Completion criteria are agreed with stakeholders as closure approaches; and o Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria. • The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour. • The final Rehabilitation and Closure Plan for the Brockman Syncline 4 Project will address options for closure of the Brockman accommodation village, including closure, removal and rehabilitation if no longer required for other projects or land users in the area. • If removal is required, all camp infrastructure including accommodation units, concrete, verandas, culverts, and other associated infrastructure will be removed. • Bituminised surfaces will be broken up and removed to an appropriate disposal site.

	• Disturbed areas will be shaped to re-establish the natural landform and drainage patterns, stockpiled topsoil and vegetation will be returned, and then areas will be ripped or scarified (dependent on degree of compaction) on the contour. • Rehabilitated areas will be monitored for erosion and vegetative regrowth.
RegID 36008	
Section No.	**Closure Related Commitment**
8.0	• Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than 1 metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting. • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring. • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. • Completion criteria are agreed with stakeholders as closure approaches. • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria.
Letter RE RegID 36008	
Section No.	**Closure Related Commitment**
8.0	• Rehabilitation of borrow pits will be carried out in accordance with the Borrow Pit Specifications and Management Procedure, including the following management actions. o Borrow pits will be designed to be free draining through appropriate location in the landscape and implementation of drainage controls (such as upslope diversion banks) if necessary. Following rehabilitation, no ponding should occur within the borrow pit, with the pit floor constructed with a fall of approximately 1:300 where practicable. o If required, appropriately sized diversion banks will be constructed on the upslope side of borrow pits. o During rehabilitation the pit walls of the borrow pit will be battered to an angle of approximately 18o or less, and the final pit contours and any drainage control structures will be constructed to blend with the surrounding landscape. o Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow o ripping along the contour perpendicular to water flow. Access roads will be ripped in the final stage of rehabilitation. o Historic disturbance on tenements will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation; and o Rehabilitated areas will be monitored in accordance with HSEQ Vegetation Monitoring Procedure – Rehabilitation. Transects will be established within rehabilitated areas and an associated control site to monitor parameters including species composition, number, and % cover. • The final Rehabilitation and Closure Plan for the Brockman Syncline 4 Project will address options for closure of the Brockman 2 to Brockman 4 road, including closure, removal and rehabilitation if no longer required for other projects or land users in the area. • If removal is required, all road infrastructure including bitumen, barriers, culverts, and other associated infrastructure will be removed. • Bituminised surfaces will be broken up and removed to an appropriate disposal site. • Disturbed areas will be shaped to re-establish the natural landform and drainage patterns, stockpiled topsoil and vegetation will be returned, and then areas will be ripped or scarified (dependent on degree of compaction) on the contour. • Rehabilitated areas will be monitored for erosion and vegetative regrowth.
RegID 38119	
Section No.	**Closure Related Commitment**
7.2	The general aims of rehabilitation works will be to: • Remove surface structures and near surface buried services • Stabilise the land surface such that it is safe, stable, and non-polluting

	• Re-establish self-sustaining vegetation that is compatible with the planned end land uses and comparable to the surrounding or pre-existing vegetation • Minimise adverse effects on the environmental values of surrounding areas, for example through changes in surface water drainage or weed infestation.
7.2.1	• Rehabilitation will include earthworks to ensure that natural drainage is reinstated where possible, and compacted areas are ripped along the contour. • Topsoil and vegetative material will be respread over areas requiring rehabilitation in accordance with the Soil Resource Management Procedure (Appendix 11) and Management Procedure 5.23 of the CEMP (Appendix 4). • Rehabilitated areas will be monitored for vegetation regrowth, and performance. • Rehabilitation of all non-permanent areas will be conducted progressively throughout and at the completion of the construction period and will ensure that all landforms at the completion of construction are left safe, stable, and non-polluting. Areas to undergo progressive rehabilitation will include borrow pits, temporary facilities and any construction laydown areas that are no longer required for permanent use.
7.2.2	The removal of infrastructure at closure will be staged and will proceed through the following steps: • The final supernatant pond would progressively evaporate after waste fines deposition has ceased. • The waste fines surface would be allowed to dry until it has sufficient strength to provide access. • The waste fines distribution pipelines will be removed from the embankment and southern area. • The decant pump and associated electrical and mechanical infrastructure will be removed. • The decant tower will be backfilled with coarse rock to the surface of the causeway. A portion of the decant causeway will be lowered so water can pass around the tower in case the rockfill becomes blocked. This will minimise the potential for water ponding back towards the embankment. • The final operating spillway would be cut to a lower level, within in-situ rock, to form the closure spillway at the same location. The level will be confirmed based on the beach slope obtained so that the facility will remain predominantly water shedding. • The underdrainage system would continue to be operated intermittently until the quantity of water reduces. • No set duration can be specified, but typically this would be in the order of 6 – 12 months, following final deposition. After the flow reduces, the underdrainage pump will be removed and the underdrainage riser pipe top will be welded closed. • The embankment external faces are to be rehabilitated if not already done so as part of the final embankment stage works earlier. • The embankment external face will be rock armoured to the 1:1,000 ARI flood level, if not already undertaken as part of the final embankment stage works. • The cover design placed over the waste fines surface and topsoil revegetation. • The monitoring bores will continue to be monitored post-deposition of waste fines, as required.
7.2.3	Final rehabilitation works will generally include: • closure, re-profiling, and rehabilitation of borrow pits, if not already undertaken. • removal of temporary surface infrastructure and near surface buried services, re-profiling of disturbed surface, re-spreading with stockpiled topsoil, contour ripping and revegetation. • closure of access roads and tracks where no longer required, re-spreading with stockpiled topsoil, contour ripping and revegetation. • closure of the landfill, re-profiling of the disturbed surface, re-spreading with stockpiled topsoil, contour ripping and revegetation. • closure of the landfarm, treatment of any contamination, re-profiling of the disturbed surface, re-spreading with stockpiled topsoil, contour ripping and revegetation. • closure of the explosive's facility, treatment of any contamination, re-profiling of the disturbed surface, respreading with stockpiled topsoil, contour ripping and revegetation • the re-establishment of self-sustaining vegetation that is compatible with the planned end land uses and comparable to the surrounding or pre-existing vegetation.
RegID 41939	
Section No.	**Closure Related Commitment**
7.6	General principles for decommissioning of infrastructure include: • Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than one metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting; and • • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring.

7.7	General principles for the rehabilitation of the Project will include: • Be undertaken in accordance with the requirements of Ministerial Statement 925 (Appendix 2). • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. • Completion criteria are agreed with stakeholders as closure approaches • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria. • The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour so as to form a safe, stable landform.
RegID 48165	
Section No.	**Closure Related Commitment**
6.4	General principles for rehabilitation include: • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. • Completion criteria are agreed with stakeholders as closure approaches. • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria. • Rehabilitation of any disturbed areas that not required for ongoing operation of the Project will be conducted progressively or after the completion of construction activities in accordance with the Rio Tinto HSEQ Rehabilitation Handbook. This will include temporary construction disturbance or other disturbed areas that are no longer required. • The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour. Rehabilitation of borrow pits will be carried out in accordance with the Borrow Pit Specifications and Management Procedure, including the following management actions: • Progressive rehabilitation of borrow pits. • Borrow pits will be designed to be free draining through appropriate location in the landscape and implementation of drainage controls (such as upslope diversion banks) if necessary. • If required, appropriately sized diversion banks will be constructed on the upslope side of borrow pits. • During rehabilitation the pit walls of the borrow pit will be battered and the final pit contours and any drainage control structures will be constructed to blend with the surrounding landscape. • Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow ripping along the contour perpendicular to water flow. Access roads will be ripped in the final stage of rehabilitation. • Historic disturbance on tenements will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation. • Rehabilitated areas will be monitored in accordance with HSEQ Rehabilitation Monitoring Procedure. • The final Rehabilitation and Closure Plan for the Rio Tinto rail network will address options for closure of this Project, including decommissioning and rehabilitation if no longer required for other projects or land users in the area. • If decommissioning is required, all infrastructure including the siding and other associated infrastructure will be removed. Bituminised surfaces will be broken up and removed to an appropriate disposal site. • Disturbed areas will be shaped to re-establish the natural landform and drainage patterns, stockpiled topsoil and vegetation will be returned, and then areas will be ripped or scarified (dependent on degree of compaction) on the contour.

	• Rehabilitated areas will be monitored for erosion and vegetative regrowth.
RegID 48689	
Section No.	**Closure Related Commitment**
7.6	General principles for decommissioning of infrastructure include: • Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than one metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring.
7.7	General principles for the rehabilitation of the Project will include: • Be undertaken in accordance with the requirements of Ministerial Statement 925 (Appendix 2). • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. • Completion criteria are agreed with stakeholders as closure approaches; and • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria. • The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour so as to form a safe, stable landform.
RegID 52815	
Section No.	**Closure Related Commitment**
6.1	Borrow pits, including associated disturbance, will be rehabilitated progressively once they are no longer required. • Historical disturbance on the tenement will be assessed and rehabilitated where required. • Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow ripping along the contour perpendicular to water flow. • Access roads will be ripped in the final stage of rehabilitation; Historic disturbance on the tenement will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation; and • Rehabilitated areas will be monitored in accordance with the HSEQ Vegetation Monitoring Procedure – Rehabilitation. Transects will be established within rehabilitated areas and an associated control site to monitor parameters including species composition, number, and percent cover.
RegID 53349	
Section No.	**Closure Related Commitment**
7.6	General principles for decommissioning of infrastructure include: • Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than one metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting; and • • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring.
7.7	General principles for the rehabilitation of the Project will include: • Be undertaken in accordance with the requirements of Ministerial Statement 925 (Appendix 2). • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for

	• each species. • Completion criteria are agreed with stakeholders as closure approaches; and • Post closure monitoring programmes are developed and implemented to demonstrate progress towards, and compliance with completion criteria. • The natural landform and drainage patterns will be re-established, stockpiled topsoil and vegetation will be returned, and the area ripped or scarified (dependent on degree of compaction) on the contour so as to form a safe, stable landform.
RegID 53685	
Section No.	**Closure Related Commitment**
8.0	General principles for decommissioning of infrastructure include: • Subject to stakeholder negotiation, above ground installations are removed and materials recycled or reused where practicable. • Infrastructure that is located more than 1 metre below the final surface level (e.g., footings, cables) remain in-situ following closure provided they are non-polluting. • Any infrastructure with the potential to be a source of contamination after closure is managed to prevent contamination from occurring. • General principles for rehabilitation include: • Where applicable and appropriate, contaminated soils are removed and treated in a landfarm facility. • Rehabilitation is undertaken so as to make the land compatible with the agreed final land use. • Consideration is given to the surface water drainage impacts, and steps taken to ensure appropriate flows following closure. • Compacted soils are ripped in order to improve rehabilitation outcomes. • Rehabilitation is conducted with seeds collected from a provenance zone appropriate for each species. • Completion criteria are agreed with stakeholders as closure approaches; and • Post closure monitoring programmes are developed and implemented to Demo Rehabilitation of borrow pits will be carried out in accordance with the *Borrow Pit Specifications and Management Procedure*, including the following management actions. • Deep ripping of compacted areas within the borrow pit will be undertaken, followed by respreading of stockpiled topsoil and vegetation, and shallow ripping along the contour perpendicular to water flow. • Access roads will be ripped in the final stage of rehabilitation. • Historic disturbance on tenements will be assessed and rehabilitated where required to achieve adequate surface drainage control and revegetation; and • **I**f removal is required, all road infrastructure including bitumen, barriers, culverts, and other associated infrastructure will be removed. Bituminised surfaces will be broken up and removed to an appropriate disposal site • Disturbed areas will be shaped to re-establish the natural landform and drainage patterns, stockpiled topsoil and vegetation will be returned, and then areas will be ripped or scarified (dependent on degree of compaction) on the contour • Rehabilitated areas will be monitored for erosion and vegetative regrowth.
RegID 85102	
Section No.	**Closure Related Commitment**
6.1	• Should the State not require the Project at the time which the road is to be decommissioned; the rehabilitation of the Project area will be done to ensure that the landform at the completion of the rehabilitation activities is considered to be safe, stable and the revegetation is reflective of the surrounding non-disturbed vegetation and is compatible with the final land use. • The borrow pit and all temporary areas (laydown areas, fuel storage) will be rehabilitated as soon as construction works are complete (expected Q4 2020). The turkeys nest dam will remain until such time as the extension of the road in ML4SA is completed (estimated 2024). The nature of the road itself is such that there will be no progressive rehabilitation, due to the requirement to maintain the area to be free of vegetation for the life of the road along with the control of the vegetation control areas. • Topsoil excavated during the construction of the road will be pushed aside and windrowed for future rehabilitation

Lease No. G848907 (Brockman Railway)	
Condition No.	**Closure conditions**
Covenant 1 (9)	That the Company upon the determination of the lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated herein or in the Agreement.
Covenant 3 (2)	That subject to the Agreement all rights in the demised premises (other than those expressly or impliedly granted under this lease) are reserved to Us, Our heirs and successors and Our Minister for Lands.

Lease No. G848898 (Brockman campsite and services)	
Condition No.	**Closure conditions**
Covenant 1 (9)	That the Company upon the determination of the lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated herein or in the Agreement.
Covenant 3 (2)	That subject to the Agreement all rights in the demised premises (other than those expressly or impliedly granted under this lease) are reserved to Us, Our heirs and successors and Our Minister for Lands.

Lease No. G848909 (Brockman communications tower)	
Condition No.	**Closure conditions**
Covenant 1 (9)	That the Company upon the determination of the lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated herein or in the Agreement.
Covenant 3 (2)	That subject to the Agreement all rights in the demised premises (other than those expressly or impliedly granted under this lease) are reserved to Us, Our heirs and successors and Our Minister for Lands.

Lease No. G848902 (Brockman access road)	
Condition No.	**Closure conditions**
Covenant 1 (9)	That the Company upon the determination of the lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated herein or in the Agreement.
Covenant 3 (2)	That subject to the Agreement all rights in the demised premises (other than those expressly or impliedly granted under this lease) are reserved to Us, Our heirs and successors and Our Minister for Lands.

Lease No. N050438 (Hamersley Pastoral Station) – underlies Nammuldi tenure	
Condition No.	**Closure conditions**
5.1b	The lessee must not use the land for any other purpose unless such use is authorised by a permit or any other Law.
7.1b	The lessee must not cause, or permit the lesee's agents to cause and contamination, pollution or environmental harm to occur in, on or under the Land or to the surrounding area, and if any contamination, pollution, material environmental harm or serious environmental harm is caused by the lessee or the lessee's agents, the lessee must give notice of it to the lessor and must minimise, contain and remediate and resultant damage and harm to the reasonable satisfaction of the lessor.
11.1b	On the expiration or earlier determination of this lease, the lessee must: a) surrender peaceably and yield up the land and all lawful improvements in accordance with section 114 of the Land Administration Act to the Minister;

(i) clean and free from any rubbish caused by the lessee or the lessee's agents to the minister's satisfaction and (ii) in a state of good repair and condition consistent with compliance by the lessee with the Land Administration Act and the provisions of this lease;

b) remove all fixtures or any other property, not being lawful improvements required to be yielded up under subclause (a), from the land and make good any damage caused by the removal to the Minister's satisfaction; and

c) remove all stock from the land.

Environmental Protection Act 1986

Native Vegetation Clearing Permit CPS 2444/4

Condition No.	Closure conditions
9	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate, and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land: and (ii) laying the vegetative material and topsoil retained under Condition 9(a). c) remove all fixtures or any other property, not being lawful improvements required to be yielded up under subclause (a), from the land and make good any damage caused by the removal to the Minister's satisfaction; and (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
10	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 9 of this Permit: (i) The location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) A description of the revegetation and rehabilitation activities undertaken; and (iii) The size of the area revegetated and rehabilitated (in hectares).

Native Vegetation Clearing Permit CPS 2446/4

Condition No.	Closure conditions
10	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) ripping the ground on contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 10(a) on the cleared area.

	c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 10(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 10(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
11	Records to be kept c) In relation to the revegetation and rehabilitation of areas pursuant to Condition 10 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) the size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 3233/3	
Condition No.	**Closure conditions**
8	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) ripping the ground on contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 8(a) on the cleared area. c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 8(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 8(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres of the area cleared.*
9	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 8 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) the size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 3915/2	
Condition No.	**Closure conditions**
5	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.

	b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 5(a). c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 5(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 5(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 100 kilometres of the area cleared.*
6	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 5 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) The size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 4549/4	
Condition No.	**Closure conditions**
7	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) ripping the ground on contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 7(a) on the cleared area. c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 7(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 7(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
8	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 7 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) the size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 4569/1	
Condition No.	**Closure conditions**

5	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 5(a). c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 5(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 5(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 100 kilometres of the area cleared.*
6	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 5 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) The size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 4712/2	
Condition No.	**Closure conditions**
8	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) ripping the ground on contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 8(a) on the cleared area. c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 8(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 8(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
9	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 8 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and

	(iii) the size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 4771/1	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 100 kilometres of the area cleared.*
10	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 9 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) The size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 5928/2	
Condition No.	**Closure conditions**
7	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) ripping the ground on contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 7(a) on the cleared area. c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 7(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 7(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
8	Records to be kept

	b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 7 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) the size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 6048/2	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
10	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 9 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) The size of the area revegetated and rehabilitated (in hectares).
Native Vegetation Clearing Permit CPS 6961/4	
Condition No.	**Closure conditions**
12	Retain and spread vegetative material and topsoil The permit holder shall: a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 12(a). c) Within 4 years of undertaking revegetation and rehabilitation in accordance with Condition 12(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 12(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by

	deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to preclearing vegetation types in that area and ensuring only local provenance* seeds and propagating material are used. **Local provenance means native vegetation seeds and propagating material from natural sources within 200 kilometres and the same Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the area cleared.*
13	Records to be kept b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 12 of this Permit: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Position System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) The size of the area revegetated and rehabilitated (in hectares).

Traditional Owner Agreements

Regional Framework Deed Regional Standards	
Reference	**Closure conditions**
Life of Mine Planning	Rio Tinto: a) will establish a forum for each Traditional Owner group made up by the LIC members and Rio Tinto representatives involved in the implementation of the regional standards; b) will meet with the forum twice a year, at the same time as the LIC and Rio Tinto will be responsible for convening the forum. Both parties must safeguard information that is commercially or culturally sensitive; c) must report at the forum on matters identified in each regional standard and on agreed matters relating to the development and operation of the Pilbara Iron Ore Business; d) must be provided by the Traditional Owner group with any concerns, feedback, submissions and recommendations as early as possible, which are consistent with development stages and agree to the use of this information by Rio Tinto; e) will consult with the Traditional Owner group through the forum about the development and implementation of Rio Tinto's community plans; and f) will, if requested through the forum, approach the State Government with Traditional Owner group to discuss retention and maintenance of infrastructure it does not wish to retain once mining finishes.
Land Access	Rio Tinto: g) must grant access to Traditional Owner group members and their immediate families access to Rio Tinto Managed Land; h) may limit or refuse access to Managed Land for safety and/or operational reasons; i) may, acting reasonably, declare an area of Managed Land to be Designated Areas where access is not permitted for reasons of safety or reasonable operational requirements which are unlikely to change in a period of six months or more; j) must provide Traditional Owner groups' Local Aboriginal Corporation (LAC) with plans that identify Designated Areas; k) where Rio Tinto subleases a pastoral lease, it must ensure that the sub-lessee is subject to this standard such that the Traditional Owner group concerned will maintain their access to the area; and l) where a Traditional Owner group holds native title in relation to a pastoral lease that is Managed Land, but not covered by a mining lease, the Group may elect to rely upon their determined native title rights and interest to access the pastoral lease.
Constructive Obligations	
Life of Mine Planning	Following concerns raised by Wintawari Guruma Aboriginal Corporation (WGAC) in 2020, Rio Tinto revised the Silvergrass East mine plan to remove the need to disturb land on the northern side of Narraminju (Caves Creek) for the purpose of mineral waste dumping. Waste dumps will be constructed during operations on the Southern side of the creek directly adjacent to current operations. In addition, the proposed Narraminju diversion at Silvergrass East Pit 1 has been removed from the mine plan.

Appendix 4: Brockman Operation Stakeholder Consultation Register

Summary of closure-related stakeholder consultation relevant to the 2022 Brockman Syncline Mine Closure Plan

Site	Date	Communication Topic	Topics / Issues Raised	Proponent Response / Outcome
Department of Water and Environmental Regulation (DWER) – Environmental Projection Authority (EPA) Services				
Brockman 2 Nammuldi	3/07/2017	Acceptance of the Brockman 2 Nammuldi closure plan to satisfy Conditions of Ministerial Statements 131, 867, and 925	The Brockman 2 Nammuldi Closure Plan was considered to satisfy Condition 4 of MS 131, condition 10-1 of MS 867, and condition 10-1 of MS 925 as the current closure plan.	N/A
All	24/10/2017	Closure planning timeframes	Overview provided of closure plans that Rio Tinto is currently working on in 2017 and planning for 2018 to either support approvals in process, for compliance purposes or to meet commitments made to the Department of State Development in 2016 to submit closure plans for all operations over a three-year period. These include: - Silvergrass East - Hope Downs 1 and Hope Downs 4 - Mesa A and Mesa J hubs - Paraburdoo - Tom Price - Brockman 4 - Eastern Range - Channar	N/A
Brockman 4 Revised	22/12/2017 23/02/2018 15/03/2018	Submission of 2017 BS4 Closure Plan	DWER provided feedback on the submission of the BS4 Mine Closure Plan. They required additional information to be included and some edits made. Comments were in the area of completion criteria, PAF and fibrous materials management, ground water recovery and progressive rehabilitation.	Proponent acknowledged the feedback from DWER and provided a response addressing each item. Where information was available it was provided and an updated closure plan submitted with the response to each comment.
Brockman 4 Marra Mamba	29/03/2018	Referral	Formal referral of the Brockman Syncline 4 Project under Section 38 of the *Environmental Protection Act* 1986.	N/A
Brockman 4 Revised	29/03/2018	Acceptance of the Brockman 4 Closure Plan to satisfy Condition 10 of MS717	The Brockman 4 Closure Plan was considered to satisfy Condition 6 of MS1000 as the current closure plan.	N/A
Silvergrass East	10/05/2018	2017 Silvergrass East Closure Plan	DWER water team undertook a site familiarisation visit to the Silvergrass East Operations and Palm Springs.	Rio Tinto provided an overview of the operation and visited Palm Springs and the Whale Tooth areas. The visit was undertaken with support from Hydrogeology, Environment and Rehabilitation and Closure teams. Discussions were held regarding conceptual groundwater modelling and monitoring programs, Environmental and Groundwater Dependant Vegetation monitoring programs and rehabilitation and closure landforms. Discussions around the closure plan feedback were also held. A suggestion was made to have a follow up meeting after the response to the DWER closure plan comments were finalised. Rio Tinto offered the additional meeting however not meeting date has been confirmed via DWER water licencing teams.
Silvergrass East	9/03/2019	2017 Silvergrass East Closure Plan	DWER EPA Services provided comment following review of the 2017 Silvergrass East Closure Plan.	Rio Tinto provided an interim response to DWER on the 4th of May (RTIO-HSE-0325477) and additional feedback addressing all items in RTIO-HSE-0324153. A revised Closure plan was also submitted with the response. Rio Tinto confirmed its commitment to meet all project approval commitments. Refinements to completion criteria and objectives were amended following the feedback. Additional detail was provided regarding the relationship between the Brockman 2 Nammuldi and Silvergrass East Closure plans and why they were managed separately. Commitments to increase the level of detail as the closure plan is refined over time was proposed.
All	11/06/2019	Closure Plan requirements to support Part IV Environmental Approvals	Following informal discussion and support with DMIRS, Proponent met with DWER to discuss closure plan requirements to support Part IV environmental approvals. Currently Closure plans are being prepared to support Part IV environmental review documents, this process can result in additional workload from both proponent and regulator perspective with additional closure plans being prepared and reviewed from a compliance and approval submission timeframe. The proponent proposes to maintain 3 yearly closure plan updates for all sites irrespective of the approvals in progress. Environmental Review documents will be supported by a brief closure strategy document which will detail the key closure considerations for the site, proposed strategies, conceptual criteria and alignment with existing closure plans. The existing closure plans will be appended to the closure strategy/ERD as supporting information. Support for this process was provided by DWER Environmental Impact Assessment North Manager.	Peter Tapsell from DWER confirmed his support following the discussion.
Brockman Syncline Proposal	18/07/2019	Referral	Formal referral of the Brockman Syncline Proposal under Section 38 of the *Environmental Protection Act* 1986.	N/A
Brockman Syncline Proposal	06/08/2019	2019 MCP scope to support Part IV expansion	Rio Tinto outline the scope of the 2019 MCP update and alignment with existing compliance MCP submission schedule, in the context of an approach proposed to submit closure management strategies to support PIV referrals. The position of the business at that time in regard to developing the closure approach for proposed areas was presented.	N/A
All	12/08/2019	Compliance closure planning schedule and Brockman Syncline Proposal	Formal request to DWER sent to amend the closure plan schedule for operations within the referred Brockman Syncline Hub Proposal. Rio Tinto proposed to waive the requirement for Rio Tinto to submit the scheduled Mine Closure Plan updates for Brockman 2 Nammuldi, Brockman 4 and Silvergrass East operations to DWER in 2020 on the grounds that the Brockman Hub has been referred and a hub-wide Mine Closure Plan, encompassing all existing and future deposits, will instead be submitted per the requirements of the consolidated Ministerial Statement, should the proposal be approved.	DWER offered official support on 19/09/2019 to not submit the Brockman compliance closure plans and instead cover them in the GBO Hub Closure plan submission undertaken to support the Part IV.
Brockman Syncline Proposal	01/11/2019	Brockman Syncline Proposal Environmental Scoping Document (ESD)	Draft ESD submitted to OEPA for review and comment.	N/A
Silvergrass East	22/03/2020	2018 resubmission of Silvergrass East closure plan	Approval of the Silvergrass East Closure Plan submitted in May 2018 to the DWER.	N/A

Site	Date	Communication Topic	Topics / Issues Raised	Proponent Response / Outcome
Brockman Syncline Proposal	09/09/2020	Developing pit void closure outcomes for the Brockman Syncline Proposal – a risk-based approach	The approach to developing a backfill strategy for proposed pit voids was presented, with detail regarding the risk-based steps involved, and the technical work completed to date.	N/A
Office of the Environmental Protection Authority				
Brockman Syncline Proposal	1/11/2019	Brockman Syncline Proposal Environmental Scoping Document (ESD)	Draft ESD submitted to OEPA for review and comment.	N/A
Department of Mines, Industry Regulation and Safety (DMIRS)				
Greater Nammuldi	2017	DMIRS Inspection 2017	<u>Rehabilitation</u> It was positive to see rehabilitation at the Pit 6 waste dump occurring at the time of the inspection. In addition, Rio Tinto staff advised that a process was being developed for waste rock to be dumped in accordance with a rehabilitation design during operations. The proactive approach being developed for integrating closure design with operational activities is a very positive step towards achieving desirable mine closure results and is commended by DMIRS. The Pit 6 Waste Dump also had an area where waste rock had been pushed over the top of a crest, leaving the material in a difficult position to rehabilitate, as well as being at angle of repose. It is understood that closure options for this material are still being considered. DMIRS is available to provide comment on any proposed designs. The concave slope trial was also inspected. It was noted that vegetation is becoming established however, some erosion gullies are present across the slope face. It appeared as though many of the gullies were self-armouring. It was positive to hear that these gullies continue to be monitored and that remedial activities will be conducted where self-armouring does not occur. <u>Potentially Acid Forming (PAF) Material Management</u> To date, PAF material has predominantly been encountered at the BS2 pit, where PAF waste was extracted and some PAF was left *in situ* in the pit wall. Post-mining backfill of the pit has now occurred and no evidence of PAF pit wall exposures were observed during the inspection. The PAF in-pit waste dump was also inspected and no evidence of acid and metalliferous drainage was observed. <u>Preparedness for Closure</u> A review of the sites preparedness for closure has been undertaken, with a score sheet against key criteria included as Appendix 2 of this report. The score sheet is generally assessed with regard to the Mine Closure Plan (MCP), Annual Environmental Review (AER) and the site inspection. Over the past 12 months DMIRS has noticed a shift in Rio Tinto's approach to closure, with closure specialists advising that going forward, closure will be implemented during the operational phase through the use of dumping waste in accordance with a rehabilitation design. This shift in approach to closure is commended by DMIRS.	N/A
Silvergrass East	21/05/2018	2017 Silvergrass East Closure Plan	Provided an overview of the SGE Closure plan and discussed aspects of the feedback provided via DWER. - Key Closure issues - Requirement for consultation requested by DWER - Proposed post-mining and closure landforms - Relationship between B2N and SGE closure plans - Completion criteria (conceptual for this operations age)	DMIRS were satisfied with the overview and the proposed approach for the SGE Closure plan. They did not have major concerns following submission of the plan and their comments were regarded as areas to consider further refinement for the next closure plan. They were not aware of DWERs directive to undertake immediate consultation. Their main areas of feedback related to completion criteria amendments and increased monitoring details. DMIRS provided a copy of their feedback comments which was provided to DWER. DMIRS agreed an ongoing regular forum to discuss rehabilitation and closure topics would be beneficial and supported. Rio Tinto suggested a bi-monthly frequency and committed to making arrangements and potentially inviting other agencies.
Brockman 4 Revised	22/06/2018	Brockman 4 Site Inspection 2018	<u>Areas noted that were well managed:</u> Development of a system to allow for monitoring data manipulation interpretation to identify trends and form conclusions is well received. <u>Land Disturbance</u> A project to identify any legacy sites and appropriately rehabilitate them has been undertaken and so far results appear promising. No areas for rehabilitation of waste landforms have commenced at Brockman 4 Area; however, several areas have been identified for progressive rehabilitation. This mine has now been operating for 8 years, which is considered sufficient time for Proponent to be able to start progressive rehabilitation on disused landform faces. <u>Waste Landform Management</u> Where possible, progressive rehabilitation on landforms should be undertaken. It is understood that several landform slopes have been identified for rehabilitation. <u>Pit/s</u> It was noted that none of the current pits had abandonment bunds in place. Where possible it is recommended that abandonment bunds be placed progressively during operations, especially where areas may not be able to be easily accessed in the future. Further to this, any bunds which are proposed to be "non-conforming" (i.e. use landforms as part of the bund wall) to the guidelines would be discussed with DMIRS - RSD as soon as possible. <u>Rehabilitation and Closure</u> DMIRS has recently developed a “Preparedness for Closure” scoresheet, to aid in the evaluation of sites against a range of criteria and provide clarity to proponents on DMIRS expectations in relation to rehabilitation and closure. The scoresheet has a range of criteria and an expected level which the Environmental Inspectors consider the site should be achieving based on the age, complexity and remaining mine life of the Project. As detailed in the scoresheet, overall, the Brockman 4 Area site was slightly behind in closure preparedness from where DMIRS expected the site should be. The key areas that appeared to be gaps were: • The MCP is out-of-date and lacking detail; • A lack of rehabilitation or trials on landforms; and • The lack of a clear abandonment bund strategy for existing pits.	N/A

Site	Date	Communication Topic	Topics / Issues Raised	Proponent Response / Outcome
Brockman Syncline Proposal	06/08/2019	2019 MCP scope to support Part IV expansion	Rio Tinto outline the scope of the 2019 MCP update and alignment with existing compliance MCP submission schedule, in the context of an approach proposed to submit closure management strategies to support PIV referrals. The position of the business at that time in regard to developing the closure approach for proposed areas was presented.	N/A
Brockman Syncline Proposal	09/09/2020	Developing pit void closure outcomes for the Brockman Syncline Proposal – a risk-based approach	The approach to developing a backfill strategy for proposed pit voids was presented, with detail regarding the risk-based steps involved, and the technical work completed to date.	N/A
Department of Jobs, Tourism, Science and Innovation (JTSI)				
Brockman Syncline Proposal	09/09/2020	Developing pit void closure outcomes for the Brockman Syncline Proposal – a risk-based approach	The approach to developing a backfill strategy for proposed pit voids was presented, with detail regarding the risk-based steps involved, and the technical work completed to date.	N/A
Traditional Owner Groups				
Brockman 2 Nammuldi	15/10/19	Meeting with Wintawari Guruma Aboriginal Corporation (WGAC)	Heritage site NM00-01 is located 60m north of the Nammuldi Lens AB proposed pit crest. WGAC raised queries around rehabilitation, how the process works and what it would look like, and requested a Closure representative attend the next meeting to discuss this with them.	Proponent noted that a 2m high abandonment bund would be built around the Lens AB pit zone of instability during closure implementation that would be approximately 20m from the heritage site boundary.
Brockman Syncline Proposal	18/12/2019	RRKAC comments on Brockman Syncline ESD	RRK People expressed concerns about the impacts of the Brockman Syncline Proposal upon RRK country, cultural heritage, landscapes and sites of significance, specifically the proximity to the Gunarika Cultural Precinct at the Eastern end of the Hamersley Range, Palm Springs, Boolgeeda Creek and groundwater abstraction. The RRK People hold concerns about any impacts that affect water. As part of the operational elements described, there will be two permanent realignments (up to three kilometres in length) of Caves Creek within the Silvergrass area and the permanent realignment of Purlykuti Creek. The ESD should specifically identify Caves Creek as a registered Aboriginal site (ID 37670) (known as Narraminju) and Purlykuti Creek as registered Aboriginal site (ID 36229) (known as Purlykuti 2). Both of these sites, whenever referenced within the ESD should be identified as such under the purview of the *Aboriginal Heritage Act* 1972 (WA).	N/A
Silvergrass East	27/11/2019	WGAC Heritage Subcommittee (HSC) and Rio Tinto meeting	WGAC meeting to discuss Silvergrass East mine plan and closure outcomes. Rio Tinto spoke to closure outcomes regarding waste dump designs, diversion of Caves Creek and impacts to Palm Springs, and conditions of Ministerial Statement. Design decisions were made through the study process to establish the dump locations. o Backfill to post-mining water table o Backfill to surface in 1:100 yr flood plain of Caves Creek o Rehabilitation of diversion drain o All external waste dumps rehandled back into pit Eastern Guruma Elders do not approve of the mine plan (dumps) that Rio Tinto is proposing at SGE and the purpose of this meeting was to discuss a way forward. Rio Tinto provided context as to where Rio Tinto landed with the mine plan. Highlighted that the plan dates back a number of years and decisions change over time, but Rio Tinto designs are consistent with previously approved Ministerial Statements.	Noted constraints to dump design and mine plan including mine lease boundaries, nearby Threatened Ecological Community which cannot be disturbed, floodplain, waste material/sediment type, footprint required for topsoil/subsoil. Outlined progressive backfill strategy due to deficit of external waste dumps. Explained that the reason for the diversion to the creek is to maintain water flow through the creek; noted that final design for the diversion has not been completed. Confirmed Rio Tinto has a commitment not to impact Palm Springs. Rio Tinto to revisit the location of the waste dumps and report back, and to provide further information to WGAC on the impact of proposed creek diversion.
Silvergrass East	29/10/2019	Letter to Rio Tinto regarding Silvergrass East proposed construction of waste dumps on the northern side of Mt. Sheila Road and the subsequent diversion of a section of Narraminju Caves Creek	Letter WGAC sent to Rio Tinto in regard to proposed location of Silvergrass waste landforms and diversion of Caves Creek. Highlighted WGAC request of Rio Tinto to revisit mine plans and to engage in discussion with the group regarding the mine plan.	Subsequent engagement commenced with Rio Tinto mine planning team and other disciplines, including in-person meeting.
Silvergrass East	30/04/2020	Letter to WGAC	Letter Rio Tinto sent to WGAC which acknowledged Eastern Guruma's concerns with the initial proposed location of Silvergrass East waste dumps, given the cultural significance of the area. Rio Tinto have been working with mine planning to explore options that meet the needs of Eastern Guruma and Rio Tinto. Notified WGAC that Rio Tinto revised the Silvergrass East mine plan, removing the need to disturb land on the Northern side of Narraminju Caves Creek for the purpose of mineral waste dumping. As suggested by WGAC in the November consultation, the waste dumps will be relocated to the Southern side of the creek directly adjacent to current operations. Proposed further reviews of the proposed diversion of Narraminju Caves Creek.	Silvergrass East site layout changed to relocate waste dumps south of Narraminju Creek, directly adjacent to current operations.
Silvergrass East	26/11/2020	Letter to WGAC	Letter Rio Tinto sent to WGAC which acknowledged the cultural significance of Narraminju to the Eastern Guruma People and the broader Pilbara Aboriginal community. Rio Tinto has made a commitment not to divert or indirectly impact the main creek line through the diversion of Silvergrass East pit 1 operations.	Silvergrass East site layout changed to remove the Narraminju diversion associated with Pit 1.
Brockman Syncline Proposal	25-26/02/2020	Social Surroundings field trip with PKKP Traditional Owners	Rio Tinto and PKKP Traditional Owner discussion of environmental and cultural values of the area within the native title determination area of the PKKP People, including groundwater, flow through system – and developing strategies to manage dewatering BWT pits and managing surface water, identifying the extent of what drawdown might be, understanding important water features through the area, climate change impacts on understanding the water story of the region, flora and fauna surveys completed that inform Rio Tinto understanding of assemblages, and the closure planning process.	N/A
Brockman Syncline Proposal	13-17/08/2020	Social Surroundings field trip with RRK Traditional Owners	Rio Tinto and PKKP Traditional Owner discussion of environmental and cultural values within the RRK Native Title area, and the region of the Development Envelope.	N/A
Brockman Syncline Proposal	20/08/2020 25/08/2020	RRK and Rio Tinto meetings in Karratha	Debrief on the time spent on-country in the week preceding, and continued discussion of environmental and cultural values within or near to the RRK Native Title area (with particular regard to Palm Springs), in the region of the Development Envelope. Rio Tinto presented on the current understanding of water in the region, the proposed expansion, and the principles of rehabilitation and closure planning. Subsequent discussion focussed on land access rights, dust pollution, and visual amenity during operations and closure.	N/A
Brockman 4	18/12/2020	Juukan Gorge Remediation Project discussion with PKKP in Perth	Discuss principals of engagement and for project planning and execution Create safe access to Juukan Gorge and remove loose material on top of and adjacent to Juukan 1 and Juukan 2 in order to:	

Site	Date	Communication Topic	Topics / Issues Raised	Proponent Response / Outcome
			1. Understand the integrity of Juukan 1 2. Recover and expose Juukan 2 floor 3. Shelter and protect Juukan 2 floor 4. Remediate Juukan 1 – safe access	
Brockman 4	21/1/2021	Juukan Gorge Remediation Project discussion with PKKP in Karratha	Information that goes to the heritage committee needs to be easy to understand. Next PKKP workshop to be held at B4 on the 9th of Feb and will include representatives from Golder and PKKP. 3rd party independent review – PKKP to get to know Golder and consider requirements for independent reviews. Discussed Gorge access options	Option 3 for gorge access is preferred option
Brockman 4	22/02/1021	Juukan Gorge Remediation Project PKK LC Meeting in Tom Price	Update on completed work. Seeking PKKP endorsement to implement Domain 3&4 rehabilitation work. Seeking PKKP endorsement for all steps in the Make Safe works.	PKK LC to review requests for endorsement; PKK subsequently endorsed the requests via email.
Silvergrass East	7/04/2021	WGAC Board Meeting – RTIO presented groundwater management at Silvergrass East with EG Traditional Owners	Overview of groundwater understanding at the Silvergrass East deposit and the interaction of Caves Creek and Palm Springs. Discussion of managed aquifer recharge (MAR) trial methods and conceptual footprint of the trial presented.. Update to the Part IV Brockman Syncline Proposal scope, including deferral of Silvergrass West, B2SW and deposits west of Juukan Gorge to a future Part IV proposal.	Proposed MAR trial scheme under consideration.
Brockman 4	7/06/2021	2 day on Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	Update on completed work. Seeking endorsements for next phase of works 2nd day included visit from Kelly Parker and Simon Trott	All requests were endorsed by the sub-committee Drone video footage of Domain 3& 4 requested
Brockman 4	15/7/21	On Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	Review of completed work Seeking endorsement for next phase of works	All requests were endorsed by the sub-committee
Brockman 4	3/09/2021	On Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	Review of completed work Seeking endorsement for next phase of works	All requests were endorsed by the sub-committee Guidance received on works close to the rockshelters Juukan 2 floor objectives confirmed Guidance received on project continuation during lore time
Brockman Syncline Proposal	7-8/09/2021	Social Surroundings field trip with PKKP Traditional Owners	Onsite workshop was held with PKKP Traditional Owners. PKKP expressed the importance of Boolgeeda Creek and maintenance of water flow to the Creek. PKKP are supportive of operational surface water diversions, however would like natural drainage to be reinstated at closure. An ethnobotanical survey was also discussed to inform consideration of the rehab seed mix.	Action to consider Traditional Owner knowledge in developing the rehabilitation seed mix. Initial Traditional Ecological Knowledge field trip undertaken 2 – 5th May 2022. A second survey is planned for Q3 2022. Surface water closure strategies to maintain Boolgeeda Creek catchment where practical is being investigated.
Brockman 4	21/09/2021	Juukan Gorge Remediation Project PKK LC Meeting in Karratha	Update on completed work Seeking guidance on Sense of place work	Guidance received on next steps for Sense of Place work
Brockman Syncline Proposal	12/10/2021	RT facilitated workshop with RRK Traditional Owners on Brockman Syncline Proposal SCHMP Development	Workshop was held to share the SCHMP template and work with RRK as to what is appropriate to cover within the management plan. Rio Tinto informed the Group that based on EPA advice the RRK SCHMP wouldn't need to be submitted with the Environmental Review Document for BSP, however Rio Tinto has committed to preparing the plan now and providing annual compliance reporting to RRK with a view to set up the future management framework and mechanisms for continued consultation and working together. Closure planning consultation was a key theme raised by RRK and a discussion of closure planning processes has been requested in the next workshop.	A workshop with RRK is planned for 2022 to discuss the closure planning process and closure strategies specific to the Brockman Operation.
Brockman 4	18/10/21	On Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	Review of completed work Seeking endorsement for next phase of works	All requests were endorsed by the sub-committee Support received to finalize the final landform Support received to commence backfilling of material Guidance on Juukan 2 floor recovery received
Brockman 4	11/11/21	PKK sub-committee meeting in Onslow to discuss the Juukan Gorge Remediation Project	Review of completed work Final landform presented Seeking endorsement for next phase of works	N/A
Silvergrass East	1/12/2021	Rio Tinto presentation to WGAC Board regarding proposed MAR scheme at Silvergrass East.	Updated proposed MAR trial scheme to be implemented at Silvergrass East to mitigate potential impacts to Palm Springs.	N/A
Brockman 4	6/12/21	On Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	Review of completed work Review of final landform options Seeking endorsement for next phase of works	Final landform endorsed Next phase of work endorsed
Silvergrass East	19/01/2022	WGAC letter to Rio Tinto	Conditional approval provided to Rio Tinto to implement the MAR trial at Silvergrass East. WGAC requested involvement with the data collection and analysis during the trial.	Rio Tinto will work with WGAC to provide all data required from the trial once implemented.
Brockman Syncline Proposal	17/02/2022	Email to WGAC	Provision of draft pit void closure strategy for pits associated with the Brockman Syncline Proposal	N/A
Brockman 4	8/03/2022	Juukan Gorge Remediation Project PKK LC Meeting in Karratha	PKK LC meeting: Update on completed work Seeking endorsement for next phase of works	N/A

Site	Date	Communication Topic	Topics / Issues Raised	Proponent Response / Outcome
Brockman 4	6/04/2022	On Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	Review of completed work Seeking endorsement for next phase of works Discussed Juukan 2 floor excavation plan	All requests were endorsed by the sub-committee
Brockman 4	10/05/2022	On Country meeting to discuss the Juukan Gorge Remediation Project	Meeting with new Rio Tinto Board Chairperson, Rio Tinto Iron Ore CEO and key PKKP members to discuss Juukan Gorge Remediation Project.	N/A
Brockman 4	17/05/2022	On Country PKK sub-committee meeting to discuss the Juukan Gorge Remediation Project	PKK SubCo meeting on country: Review of completed work Seeking endorsement for next phase of works Requesting direction on Juukan 2 remediation objectives	All requests were endorsed by the sub-committee Juukan 2 remediation objectives confirmed
Pastoral Stations				
Brockman 4	13/09/2019	DP1 rehabilitation	Emailed CPPS to inform them of the DP1 waste dump rehabilitation works. CPPS were curious to know what type of rehab will be completed and the area involved, including the processes used. CPPS stated DP1 is the waste dump that had several large erosion events from rainfall a couple of years ago that damaged the access track and subsequently there were attempts to repair the damaged areas.	Rio Tinto is implementing a batter/berm configuration on the lowest lift of DP1. The design parameters are based on materials characterisation, in this case 15m lifts, 20 degree and 10m wide berms. The dump will be reshaped utilising bulk earthworks equipment. Growth medium will be installed – we're considering a trial of 50% of the project in topsoil and 50% of the project in subsoil. The area will be cross ripped (along the slope) and seeded with native species. The species list is not yet confirmed. It is likely that the subsoil areas might get a different seed mix (more, different species, different pre-treatments, etc.) to encourage that area to perform as well as topsoil. The erosion events mentioned are within the area that will be rehabilitated. Rehabilitated batters are designed to withstand significant rainfall events, both in terms of slope stability and berm capacity over a long period of time. As vegetation grows and the surface hardens, erosion should reduce and the surface becomes stable. We will also install a bund along the toe to catch any sediment before it gets to the road.
Brockman 4	22/10/2019	DP1 site visit with Cheela Plains Pastoral Station	Site visit to DP1 in consultation with Cheela Plains to inspect how the waste dumps are being managed. CPPS queried how water at the top of the waste dumps are being managed. They noted the same waste dump erosion event during a big rain event a few years ago.	Proponent explained that the waste dump surface is designed to slope away from the edge to avoid water pooling on the edges and ultimately protect the integrity of the waste dump. CPPS were satisfied with the visit and were asked if they wanted any more detail on the processes, design etc. which they declined.
Neighbouring Mining Companies				
Brockman Syncline 1	17/03/2022	BS1 & Flying Fish Working Group (Rio Tinto & FMG)	Data sharing agreement discussed between FMG and Rio Tinto. Information to be shared may include surface and groundwater monitoring data as well as potential changes to natural surface water flow resulting from operational surface water management strategies. Discussed potential to share closure SW management. FMG expressed concern that Rio Tinto may be storing PAF material upstream of Flying Fish.	Level of detail of shared information to be decided in future meetings.

Appendix 5: Brockman Operation Closure Risk Register

Brockman Operation Closure Risk Assessment

Risk Record	Causes (triggers/ pathways)	Inherent Risk			Risk Treatment / Controls	Current Risk		
		Likelihood Rating	Consequence Rating	Risk Class		Likelihood	Consequence Rating	Risk Class
Inability to maintain self-sustaining function of Palm Springs, and restore pre-mining cultural and environmental values of Caves Creek system [880204]	Impact realised before mitigation developed. Regulator and Traditional Owner engagement/impact response plan not implemented. Inability to obtain sufficient water to recharge the Palm Spring system and maintain phreatophytic vegetation along Caves Creek (No suitable source for MAR scheme after closure). Recharge program is not effective within the specified timeframe. Management of the aquifer re-injection, recharge fails. Insufficient knowledge of "pre-mining values". MAR required after dewatering ceases due to lag in groundwater rebound. Source and volume of MAR water at closure not confirmed.	Likely	Very High	**Class IV**	Environmental and groundwater monitoring regime in place during operations. [699589] Groundwater operating and monitoring plan [702372] Closure legal obligations register [757139] Stakeholder Engagement Register [757141] Mine Closure Plan is updated for approval every three years [757145] Quarterly regulator closure forum [758282] Baseline flora and fauna surveys [759550] Water management strategies during operations prioritize minimization of closure management liability [786840]	Possible	Very High	**Class IV**
Implementation of the closure strategy does not achieve the required cultural heritage outcomes [878376]	Downstream regional area of high value to multiple Traditional Owner groups. Previously unidentified heritage sites or cultural heritage values, not considered in existing assessment, discussions, agreements or with no authority to disturb. Cessation of maintenance of / access to heritage site. Cultural values not considered in rehabilitation strategies. The presence of several heritage sites in close proximity to mining areas. Plans for repatriation of salvaged artefacts not well understood. Changes to landforms at closure have potential to alter conditions at downstream sites, e.g. consider drainage, landform footprint, erosion implications. Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation. Visual amenity of area is so drastically altered that Traditional Owners are outraged at the closure landscape and footprint.	Likely	High	**Class IV**	Heritage GIS database [519558] Cultural Heritage Management Plan [703848] Mine Closure Plan is updated for approval every three years [757145] Closure Studies process (OoM, PFS, FS) [758192] Ground disturbance Approval Request system [758266] Biannual Local Implementation Committee meetings with TO's [758281] Cultural Heritage Management Guidance Note [759521] Pit void closure guidance [759544] Tip to Conformance on RTIO waste dumps [776193] Water management strategies during operations prioritize minimization of closure management liability [786840] Business processes require protection of cultural heritage with unavoidable impacts approved at an appropriate level of management [964439] Contractor management (CHMP compliance) [964440] Cultural heritage competent leadership team & workforce [964441] Cultural heritage consultation and engagement [964442] Cultural Heritage impact mitigation program [964443] Cultural heritage legal permits & approvals [964444] Cultural heritage management of change [964445] Cultural Heritage management plan (CHMP) implemented [964446] Cultural Heritage Management System (CHMS) [964447] Cultural Heritage site boundaries physically demarcated [964448] Maintain Community approvals [964449] Seek Community approvals [964450]	Possible	High	**Class IV**
Insufficient material for capping and/or backfill increases closure liability and complexity [880210]	Waste materials balance does not accurately reflect availability of materials for closure backfill. Settlement exceeds estimates (more backfill required). Operational decisions influenced by short term economic/planning drivers possibly leading to sub-optimal closure outcomes.	Likely	Moderate	**Class III**	Annual update of RTIO's Present Closure Obligation cost estimate [754096] Mine planning updates actively considers backfill opportunities in life of mine strategy [758261] Tip to Conformance on RTIO waste dumps [776193]	Possible	Moderate	**Class III**
Failure to reach agreement with the State on suitable completion criteria for Brockman Operation [880208]	Current completion criteria still at conceptual stage. Final completion criteria not agreed with key stakeholders. Inadequate consultation with stakeholders to identify expectations. Stakeholder expectations and standards change with time (regulators and TOs). Insufficient or unreliable corporate knowledge to define final completion criteria. Unrealistic expectations for closure outcomes (restoration compared to rehabilitation). Research not being undertaken and/or outcomes not being analyzed/utilized. Conceptual models and/or limited technical data to achieve proposed closure strategies.	Likely	Moderate	**Class III**	RTIO - Stakeholder Engagement Strategy for Closure [754125] Closure legal obligations register [757139] Stakeholder Engagement Register [757141] Mine Closure Plan is updated for approval every three years [757145] Quarterly regulator closure forum [758282] Progressive rehabilitation is trialed and completed during operations [758285] Baseline flora and fauna surveys [759550] R&D Program [764041]	Possible	Moderate	**Class III**

Brockman Operation Closure Risk Assessment

Risk Record	Causes (triggers/ pathways)	Inherent Risk			Risk Treatment / Controls	Current Risk		
		Likelihood Rating	Consequence Rating	Risk Class		Likelihood	Consequence Rating	Risk Class
Implementation of the closure strategy does not achieve the required environmental outcomes [880193]	Scheduled, listed or declared rare flora or threatened fauna recorded in/adjacent to site. Downstream regional area and hydrological receptors (pools) of high value. Failure to understand or consider indirect or cumulative impacts to off-site areas. Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation. Regional groundwater impacts not well understood.	Likely	Moderate	**Class III**	GBO Environmental Management Plans [496984] RTIO SCARD management plan [519521] Temporary and permanent surface water structures designed to conform with relevant legal and engineering standards. [519543] Ground disturbance Approval Request system [758266] Environmental Management Plan [759548] Baseline flora and fauna surveys [759550] Skilled and resourced Rehabilitation and Closure team in RTIO [759826] Biological GIS database [782559] Tailings Management Plan [787563]	Possible	Moderate	**Class III**
Rehabilitation outcomes at Brockman Operation do not meet closure outcomes [880176]	Inadequate top soil stockpile soil / poor stockpile management. Environmental conditions post-closure differ significantly from pre-mining conditions. Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation. Chemical properties of materials on waste dump / rehab surface not adequately understood e.g. salt circulation. Rehabilitation is not undertaken in accordance with design standards or closure strategy. Species selection / species diversity inadequate to support objectives.	Likely	Moderate	**Class III**	Weed Management Strategy [498467] Ground disturbance Approval Request system [758266] Progressive rehabilitation is trialed and completed during operations [758285] Rehabilitation trials to increase confidence in rehabilitation outcomes [759222] Seed management and procurement program [759225] Soil resource management work practice [759226] RTIO Rehabilitation handbook [759546] Rehabilitation monitoring program [759547] Environmental Management Plan [759548] Baseline flora and fauna surveys [759550] R&D Program [764041] Biological GIS database [782559]	Possible	Moderate	**Class III**
Waste dumps and/or landbridges at Brockman Operation are subject to excessive erosion [878352]	Physical material properties not adequately considered considered in design. Poor drainage and erosion management. Construction of landforms / waste dumps not to design requirements. Design does not consider PMP/PMF flood or significant rainfall events as they are not readily modelled. Sensitive receptors identified downstream. Failure of permananet diversion levees.	Likely	Moderate	**Class III**	Geotechnical assessments for wall stability and zone of collapse as part of mine design reviews, as required. [519534] Physical materials characterisation completed for common waste types [519539] Temporary and permanent surface water structures designed to conform with relevant legal and engineering standards. [519543] Landform Design Guidelines [754554] Closure review of landform designs through MDAS system [758263] RTIO Rehabilitation handbook [759546] Closure Monitoring and Maintenance Plan [759549] Tip to Conformance on RTIO waste dumps [776193]	Possible	Moderate	**Class III**
Consultation fails to identify and/or address stakeholder concerns [878269]	MCP is not approved and significant rework and consultation is required. Closure strategy poorly defined during consultation. Consultation doesn't occur with the right stakeholder reps. Consultation doesn't occur at appropriate frequency. Consultation is not appropriate to stakeholder group. Communication of anticipated closure outcomes and post-closure land use options does not enable adequate understanding. Large number of stakeholders engaged in the project require a complex and coordinated consultation strategy. Stakeholder expectations change over time, due to changing global benchmarks for mine rehabilitation success, intergenerational change, regulatory changes etc.	Possible	Moderate	**Class III**	RTIO - Stakeholder Engagement Strategy for Closure [754125] Closure legal obligations register [757139] Stakeholder Engagement Register [757141] Mine Closure Plan is updated for approval every three years [757145] Closure Studies process (OoM, PFS, FS) [758192] Biannual Local Implementation Committee meetings with TO's [758281] Quarterly regulator closure forum [758282]	Possible	Moderate	**Class III**

Brockman Operation Closure Risk Assessment

Risk Record	Causes (triggers/ pathways)	Inherent Risk			Risk Treatment / Controls	Current Risk		
		Likelihood Rating	Consequence Rating	Risk Class		Likelihood	Consequence Rating	Risk Class
Seepage is released from the Brockman Operation WFSFs into the surrounding environment [878268]	Throughout the life of a TSF seepage will occur. Seepage is driven through the deposited tailings by an hydraulic gradient generated by the water held in the decant pond. Cell not operated in accordance with design criteria resulting in compromised structure. Potential trajectory of plume beneath cell impacts an environmental receptor. Impacts to surrounding vegetation as a result of seepage from waste fines disposal.	Likely	Moderate	**Class III**	RTIO tailings closure guideline [754556] D5 Standard Management of Tailings and Water Storage Facilities [754557] Skilled and resourced tailings team within RTIO [759841] Tailings Closure Studies [759850] Tailings Management Plan [787563]	Possible	Moderate	**Class III**
Pit void at Brockman Operation presents an unacceptable environmental risk [878264]	Open water bodies in Pilbara naturally attract fauna (feral and native species) for food/ water/ refuge, safe access to water required. Concentration of natural groundwater or mineral waste derived salts through evapoconcentration in open water bodies. Release of metals from natural geology or mineral waste into water (infiltration or groundwater flow). Water quality contributes to plant /weed growth (toxic algal blooms, noxious weeds). Certain plant / animal species bio-accumulate / magnify toxic metals. Impacts to catchment areas have impacts to heritage water holes and water flow.	Possible	High	**Class IV**	RTIO SCARD management plan [519521] Geotechnical assessments for wall stability and zone of collapse as part of mine design reviews, as required. [519534] Environmental and groundwater monitoring regime in place during operations. [699589] Groundwater operating and monitoring plan [702372] Pit void closure guidance [759544] Closure Monitoring and Maintenance Plan [759549] Baseline flora and fauna surveys [759550] Pit lake modelling undertaken at asset level [764053] Water management strategies during operations prioritize minimization of closure management liability [786840]	Unlikely	High	**Class III**
The safety risk for people entering the Brockman Operation after it has been rehabilitated and closed has not been effectively mitigated [877778]	Post-closure access / land-use requirements, e.g. for stock, people, heritage, environmental monitoring, adjacent mining activities etc. Long term integrity of abandonment bunds compromised. Decommissioning of infrastructure not implemented effectively. Fibrous materials not mnaged or encapsulated effectively during operations. Some roads retained for post-closure access. Toxic algal blooms and / or noxious weeds. Waterborne pests and disease e.g. mosquitos. Safety/welfare impacts for pastoral stations. Water bores potentially retained.	Possible	High	**Class IV**	IOWA Fibrous Materials Management Plan [702422] RTIO Closure Strategy [758188] Rio Tinto Closure Standard [758190] Pit lake modelling undertaken at asset level [764053] Abandonment bunds to prevent inadvertent access [782553] Backfill of pit voids (to varying levels) [782554] Above ground infrastructure made safe or removed [782555]	Unlikely	High	**Class III**
Inadequate management of PAF material at Brockman Syncline results in AMD and increased closure complexity and costs [877773]	Interaction of water and mineral waste could generate acid / alkaline levels that leach metals / salts from the mineral waste or local environment. Presence of temporary or permanent open water bodies, enabling evapoconcentration to occur with creation of alkaline / hypersaline water quality. Ability of metals / salts to move through environment to impact a sensitive receptor, to meet definitions in Contaminated Sites Act 2003. Poor management of PAF material in waste dumps. Strategies do not effectively mitigate risk. Acceptable impact not defined/understood. Scale of impact at closure is also unknown. Leaching from PAF on and behind pit walls.	Likely	Moderate	**Class III**	Wet season management plans to control run off [519520] RTIO SCARD management plan [519521] Store and release covers implemented [519524] Geochemical waste characterisation and column leach tests [702369] Groundwater operating and monitoring plan [702372] Annual update of RTIO's Present Closure Obligation cost estimate [754096] Closure estimates developed in accordance with RT Closure Standard [754099] RTIO Mineral Waste Management Plan for undeveloped resource and studies [754152] E13 Standard Chemical Reactive Waste [754153] Mine Closure Plan is updated for approval every three years [757145] Strategic placement of neutralising material to mitigate AMD risks [759539] PAF wall exposures will be covered with waste material and/or water [759541] Skilled and resourced Rehabilitation and Closure team in RTIO [759826]	Possible	Moderate	**Class III**

Brockman Operation Closure Risk Assessment

Risk Record	Causes (triggers/ pathways)	Inherent Risk			Risk Treatment / Controls	Current Risk		
		Likelihood Rating	Consequence Rating	Risk Class		Likelihood	Consequence Rating	Risk Class
Inadequate management of surface water results in increased closure complexity and costs [880197]	Unplanned post-closure impacts occur as a result of migration of a contaminant (e.g. sediment, AMD) off-site. Catchment of important surface water flows on-site, impacting on downstream areas off-site. Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation. Unplanned impacts to permanent Springs or named Creeks due to reduced catchment area at closure/catchment of SW in-pit	Possible	Moderate	**Class III**	Wet season management plans to control run off [519520] Water Discharge Monitoirng and Management plan [702366] Stakeholder Engagement Register [757141] Closure Studies process (OoM, PFS, FS) [758192] Pit void closure guidance [759544] Environmental Management Plan [759548] Biological GIS database [782559] Water management strategies during operations prioritize minimization of closure management liability [786840]	Unlikely	Moderate	**Class II**
Pit wall stability at the Brockman Syncline compromises closure outcomes [878343]	Influence of erosion, subsidence, seismicity, wall slip. Influence of groundwater recovery and surface water flow on stability. Creek system neighbouring or within zone of instability, potential stream capture. Geotechnical assessment incorrectly defines the zone of instability. Run on from surface water catchments onto waste dumps and pits (currently not incorporated into design). Built landforms (waste dumps/landbridges) within potentially unstable pit edge zone.	Possible	Moderate	**Class III**	Geotechnical assessments for wall stability and zone of collapse as part of mine design reviews, as required. [519534] Temporary and permanent surface water structures designed to conform with relevant legal and engineering standards. [519543] Surface water diversion have been designed for appropriate flood events [723039] Annual update of RTIO's Present Closure Obligation cost estimate [754096] Mine Closure Plan is updated for approval every three years [757145] Closure review of landform designs through MDAS system [758263] D3 Standard Management of Slope Geotechnical Hazards [758274] Pit void closure guidance [759544] Closure Monitoring and Maintenance Plan [759549] Skilled and resourced Rehabilitation and Closure team in RTIO [759826] Backfill of pit voids (to varying levels) [782554] Water management strategies during operations prioritize minimization of closure management liability [786840]	Unlikely	Moderate	**Class II**
Inadequate management of contaminating activities during operations increases closure costs [877761]	Poor use or uncontrolled use of chemicals and hydrocarbons during operations. Inadequate housekeeping practice and maintenance of work areas and equipment. Contaminated sites have not been identified. Inadequate clean-up of contamination. Potential contamination source has not been addressed. The full nature and extent of reportable contaminated sites have not been adequately determined. Lag contamination events from historical waste disposal practices. Changes in regulatory expectations and continually developing regulatory understanding of emerging contaminates of concern. Unknown or uncontrolled landfilling during operations.	Likely	Low	**Class III**	RTIO Potentially Contaminated Sites Register [519506] RTIO Spill Response Procedure [779354] RTIO Landfill Work Practice [782518] RTIO Landfarm Work Practice [782519] RTIO Contaminated Sites Strategy [782520] RTIO Environment Design Standard for Infrastructure [782521] RTIO Environment Design Standards Temporary Infrastructure [782523] Licensing of Prescribed Premises [783245]	Possible	Low	**Class II**
WFSF embankments at Brockman Syncline are subject to excessive erosion [878369]	Erosion causing instability or collapse, resulting in environmental/safety impacts Inappropriate design leads to wall failure. WFSF not operated in accordance with design criteria resulting in compromised structure. Engineering solutions are not effective post-closure.	Likely	Very Low	**Class II**	RTIO tailings closure guideline [754556] D5 Standard Management of Tailings and Water Storage Facilities [754557] Skilled and resourced tailings team within RTIO [759841] Tailings Closure Studies [759850] Tailings Management Plan [787563]	Possible	Very Low	**Class I**
Human health impacts arise from fibrous material at Brockman Syncline exposures after closure [878261]	Hazardous fibres exposed in situ by mining, mined and moved to encapsulated areas or naturally present in soils disturbed by mining / rehabilitation activities. Erosion of materials containing hazardous fibres post-closure. Inadequate encapsulation of fibrous material. Final pit void contains exposed fibres. Disposal of fibrous building materials	Unlikely	Moderate	**Class II**	Physical materials characterisation completed for common waste types [519539] IOWA Fibrous Materials Management Plan [702422] Landform Design Guidelines [754554] Closure review of landform designs through MDAS system [758263]	Rare	Low	**Class I**

Rio Tinto Risk Evaluation Scheme - Qualitative Consequence Criteria - Brockman Operations

Consequence	Threat or Opportunity	Very Low	Low	Moderate	High	Very High
General Description	Threat	Initial signs of problems, no impact	Concrete signs, no impact on business performance (inconvenient, but manageable)	Low level impact on business performance (painful, but manageable)	Significant impact on business performance (painful, but recoverable)	Severe impact on business performance (very painful, difficult to recover from, but able to continue operating)
	Opportunity	Initial signs of improvement, no impact	Concrete signs of improvement, but no improvement in business performance (benefits easily captured)	Low level improvement on business performance (noticeable benefits easily captured)	Significant improvement in business performance (substantial and sustainable benefits)	Major improvement in business performance (value of asset enhanced)

Core Qualitative Consequences (Non-Financial)

Consequence	Threat or Opportunity	Very Low	Low	Moderate	High	Very High
Health and Safety	Threat	**Low level short term inconvenience or symptoms. Typically a first aid case** with no medical treatment.	**Injury or illness requiring medical treatment, that does not lead to restricted duties or lost time.** Typically a medical treatment case injury or illness. Also includes diagnosed occupational illnesses that do not require medical treatment E.g., Dermatitis, laceration requiring suturing, NIHL, pneumoconiosis or other diagnosis without significant impairment or disability.	**Injury / illness with moderate damage or impairment (<30% on impairment scale) to one or more person**s. Typically a restricted duties or lost time injury/illness. E.g., Loss of finger, broken leg, injury requiring in-patient care, severe asthma attack, mental illness (with lost time), NIHL, pneumoconiosis or other diagnosis with significant impairment or disability.	**Single fatality or severe permanent impairment** to a person (>30%) e.g. loss of hand or lower limb (at knee), paraplegia	**Multiple fatalities or severe permanent impairment to multiple people** (<5 people).
License to Operate / Stakeholders (reputation with external stakeholders)	Threat	**Informal disapproval from local stakeholders**, manageable by site personnel with limited additional effort. No significant residual impact on reputation.	**Stakeholder actions resulting in operational or commercial impacts equivalent in value to days to weeks of operational inefficiency at a tier 1 asset.** Formal public disapproval from local stakeholder(s) requiring specific local management response. Some residual local reputational impact, with potential accumulate over time.	**Stakeholder actions resulting in operational or commercial impacts equivalent in value to days to weeks of production from a tier 1 asset.** Organised local action / prolonged formal high profile disapproval influencing policy, regulation, commercial and / or social activity at the local level. Reputation damage requiring significant local management intervention and concessions. Prolonged scrutiny by local stakeholders contributing to cumulative reputation harm.	**Stakeholder actions and / or rent seeking resulting in operational or commercial impacts equivalent in value to weeks to months of production from a tier 1 asset**, but not compromising financial viability. Organised formal action influencing relevant policy, regulation, commercial and / or social activity at the national level. Reputation damage on a national scale, credibly constraining future business activities at that level for around 6 months due to prolonged scrutiny by stakeholders.	**Stakeholder actions and / or rent seeking resulting in operational or commercial impacts equivalent in value to months to years of production from a tier 1 ass**et, compromising the financial viability of the asset and driving a minor formal impairment disclosure. Organised formal action at the international level influencing relevant policy, regulation, commercial or social activity across multiple jurisdictions. Reputation damage on an international (~ 1 year) or national (multiple years) scale, credibly preventing realisation of a major future opportunity or prolonged scrutiny of the Group's assets and business activities. Severe reputation damage on a local scale, requiring a transformational change in strategy / leadership to maintain ongoing viability of an asset
Communities & Social Performance	Threat	**Short term loss of trust with communities**, repaired within days. **Damage to cultural heritage site or item of low significance**	**Loss of trust with communities taking weeks to months to resolve**. **Non-disruptive organised opposition**. **Damage to cultural heritage site or item of moderate significance**. Ad hoc complaints about some aspects of agreement or commitments	**Loss of trust with communities that cannot be resolved through routine procedures.** **Disruptive organised opposition. Mitigatable damage to cultural heritage site of high local or national significance**. Material non-conformance with agreements or commitments	**Widespread, sustained opposition from communities.** Blockades resolved with routine procedures. Major negative impact on communities' economic viability. **Irreparable damage to cultural heritage site of high local significance**. Most aspects of agreements or commitments not met and independent mediation required to resolve the impasse	**Sporadic or short term (ie weeks) interruptions to operations and projects, due to:** **Systemic opposition** from communities that impacts community trust at other Rio Tinto assets. Blockades not resolved by routine procedures. Sporadic outbreaks of violence, directed at company assets or people. One-off deployment of public security as a result of a communities issue. Loss of community's economic viability. Irreparable damage to cultural heritage site/s of national significance. Complete failure of agreement or commitment

Financial Markets (reputation with shareholders and finance community)	**Threat**	**Localised, public expressions of opinion by commentators** with no influence on investment community	**Informal expressions of negative sentiment among special interest investo**r with limited influence on investment community	Low-level, **informal expressions of negative sentiment from key investor**; or formal, public expressions from special-interest groups with some influence. Event or condition triggers monitoring at Group level, but limited management effort. Active management may be triggered at a localised level.	**Public expressions of negative investor / analyst sentiment** with potential to influence trend of market value / share price. Significant work to rectify at a Group Function level with active oversight from Rio Tinto leadership. Eg, Material short term reduction to market value of an operating asset or major commercial initiative.	**Negative investor / financial community sentiment, driving short-term (months) reduction in market value** / share price of Rio Tinto relative to industry benchmarks. Eg, Long term structural reduction to market value of a single high value asset. Eg, Perceived failure to deliver a notable market commitment.
People	**Threat**	**Low level employee relations issues expressed through appropriate internal channels** (eg, line management, speak-out). Minor, localised disengagement with limited effort to manage	**Formal public expression of employee concerns, requiring management effort to address** (eg accusation of discriminatory employment practices) Localised challenges in accessing, engaging, attracting and retaining staff, diverting management attention, but with limited operational impact	**Localised, medium term (eg, months) challenges in accessing, attracting, engaging or retaining people** leading to diversity, capability or capacity shortfalls and/or tangible underperformance against core local (eg, site) plan objectives Union or industrial relations activity causing short term operational inconvenience or significant management effort to address	**Major, protracted (eg, year) challenges in accessing, attracting engaging and retaining people** leading to material gaps in diversity, core capabilities or capacity and resulting in widespread failures to deliver local (eg site) plan objectives (eg through impacts on critical work, significant operational costs or significant operational errors due to lack of sufficient experience). Formal union or industrial action causing short term suspension (weeks) or ongoing constraints to operational activity	**Systemic and ongoing (years) local challenges in accessing, engaging, attracting or retaining people** leading to reduced performance such that a key asset or opportunity becomes marginal; OR widespread challenges, significantly impacting diversity, productivity and operational performance across a portfolio of assets or business activities. Protracted industrial action causing long term suspension (>month) or severely constrained operational activity at the local level; or contagion of short term industrial action across multiple operations
Environment	**Threat**	An unplanned, unpermitted or unintended event; or a series of chronic or cumulative events resulting in: **Localised harm** to the environment that is **confined to the operating footprint**, affects no sensitive receptors and can be **rectified or reversed within a day** (or within a month for impacts to groundwater	An unplanned, unpermitted or unintended event; or a series of chronic or cumulative events resulting in: **Harm** to the environment **that may extend outside the operating footprint**, affects no sensitive receptors and can be **rectified or reversed within days to weeks** of work effort or natural recovery (or several months for impacts to groundwater)	An unplanned, unpermitted or unintended event; or a series of chronic or cumulative events resulting in: **Harm to** a r**egionally significant sensitive receptor** that can be **rectified or reversed within weeks to months** of work effort or natural recovery (or months to years for impacts to groundwater)	An unplanned, unpermitted or unintended event; or a series of chronic or cumulative events resulting in: **Harm to** a **nationally-significant sensitive receptor** that can be **rectified or reversed within months to years** of work effort or natural recovery (or years to decades for impacts to groundwater)	An unplanned, unpermitted or unintended event; or a series of chronic or cumulative events resulting in: **Widespread harm to** a **globally-significant sensitive receptor** that can be **rectified or reversed within years to decades** of work effort or natural recovery (or many decades for impacts to groundwater)
Business Integrity	**Threat**	**Isolated and low level incidents of inappropriate behaviour** manageable via routine management activity	**Formal accusations of inappropriate behaviour** requiring management intervention and low level disciplinary action against individuals	**Business integrity breaches requiring formal internal disciplinary action** but not requiring involvement of law enforcement or regulators	**Business integrity breaches involving severe internal disciplinary action and fines**; or non-criminal action or sanction from law enforcement or regulators against individuals or a Rio Tinto operating entity / BU	**Business integrity breaches** primarily in the jurisdiction of law enforcement **involving significant fines, criminal charges against individuals or a Rio Tinto operating entity** / BU and extensive investigations
Legal & Regulatory Compliance	**Threat**	**Non-compliance** with agreements or laws that can be **resolved via informal discussion or direct engagement**	**Breaches** of agreements or laws **resulting in formal notices or written warnings** to Rio Tinto	**Breaches** of agreements or laws **resulting in low-level fines or payments** by Rio Tinto.	**Breaches** of agreements or laws or legal action **resulting in fines, settlements or payments that are material at the site level**, or short term suspension of operations.	**Breaches** of agreements or laws or legal action **resulting in fines, settlements or payments that are material at the business unit level**, long term suspension of operations or sanctions against responsible managers

Notes

*Note: in these descriptors “agreement / commitment” refers to any type of agreement or commitment between community and company. Included, among others, are: Indigenous Land Use Agreements, compensation agreements, Land Acquisition Strategy, Cultural Heritage Management Plan, Resettlement Action Plan, Impact Benefit Agreement, Partnership agreements, etc agreements, Land Acquisition Strategy, Cultural Heritage Management Plan, Resettlement Action Plan, Impact Benefit Agreement, Partnership agreements, etc

*Note: references to communities in communities & social performance also includes local stakeholders

*Note: references to extended periods of time in communities & social performance will generally equate to 1 year or more

Rio Tinto Risk Evaluation Scheme

Likelihood Classification

Likelihood	Qualitative description	Frequency	Probability
Almost certain	Almost certainly will occur	>2/year	>75%
Likely	More likely to occur than not	2/year – 1/year	50% - 75%
Possible	Fairly likely to occur	1/year – 1/10 years	20% - 50%
Unlikely	Unlikely to occur	1/10 - 1/100 years	5% - 20%
Rare	Extremely unlikely or virtually impossible	<1/100 years	0 - 5%

Risk Class Determination

Likelihood	Most serious consequence				
	Very low	Low	Moderate	High	Very high
Almost certain	Class II	Class III	Class IV	Class IV	Class IV
Likely	Class II	Class III	Class III	Class IV	Class IV
Possible	Class I	Class II	Class III	Class IV	Class IV
Unlikely	Class I	Class I	Class II	Class III	Class IV
Rare	Class I	Class I	Class II	Class III	Class III

Appendix 6: Brockman Operation Action Register

Ref	Task [Risk register action ID]	Indicative timeframe
1	Complete backfill reconciliation ensuring volumes align with 5YP and closure backfill commitments [880168]	2023
2	Complete Total Preliminary Cost for Brockman Syncline in 2023 [878342]	2023
3	Develop and implement a framework for engagement and information sharing with third party miners operating in the region [869804]	2022
4	Undertake a hydrological and engineering assessment of the final landform to assess risk areas related to surface water management at closure and design structures required to control erosion [880194]	2025
5	Assess the potential water quality, chemical composition, turbidity etc of stored water sources for Closure MAR scheme use suitability [1086390]	2028
6	Complete groundwater mounding modelling to assess risks that may adversely impact the health of surrounding ecosystems and development of effective monitoring and operational controls to ensure surrounding water levels are not adversely affected [1086392]	2034
7	Complete Managed Aquifer Recharge trial with support from EG [561754]	2022
8	Develop a water balance during closure to ensure suitable water availability for the duration of the closure MAR scheme at Caves Creek [1086385]	2024
9	Simulate timing, scale (water volumes, rates of recharge and infrastructure requirements) and identify location of a Closure MAR scheme along Caves Creek or SGE using the latest groundwater model following the MAR trial. [1086394]	2028
10	Update and further define the strategy for reinstating the aquifer post mining, including the re-establishment of self sustaining Palm Springs, ground- and surface-water dependent ecosystems to pre-mining condition. [895133]	2022
11	Collate current ethnobotanical knowledge into a database [1053969]	2022
12	Confirm final land use and post-closure access expectations with stakeholders and determine social and cultural heritage values to be maintained at closure [878255]	2026
13	Develop a framework for iterative visual impact assessment for cultural heritage important sites [1085625]	2024
14	Develop a strategy for the safe keeping or return of any artefacts or materials salvaged during operations [1085629]	2033
15	Establish a practice of the incorporation, where appropriate, of ethnobotanical species of importance into site seed mix lists for progressive rehabilitation [1053971]	2022
16	Identify and model further opportunities to construct permanent surface water diversion bunds or pit buttressing of BS1 pits to reduce catchment loss to Boolgeeda Creek [1085630]	2024
17	Identify sites with existing ethnobotanical survey and knowledge reports and develop a schedule for remaining sites [1053968]	2022
18	Review of the appropriateness of the specific species for use in seed mixes considering such factors as suitability for rehabilitation domains and availability of seed volumes required. [1053970]	2022
19	Develop a rehabilitation materials inventory to establish volumes required at closure, including competent capping materials, and identify material source and stockpiling areas. [878248]	2024
20	Undertake a construction and performance trial of the competent waste armouring in final landform designs [880171]	2024

21	Undertake waste materials balance assessment across sites, and investigate settlement behaviour of backfill materials post-closure, challenging swell factor and loose material density assumptions to verify volume of material required to meet backfill commitments. [880209]	2030
22	Undertake studies to evaluate the risks associated with post-closure pastoral activities within the mine footprint [878256]	2034
23	Assess baseline data and surveys to refine completion criteria applicable for rehabilitation [1086425]	2028
24	Implement mine planning approval process to include evaluation of Abandonment bund locations and MRZ/ MEZs [1086429]	2024
25	Review effectiveness of MEZs during operations to ensure they are adequate to meet completion criteria. [1086435]	2038
26	Undertake a baseline soil assessment for the BSP disturbance areas [1085670]	2023
27	Undertake representative sampling of existing subsoil stockpiles at BS4, B2N and SGE [1085669]	2024
28	Undertake research to improve business knowledge of rehabilitation of riparian environments, including methods for restoration of Pilbara creek line habitats [880190]	2028
29	Update actual recovery rates of soil to date and apply to calculation of predicted soil volumes available at closure [1085671]	2024
30	Identify appropriate native plant species to grow on cover systems, taking into account requirements for specific requirements such as shallow rooting depth [878366]	2025
31	Review of Brockman Operation rehabilitation reference sites to determine if they are appropriate for ongoing use in the rehabilitation monitoring program. [1086440]	2024
32	Remove all ramps from WRL rehabilitation designs unless post-closure access is required. [1085721]	2024
33	Undertake physical waste characterisation on mineral waste units that do not have site-specific data and mineral waste from proposed pits once mining commences. [1085720]	2024
34	Negotiate with stakeholders regarding decommissioning or retention of infrastructure on special leases (railway, communication tower, access road, campsite and services) [878338]	2030
35	Social and economic impact assessment to be completed during closure studies within 5 years of planned closure. [1085668]	2038
36	Determine closure design for WFSFs in accordance with GISTM [878267]	2022
37	Undertake hydrogeological modelling of WFSF facilities (ex-pit and in-pit) to understand groundwater recovery beneath the facility post-closure [878266]	2028
38	Assess alternative pit designs to reduce PAF exposures in final pit wall and/or potential to leave benches on which calcrete or alternative neutralising material maybe tipped to cover exposures. [992142]	2025
39	Assess the potential for density driver pit lake water outflow to the surrounding aquifer due to high salinity. [1085733]	2024
40	Develop geochemical pit lake models for all pit voids with PAF exposure in the final pit wall and a strategy to leave as a pit lake [951343]	2022
41	Update pit lake water balance modelling, including sensitivity analyses, and undertake a review of model assumptions and parameters [878262]	2024
42	Confirm presence of in-situ designated hazardous material in final pit walls and complete a risk assessment for potential health and safety risks as required. [1085726]	2028
43	Develop engineering designs for mitigating surface water risks to permanent WRL and abandonment bunds located within flood plains [1085717]	2033

44	Review Pit 1 final design PUPEZ relative to the Juukan Gorge Remediation Project and design pit buttress to ensure fundamental stability. [1085718]	2024
45	Update conceptual abandonment bund designs to reflect updated mine plan and rehabilitation designs [1085715]	2024
46	Identify opportunities to use SR4 neutralising material to reduce the risk of AMD at closure. [1085725]	2024
47	Identify suitable material to construct store and release covers on WRLs containing PAF material and calculate volumes required to cover all WRLs containing PAF material. [1085724]	2024
48	Review characterisation of predicted PAF exposures and risk ranking within the mine model, based on Greater Brockman 2021 AMD Risk Assessment [878249]	2022
49	Define acceptable creek health outcome on cessation of discharge to creeks given there may be permanent catchment area reduction. [1086402]	2024
50	Develop strategy to gradually reduce surplus water discharge to creeks to ensure ecological values are retained. [1086405]	2024
51	Investigate closure outcomes associated with capture of surface water flows by mine voids [897073]	2024
52	Develop post closure monitoring and maintenance plan [1086419]	2038
53	Undertake Detailed Site Investigation 5 years prior to closure. [1086415]	2038
54	Undertake Preliminary Site Investigation 10 years prior to closure [1086414]	2033
55	Execute OOM Closure Study - Nammuldi WFSF closure design [878368]	2023
56	Investigate the revised SGE DP1/DHW design and confirm design appropriate to leave the DHW external at closure, and avoidance of safety risk associated with re-handling fibrous material [878259]	2022

Appendix 7: Brockman Operation Biological Knowledge Database

RioTinto

Brockman Operation Mine Closure Plan

Biological Knowledge Database

September 2022

IMS #

Hamersley Iron Pty Ltd

ABN: 49 004 558 276

RioTinto

Disclaimer and Limitation

This report has been prepared by Rio Tinto's Iron Ore Group (Rio Tinto), on behalf of Hamersley Iron Pty Limited (the Proponent), specifically for the Brockman Syncline Mine Closure Plan. Neither the report nor its contents may be referred to without the express approval of Rio Tinto.

Document Status		
Rev	**Author**	**Date**
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2	Casey Miller	September 2022

RioTinto

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1 PURPOSE

This document presents the current knowledge for biological baseline information relevant to the Brockman Operation.

Information supporting this document has been sourced from baseline surveys completed to support the following environmental approvals:

- Brockman Syncline 2 (BS2) – approved via Ministerial Statement (MS) 131 and 867;
- Brockman Syncline 4 (BS4) – approved via MS 1000;
- Nammuldi-Silvergrass – approved via MS 925; and
- Brockman Syncline Proposal – currently under assessment via Part IV of the Environmental Protection Act 1986 (EP Act).

This database will be reviewed in support of future Brockman Operation Mine Closure Plan (MCP) updates to ensure that the biological knowledge remains current.

At the time of drafting this document and the Brockman Operation MCP (2022) the BSP Development Envelope and the Closure Boundary were largely the same, with minor differences attributable to the MCP including minor access roads. These differences are not considered significant and therefore the use of the terms is interchangeable.

2 BIOREGION

The Interim Biogeographic Regionalisation for Australia (IBRA) divides the Australian continent into 89 geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (Thackway & Creswell 1995). The 89 bioregions are further divided into 419 sub-regions, which are more localised and homogenous geomorphological units within each bioregion.

The IBRA region represents a landscape-based approach to classifying the land surface, including climate, geomorphology, landform, lithology, and characteristic flora and fauna.

The Brockman Operation is located within the Pilbara IBRA bioregion, north of Western Australia. The Pilbara bioregion is divided into four sub-regions: Chichester, Roebourne, Fortescue Plains, and Hamersley. The Development Envelope is entirely within the Hamersley (PIL3) subregion (6,215,092 ha), which has significant mineral resources associated with the ranges and is described by Kendrick (2001) as:

> "Mountainous area of Proterozoic sedimentary ranges and plateaus, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine-textured soils in valley floors, and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges. The climate is semi-desert tropical, average 300 mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon. Drainage into either the Fortescue River (to the north), the Ashburton River to the south, or the Robe River to the west".

3 LAND SYSTEMS

The Brockman Operation is located within the western end of the Hamersley Ranges, on the southern side of the divide between the Ashburton and Robe Rivers. The Hamersley Ranges escarpment above Narraminju Wuntu (Caves Creek) rises steeply to around 300–400 m from the valley floor. The highest peak associated with the Brockman Operation is Juwunpa (Mount Brockman) (1,127 m), located adjacent to the B2N operation and is a dominant landscape feature.

The southern portion of the Brockman Operation is situated along the limbs of the Brockman Syncline, a prominent geological formation with ridgelines extending either side of Mount Brockman which reach around 300–400 m above the valley floor. These steep areas are characterised by rough, rocky features such as cliffs, gorges, rock outcrops and the Hamersley Range signature 'Bruno's Band' 'tram tracks' that typically outcrop horizontally along the slopes. Broad, flat to undulating plains extend from the edges of the steep hills and escarpments throughout the Development Envelope. The BS4 rail loop and associated infrastructure are located on a large floodplain area where elevation can occur up to 150 m above the adjacent valley floors.

In the northern portion of the Brockman Operation, the Nammuldi-Silvergrass consists of low undulating hills separated from the steep Brockman Iron Formation escarpments by the valley floors. Caves Creek, Kartajirri Wuntu (Duck Creek) and Pulykati Wuntu (Boolgeeda Creek) are the three main watercourses that divide the Brockman Operation Closure Boundary. Maliwartu Wunti (Beasley River) is east-southeast of the operation

The Brockman Operation intersects approximately 15 land systems, of which the Newman and Boolgeeda cover almost two-thirds of the Development Envelope (Table 3-1 & Figure 3-1). These two land systems are defined by plateaux, ridges and mountains progressing to stony lower slopes and plains.

Table 3-1: Description of Land Systems within the Development Envelope

Land system	Description	Extent in Closure Boundary	
		ha	%
Newman	Rugged, jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	14,042	32.2
Boolgeeda	Stony lower slopes and plains below hill systems and supporting hard and soft spinifex grasslands or mulga shrublands.	14,430	33.1
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard (and occasionally soft spinifex) grasslands.	4,923	11.3
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands	3,303	7.6
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grassland.	2,133	4.9
McKay	Hills, ridges, plateaux remnants and breakaways of meta sedimentary rocks supporting hard spinifex grasslands	1,761	4.0
River	Active floodplains and major rivers supporting grassy Eucalyptus woodlands, tussock grasslands and soft spinifex grasslands.	830	1.9
Wannamunna	Hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally Eucalyptus woodlands)	667	1.5
Table	Low calcrete plateaus, mesas and lower plains supporting mulga and cassia shrublands and minor spinifex grasslands.	400	0.9
Hooley	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands.	314	0.7
Nooingnin	Hardpan plains with very large groves supporting mulga shrublands.	277	0.6
Paraburdoo	Basalt derived stony gilgai plains and stony plains supporting snakewood and mulga shrublands with spinifex and tussock grasses.	275	0.6
Brockman	Alluvial plains with cracking clay soils supporting tussock grasslands.	200	0.5
Jurrawarrina	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.	56	0.1
Pindering	Gravelly hardpan plains supporting grooved mulga shrublands with hard and soft spinifex.	23	0.1

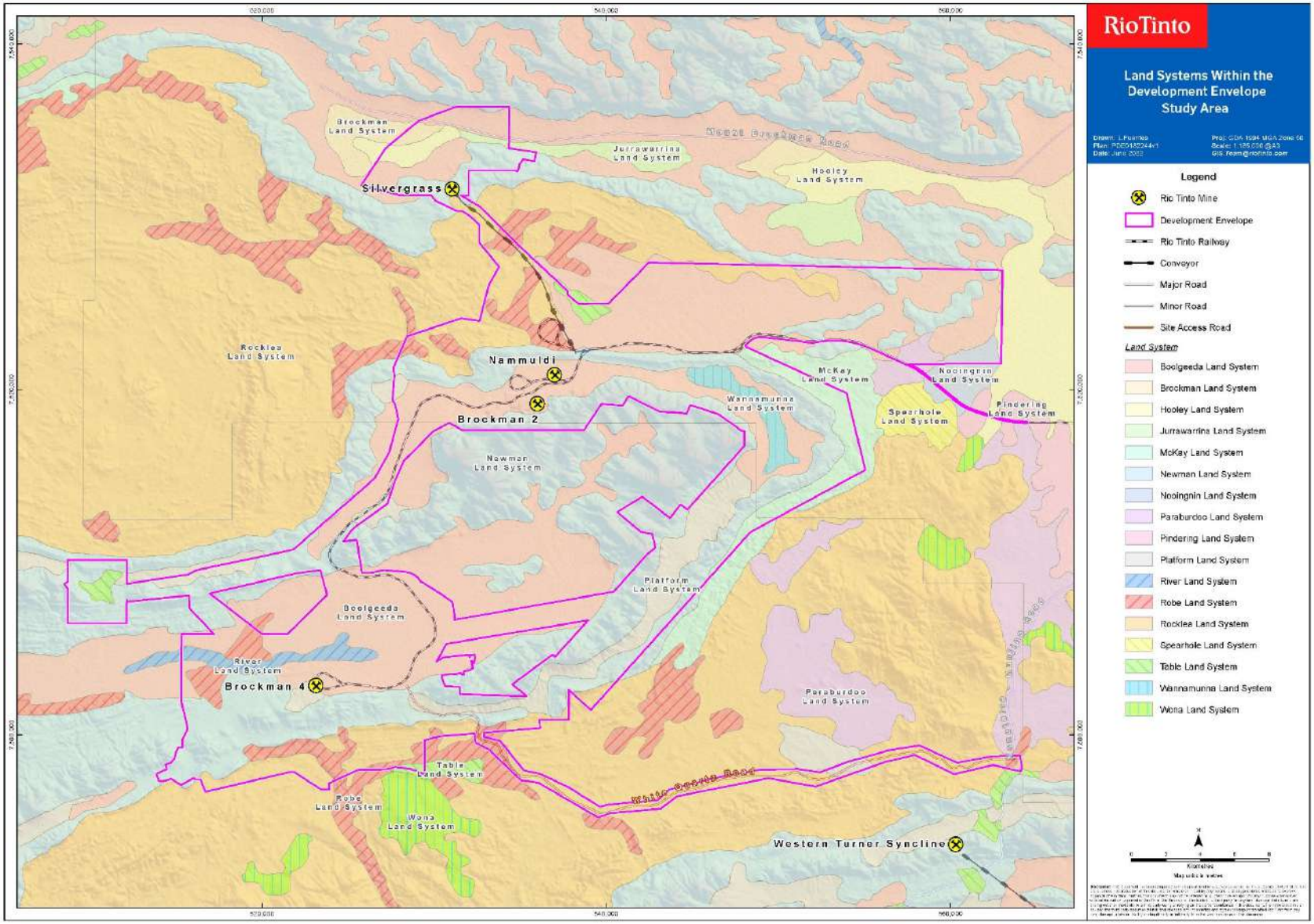


Figure 3-1: Land systems within the BSP Development Envelope

4 FLORA AND VEGETATION

The EPA's objective for flora and vegetation is to *protect flora and vegetation so that biological diversity and ecological integrity are maintained* (EPA 2021).

The Key Flora and Vegetation values identified in the Development Envelope include:

- Two vegetation types with Regional significance (P33 and A6)
- Seven vegetation types with High local significance
- 35 vegetation types with Moderate local significance
- Presence of Groundwater Dependent Ecosystems (GDE) and riparian vegetation
- 27 Priority flora species (including one species, *Tetratheca butcheriana* with potential to be listed as Critically Endangered).

This section describes the flora and vegetation that occurs within the BSP Development Envelope and regionally.

4.1 Studies and Survey Effort

Table 4-1 summarises the relevant regional surveys and studies undertaken for Flora and Vegetation. Key study/survey reports are referenced.

Table 4-1: Summary of Technical Studies for Flora and Vegetation

Study Area, Type and Timing	Consistency with Guidance
Greater Brockman Syncline: Consolidated Vegetation Type and Condition Mapping (Stantec 2021)	
Study/Survey area: The Development Envelope consists of previously mapped and unmapped areas of the Greater Brockman Operation hub. The consolidated vegetation mapping covered an area of 76,199 ha. This area had been ground truthed by multiple surveys in the last 5 years. **Type:** Desktop assessment and multi-phase ground-truthing, consolidation of previous and current vegetation type and condition mapping. The consolidated vegetation mapping layer was compiled using data from 58 surveys within the Development Envelope. **Timing:** 17 to 29 May, 11 to 23 August and 26 to 31 August 2019.	Survey meets relevant EPA Act policy and guidance. Survey approach and method were undertaken with consideration of the following: Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e) The following limitations and constraints associated with this report are detailed below: Vegetation types and condition have been extrapolated based on aerial imagery and surrounding habitat types. However, the whole survey area has been ground truthed within the last 5 years. The confidence of this consolidation mapping is limited by the quality, consistency, scope, seasonal conditions and date of previous reports.
Greater Brockman *Tetratheca butcheriana* Survey Effort Summary (Rio Tinto 2021).	
Study/Survey area: Targeted study area of 3,009 ha, based on known and potential locations of *T. butcheriana*. **Type:** Field surveys, historical survey information, geological information and desktop analyses were used to guide field searches, including foot traverses and helicopter surveys for new populations. **Timing:** 27 to 30 August 2019 and 24 to 25 October 2019	The survey methodology meets relevant EPA Act policy and guidance. Survey approach and method undertaken with consideration of the following: Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e) concerning targeted surveys
BS Riparian Vegetation Survey Duck Creek (Biologic 2021a)	
Study/Survey area: Duck Creek, 120 km watercourse located approximately 53 km northwest of Tom Price. **Type:** Desktop assessment and detailed riparian flora and vegetation assessment over two seasons, Phase 1 and Phase 2. Sixty-six quadrats were surveyed in both 2019 and 2020. **Timing:** 15 to 21 October and 24 October to 1 November 2019 (Phase 1) and 12 to 19 June 2020 (Phase 2).	Survey meets relevant EPA Act policy and guidance. Survey approach and method were undertaken with consideration of the following: Statement of Environmental Principles. Factors and Objectives (EPA 2021) Environmental Factor Guideline: Flora and Vegetation (EPA 2016d) Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e) Environmental Factor Guideline: Inland Waters (EPA 2018) Establishing Vegetation Transects (DEC 2009). The following limitations and constraints associated with this report are detailed below: The phase one survey followed below-average rainfall, which hindered the ability to confirm taxonomic identifications. Due to the global pandemic, transects were unable to be resampled during the phase two survey Some portions of the study area were inaccessible by vehicle, and quadrats were unable to be established.

Study Area, Type and Timing	Consistency with Guidance
	Some portions of Duck Creek were flooded during the phase two survey, which led to an underrepresentation of flora on creek banks than anticipated Some quadrats were re-scored on one side only due to inaccessibility as a result of flooding.
Brockman Syncline Proposal (Revised Operations) Baseline Groundwater Dependent Ecosystem Exposure Assessment for the Greater Brockman Operations (Biologic 2021b)	
Study/Survey area: Greater Brockman Operations hub, which encompasses the Development Envelope. **Type:** Desktop assessment to identify significant riparian vegetation containing potential GDEs and assess their exposure to potential impacts of groundwater drawdown or changes to catchment attributable to the BSP. **Timing:** No field survey was conducted.	N/A – The EPA has developed no guidance specific to this type of study. The study has drawn on hydrogeological, hydrological and vegetation studies undertaken for the BSP, based on relevant EPA guidance.
Brockman Syncline Riparian Vegetation Survey Boolgeeda Creek (Biologic 2020c). Prepared for Rio Tinto	
Study/Survey area: A 48 km stretch of Boolgeeda Creek, located within the Ashburton River basin and Duck Creek sub-catchment. **Type:** Desktop assessment and detailed riparian flora and vegetation assessment over two seasons, Phase 1 and Phase 2. Forty quadrats were sampled in 2019, and 24 resampled in 2020. **Timing:** 17 to 20 October and 27 October to 3 November 2019 (Phase 1) and 18 to 19 June 2020 (Phase 2).	Survey meets relevant EPA Act policy and guidance. Survey approach and method undertaken with consideration of the following: Statement of Environmental Principles. Factors and Objectives (EPA 2021) Environmental Factor Guideline: Flora and Vegetation (EPA 2016d) Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e) Environmental Factor Guideline: Inland Waters (EPA 2018) Establishing Vegetation Transects (DEC 2009). The following limitations and constraints associated with this report are detailed below: Foot traverses were used to complete the survey for a large portion of the study area due to inaccessibility The phase one survey was undertaken followed below-average rainfall, which resulted in an underrepresentation of the flora expected to occur Due to the global pandemic, time allocation for resampling of quadrats was impacted in the phase two survey, with a total of 29 quadrats unable to be resampled.
Brockman 2 Deposits Detailed Flora and Vegetation Survey: Phase 1 and 2 (Biota 2019a)	
Study/Survey area: Brockman Syncline 2 (BS2) (comprising BS2 South West tenure, BS2 South West non-tenure, BS2 West Extension and Maybelline), and Lens G/Diesel (comprising of Pit 14, Lens G, Lens G non-tenure, Diesel, Sandalford Monkey, BS3 and BS3 Extension). **Type:** Two phased detailed flora and vegetation survey. One hundred and fifty-six sites were surveyed, comprising 96 quadrats and 60 relevés. **Timing:** October 2018 and March 2019.	Survey approach and methodology were undertaken with consideration of the following: Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e) Environmental Factor Guideline: Flora and Vegetation (EPA 2016d).
Flora and Vegetation Assessment: Boolgeeda Valley, Pilbara, WA (Mattiske 2019). Prepared for Rio Tinto	

Study Area, Type and Timing	Consistency with Guidance
Study/Survey area: Boolgeeda valley area. **Type:** Single Phase Level 2 flora and vegetation survey. Two hundred and two sites (quadrats) were surveyed. **Timing:** May 2019 and June 2019	Survey approach and methodology were undertaken with consideration of the following: Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e) Environmental Factor Guideline: Flora and Vegetation (EPA 2016d).
Greater Brockman 4 Sustaining Tonnes Project: Detailed Flora and Vegetation Survey 2019 (Stantec 2019). Prepared for Rio Tinto	
Study/Survey area: BS1, BS1 Extension Area, Vivash, Infrastructure corridors (BS1 Eastern Corridor, Central Corridor and BS3). **Type**: Two detailed seasonal flora and vegetation surveys. One hundred and fifty-two sites were surveyed, comprising of 113 quadrats and 39 relevés. **Timing:** May 2019 and August 2019.	The survey approach and methodology were undertaken with consideration of the following: Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016e).

4.2 Vegetation

4.2.1 Threatened and Priority Ecological Communities

No Threatened Ecological Communities (TECs) as defined by the Environment Protection Biodiversity Conservation Act (EPBC Act) or the Biodiversity Conservation Act (BC Act), occur within the Development Envelope. The closest TEC is the Themeda grasslands on cracking clays (Hamersley Station, Pilbara), located approximately 1.2 km east of the Development Envelope (Figure 4-1).

One Priority Ecological Community (PEC) as defined by the Department of Biodiversity, Conservation and Attractions (DBCA 2022) occurs within the Development Envelope. This Priority 1 PEC is known as the Brockman Iron cracking clay communities of the Hamersley Range (DBCA 2022). One vegetation type (P33) was considered to represent the Brockman Iron Cracking Clay PEC of the Hamersley Ranges (P1) (Plate 4-1). Approximately 56 ha of this vegetation type is within the approved Silvergrass Mining Area and represents the westernmost known occurrence of this PEC (Figure 4-1; Biota 2019c). This PEC has been mapped in various locations outside the Development Envelope.

The PEC occurs on cracking clays derived in the valley or depositional floors of the Hamersley Range. It is described as a “rare tussock grassland dominated by *Astrebla lappacea* (DBCA 2022).

Four additional vegetation types (P27, P28, P29 and P31) were identified as sharing broad similarities to the Brockman Iron Cracking Clay PEC, such as the presence of Astrebla spp (mainly A. elymoides and A. pectinata). P27 is the only vegetation type to occur within the Development Envelope, covering 217.2 ha and is restricted to areas around the Silvergrass Mine and the NAP.



Plate 4-1: P33 Priority 1 PEC - Brockman Iron Cracking Clay Communities of the Hamersley Range

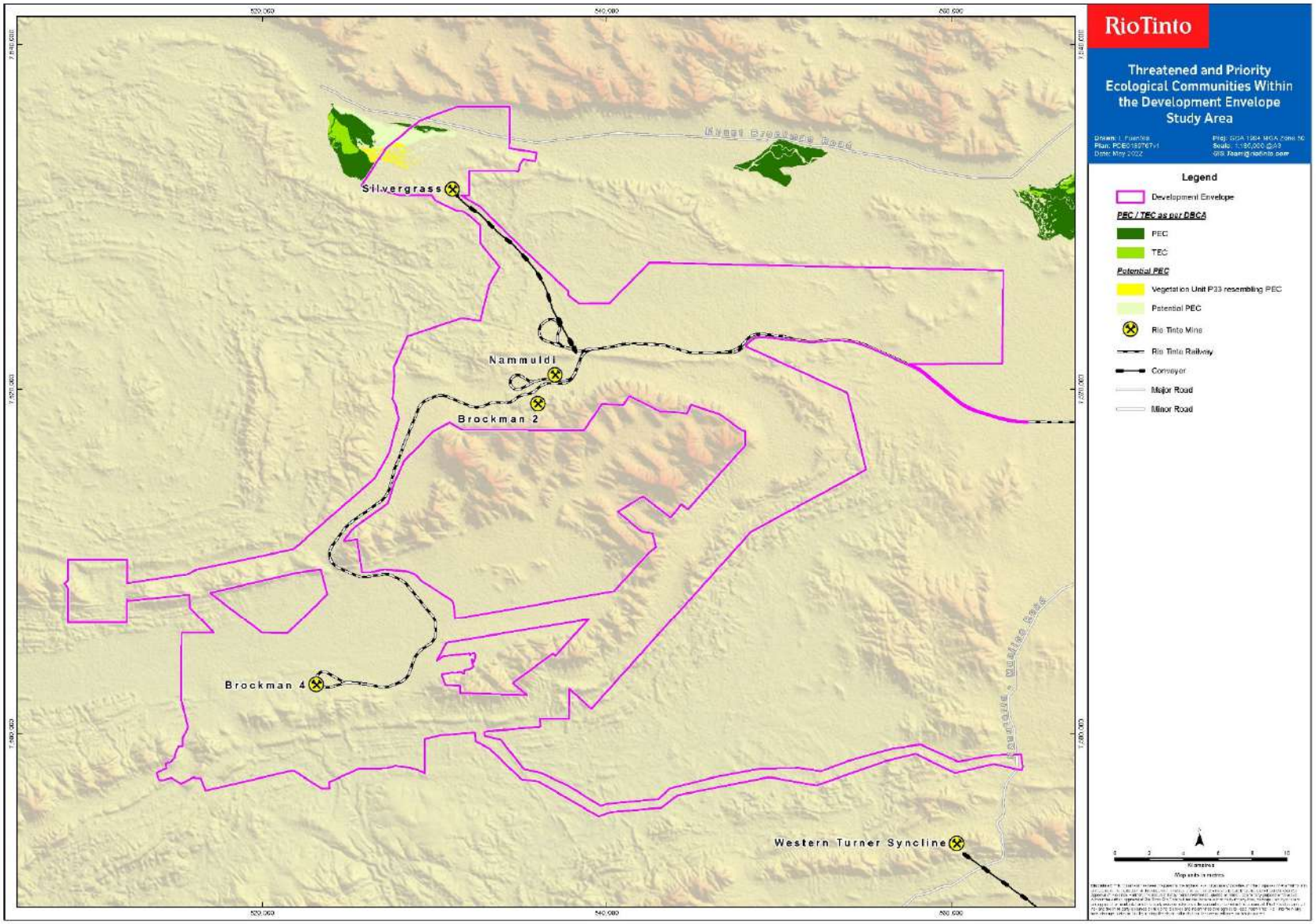


Figure 4-1: Threatened and Priority Ecological Communities within the BSP Development Envelope

4.2.2 Vegetation Types

Numerous (>360) vegetation surveys and mapping within or overlapping the Development Envelope have been undertaken over many years. Vegetation mapping from the 58 most suitable sources has been reviewed and consolidated, with a consolidated vegetation mapping layer produced (Stantec 2021).

Excluding 'Disturbed' areas, a total of 112 vegetation types (derived from 477 unique vegetation type codes from the original sources) have been mapped within the consolidated vegetation mapping area (Stantec 2021), and 104 occur within the Development Envelope (Table 4-2). In undertaking the analysis underpinning the consolidation process, some areas mapped according to a particular vegetation code were deemed suitable to be matched with another as part of a two-code mosaic; thus, 'mosaic' is denoted in Table 4-2 where appropriate. Note that all the vegetation codes comprising a mosaic unit also form their own standalone units (i.e., in areas determined not to be part of a mosaic unit). There is no overlap between them.

Dominant vegetation types within the Development Envelope include the following:

- P17: *Eucalyptus leucophloia* subsp. *leucophloia* (*Corymbia deserticola* subsp. *deserticola* and *C. hamersleyana*) scattered low trees and/or *E. gamophylla* scattered low mallees over *Acacia atkinsiana, A. exigua and A. bivenosa* shrubland over *Triodia epactia* and/or *T. wiseana* hummock grassland (occupying 7,409.8 ha or 17.0% of the Development Envelope)
- H26: *Eucalyptus leucophloia* subsp. *leucophloia* scattered low tree over *Acacia maitlandii* shrubland over *Triodia wiseana* open hummock grassland (occupying 6,333 ha or 14.5%)
- P24: *Corymbia deserticola* subsp. *deserticola* scattered low trees to low open woodland over *Eucalyptus gamophylla* low open mallee woodland over *Acacia exigua* and *A. atkinsiana* (*A. kempeana*) tall open shrubland over *Triodia wiseana* and *T. epactia* open hummock grassland (occupying 2,920 ha or 6.7% of the Development Envelope)

The extent of all vegetation types within the Development Envelope is presented in Figure 4-2.

Table 4-2: Vegetation types within the Development Envelope

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
Acacia 'aneura' Woodlands and Shrublands				
A1	AanAayTeTw	*Acacia 'aneura'* and *A. ayersiana* low woodland over *Triodia epactia* and *T. wiseana* open hummock grassland.	380	227
A2	AanAprAbAeTe	*Acacia 'aneura'* scattered low trees to low open woodland over *A. pruinocarpa* scattered tall shrubs over *A. bivenosa* and *A. exigua* open shrubland over *Triodia epactia* hummock grassland.	3,202	2,828
A3	AanAprTwTe	*Acacia aneura* (*A. pruinocarpa*) low open forest over *Triodia epactia* hummock grassland.	48	19
A4	Mosaic: AanAprTwTe/AxAanTspp	*Acacia aneura* (*A. pruinocarpa*) low open forest over *Triodia epactia* hummock grassland / *Acacia xiphophylla* (*A. 'aneura'*) tall shrubland over *Triodia* spp. very open hummock grassland.	1	1
A5	AanCHf	*Acacia 'aneura'* low open woodland over *Chrysopogon fallax* very open tussock grassland.	90	90
A6	AanCHfTe	*Acacia 'aneura'* low woodland over *Chrysopogon fallax* very open tussock grassland over *Triodia epactia* very open hummock grassland.	932	700
A8	AanGsTbrTlo	*Acacia 'aneura'* and *Grevillea saxicola* low open woodland over *Triodia brizoides* and *T. longiceps* very open hummock grassland.	1	1
A9	AanTeTw	*Acacia 'aneura'* low woodland to tall open scrub over *Triodia epactia* and *T. wiseana* very open hummock grassland.	1,359	945
A10	AanTspp	*Acacia 'aneura'* low open forest over *Triodia* spp. very open hummock grassland and mixed bunch grassland.	49	20
Creeklines and Floodplains				
C1	EvAciGOrSsAbApyTrFTeCc	*Eucalyptus victrix* low woodland over *Acacia citrinoviridis* and *Gossypium robinsonii* tall shrubland over *Stylobasium spathulatum, A. bivenosa* and *A. pyrifolia* scattered shrubs to open shrubland over *Tephrosia rosea* var. Fortescue creeks (M.I.H Brooker 2186) low open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* (*Themeda triandra*) tussock grassland.	122	69

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
C2	ExAciAlTHtTe	*Eucalyptus xerothermica* scattered low trees over *Acacia citrinoviridis* tall shrubland to tall open scrub over *Androcalva luteiflora*, (*A. maitlandii*) open shrubland over *Themeda triandra* very open tussock grassland over *Triodia epactia* very open hummock grassland.	336	336
C3	EcGOrSsANlTErTHtTe	Eucalyptus camaldulensis subsp. refulgens (E. victrix) scattered trees to open woodland over Gossypium robinsonii (Acacia citrinoviridis, A. coriacea subsp. pendens and Melaleuca glomerata) tall shrubland over Stylobasium spathulatum, Androcalva luteiflora shrubland over Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186) low shrubland over Themeda triandra very open tussock grassland and Triodia epactia very open hummock grassland.	53	51
C5	EvAciTeCc	*Eucalyptus victrix* scattered trees over *Acacia citrinoviridis* tall shrubland over *Triodia epactia* open hummock grassland and/or **Cenchrus ciliaris* open tussock grassland.	2	0.1
C6	EvEcChAcEUa	Eucalyptus victrix and E. camaldulensis subsp. refulgens woodland over Corymbia hamersleyana scattered low trees over Acacia citrinoviridis (*Vachellia farnesiana) tall open scrub over Eulalia aurea (Themeda triandra, Enteropogon ramosus, Dichanthium fecundum and Bothriochloa ewartiana) open tussock grassland.	124	56
C7	AciAbTe	Acacia citrinoviridis (Eucalyptus leucophloia subsp. leucophloia) low open woodland over Acacia bivenosa tall shrubland over Triodia epactia open hummock grassland.	49	38
C8	AciAtuAbTe	Acacia citrinoviridis (Eucalyptus leucophloia subsp. leucophloia) low open woodland over A. tumida var. pilbarensis and A bivenosa tall shrubland over Triodia epactia open hummock grassland.	10	9
C9	CdEgAatAeTw	*Corymbia deserticola* subsp. *deserticola* low open woodland over *Eucalyptus gamophylla* low open mallee woodland over *Acacia atkinsiana* (*A. exigua*) tall open shrubland over *Triodia epactia* and *T. wiseana* hummock grassland.	85	9
C10	ChAciGOsSsVfCcTHt	Corymbia hamersleyana low open woodland over Acacia citrinoviridis high shrubland over Gossypium sturtianum, Stylobasium spathulatum and *Vachellia farnesiana open shrubland over *Cenchrus ciliaris and Themeda triandra open tussock grassland to tussock grassland.	91	15

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
C11	ChAncAmonAbAciSaoTeTHtERmCc	*Corymbia hamersleyana* scattered low trees over *Acacia ancistrocarpa*, *A. monticola*, *A. bivenosa* and *A. citrinoviridis* tall open scrub over *Senna artemisioides* subsp. *oligophylla* scattered shrubs *Triodia epactia* open hummock grassland to hummock grassland and Themeda triandra, *Eriachne mucronata* and **Cenchrus ciliaris* scattered hummock grasses.	6	0.3
C12	Mosaic: ChAncAmonAbAciSaoTeTHtERmCc/Tw	*Corymbia hamersleyana* scattered low trees over *Acacia ancistrocarpa*, *A. monticola*, *A. bivenosa* and *A. citrinoviridis* tall open scrub over *Senna artemisioides* subsp. *oligophylla* scattered shrubs *Triodia epactia* open hummock grassland to hummock grassland and *Themeda triandra*, *Eriachne mucronata* and **Cenchrus ciliaris* scattered hummock grasses / *T. wiseana* hummock grassland.	131	3
C13	ChAtuGOrApyCOcPoTrFTHtTe	Corymbia hamersleyana low open woodland over Acacia tumida var. pilbarensis and Gossypium robinsonii tall open shrubland over A. pyrifolia open shrubland over Corchorus crozophorifolius, Ptilotus obovatus and Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186) low open shrubland over Themeda triandra (*Cenchrus ciliaris) very open tussock grassland	32	11
C14	ChElAlTrFTeEUaTHtCc	Corymbia hamersleyana low open woodland to low woodland over Eremophila longifolia and Androcalva luteiflora open shrubland over Tephrosia rosea var. Fortescue creeks (M.I.H Brooker 2186) (Acacia pyrifolia, Senna artemisioides subsp. oligophylla and Ptilotus obovatus subsp. obovatus) low open shrubland to low shrubland over Triodia epactia very open hummock grassland and Eulalia aurea, Themeda triandra and *Cenchrus ciliaris (Chrysopogon fallax, Cymbopogon ambiguus and Enneapogon robustissimus) tussock grassland.	1,592	1,390
C15	ChElGwGOrTsMBEUaPmTe	Corymbia hamersleyana and Eucalyptus leucophloia low woodland over Grevillea wickhamii tall shrubland over Gossypium robinsonii open shrubland over Themeda sp. Mt. Barricade, Eulalia aurea and Paraneurachne muelleri open tussock grassland or Triodia epactia hummock grassland.	119	93
C16	EcExAciAanTe	*Eucalyptus camaldulensis* and *E. xerothermica* low woodland over *Acacia citrinoviridis* and *A. 'aneura'* tall open shrubland over mixed tussock grassland and *Triodia epactia* very open hummock grassland.	582	543

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
C18	ElAciAbAmonTeTHt	*Eucalyptus leucophloia* low open woodland over *Acacia citrinoviridis, A. bivenosa* and *A. monticola* high shrubland over *Triodia epactia* open hummock grassland and *Themeda triandra* very open tussock grassland.	52	39
C20	ElChGOrApyTHtTe	Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana scattered low trees over Gossypium robinsonii and Acacia pyrifolia var. pyrifolia open shrubland over Themeda triandra very open tussock grassland over Triodia epactia very open hummock grassland.	24	23
C21	ElAbTe	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia bivenosa* shrubland over *Triodia epactia* hummock grassland.	50	30
C22	EvAciAtuApyTHtTe	*Eucalyptus victrix* open woodland over *Acacia citrinoviridis* scattered low trees over *Acacia tumida, A. bivenosa* and *A. pyrifolia* tall open shrubland over *Themeda triandra* very open tussock grassland over *Triodia epactia* very open hummock grassland.	90	81
C23	ExAciSsAbElTe	Eucalyptus xerothermica scattered low trees over Acacia citrinoviridis, Stylobasium spathulatum and Acacia bivenosa high shrubland over Eremophila longifolia open shrubland over Triodia epactia (Triodia angusta) hummock grassland.	100	67
C24	ExAciTeCc	*Eucalyptus xerothermica* open woodland over *Acacia citrinoviridis* low woodland over *Triodia epactia* very open hummock grassland with **Cenchrus ciliaris* and *Themeda triandra* tussock grassland.	313	228
C25	ExChAbAcAelaAeTeEUa	*Eucalyptus xerothermica* and *Corymbia hamersleyana* scattered low trees over *Acacia bivenosa*, *A. cowleana*, *A. elachantha* and *A. exigua* tall shrubland over *Triodia epactia* hummock grassland and *Eulalia aurea* open tussock grassland.	110	99
C26	ExChAsppGgTe	*Eucalyptus xerothermica* and/or *Corymbia hamersleyana* low open woodland over *Acacia* spp. and *Gastrolobium grandiflorum* open shrubland over *Triodia epactia* (*T. wiseana*) open hummock grassland.	156	81
C27	ExEvMgAciAcpAbTaTeTHtCc	Eucalyptus xerothermica and Eucalyptus victrix low open woodland to low woodland over Melaleuca glomerata, Acacia citrinoviridis, A. coriacea subsp. pendens and A. bivenosa tall shrubland over Triodia angusta and Triodia epactia very open hummock grassland and Themeda triandra and *Cenchrus ciliaris very open tussock grassland.	137	106

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
C28	EcFgFbTYdPLr	*Eucalyptus camaldulensis* subsp. *refulgens* open woodland over *Ficus geniculata* var. insignis, (*F. brachypoda*) low open woodland over *Typha domingensis* very open sedgeland with *Pluchea rubelliflora* scattered low shrubs.	0.3	0.3
C29	ElAmonAmaiAatTeTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia monticola*, *A. maitlandii* and *A. atkinsiana* tall open scrub over *Triodia epactia* and *T. wiseana* open hummock grassland.	621	508
C30	AancAciTe	*Acacia ancistrocarpa*, (*A. citrinoviridis*) tall open shrubland over *Triodia epactia* open hummock grassland.	30	19
Hills				
H1	ChAiAbTw	*Corymbia hamersleyana* low open woodland over *Acacia inaequilatera* and *A. bivenosa* open shrubland over *Triodia wiseana* hummock grassland.	2,057	1,960
H2	ElAbMeTw	*Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered tall shrubs over *Melaleuca eleuterostachya* over *Triodia wiseana* hummock grassland	53	42
H3	ElAeTw	*Eucalyptus leucophloia* scattered low trees over *Acacia exigua* open shrubland over *Triodia wiseana* open hummock grassland.	411	174
H4	ElTbr	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia brizoides* open hummock grassland.	824	816
H5	ElTe	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia epactia* open hummock grassland.	217	216
H6	EsTw	*Eucalyptus socialis* subsp. *eucentrica* low open mallee over *Triodia wiseana* open hummock grassland.	474	381
H7	AapAciTeTw	*Acacia* 'aneura' and *A. citrinoviridis* tall shrubland over *Triodia epactia* and *T. wiseana* open hummock grassland.	167	125
H8	AbAexAaTw	*Acacia bivenosa*, *A. exigua* and *A. ancistrocarpa* tall open shrubland over *Triodia wiseana* hummock grassland.	419	278
H9	AiTbr	*Acacia inaequilatera* scattered tall shrubs over *Triodia brizoides* hummock grassland.	203	155

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
H10	AiTw	*Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland.	589	231
H11	ElEpTspp	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Eucalyptus pilbarensis* low open mallee woodland over *Triodia longiceps*, *T. wiseana* and *T. epactia* open hummock grassland.	168	22
H13	ElAatAciAprAmarTwTe	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia atkinsiana*, *A. citrinoviridis* and *A. pruinocarpa* open shrubland over A. *marramamba* open shrubland over *Triodia wiseana* and *Triodia epactia* hummock grassland.	632	605
H14	ElAatAkAprTbrTeTw	Eucalyptus leucophloia (Corymbia hamersleyana) low open woodland over Acacia atkinsiana, A. kempeana and A. pruinocarpa shrubland over Triodia brizoides, Triodia epactia and Triodia wiseana hummock grassland.	597	43
H15	ElTaTl	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia angusta* and *T. longiceps* hummock grassland.	1,129	759
H16	AsiEeTe	*Acacia sibirica* low open woodland over *Eremophila exilifolia* scattered shrubs over *Triodia epactia* hummock grassland.	132	41
H17	ElAbTbr	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia bivenosa* open shrubland over *Triodia brizoides* hummock grassland.	301	212
H18	ElAbTbrTeTHsMBCa	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia bivenosa* open shrubland over *Triodia brizoides* and *T. epactia* hummock grassland with *Themeda* sp. Mt. Barricade (M.E. Trudgen 2471) and *Cymbopogon ambiguus* open tussock grassland.	1	0.2
H19	AcAbTw	*Acacia citrinoviridis* tall open shrubland over *Acacia bivenosa* open shrubland over *Triodia wiseana* very open hummock grassland	8	4
H20	ElAbTw	*Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* tall shrubland over *Triodia wiseana* hummock grassland.	284	181
H21	ElTwTbas	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia wiseana* (*Triodia basitricha*) open hummock grassland.	301	268
H23	ElAiTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland.	1,282	770

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
H24	ElAmaiAatAeTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia maitlandii*, *A. atkinsiana* and *A. exigua* open shrubland over *Triodia wiseana* hummock grassland.	1,060	552
H26	ElAmTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low tree over *Acacia maitlandii* shrubland over *Triodia wiseana* open hummock grassland.	8,904	6,333
H27	ElAmTwTe	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia maitlandii* open shrubland over *Triodia wiseana* and/or *T. epactia* open hummock grassland.	17	17
H28	ElAprAciTe	Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia pruinocarpa, A. citrinoviridis tall open shrubland.	6	6
H29	ElAprTwTe	*Eucalyptus leucophloia* scattered low trees over *Acacia pruinocarpa* (A. *atkinsiana*) tall open shrubland over *Triodia wiseana* and *Triodia epactia* hummock grassland.	367	219
H32	ElEgAbTwTbr	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *E. gamophylla* low open mallee woodland over *Acacia bivenosa* scattered shrubs over *Triodia wiseana* and *T. brizoides* open hummock grassland.	3	3
H33	ElEgAmaiTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *E. gamophylla* low open mallee woodland over *Acacia bivenosa* scattered shrubs over *Triodia wiseana* and *T. brizoides* open hummock grassland.	303	303
H34	Tw	*Triodia wiseana* hummock grassland.	925	376
H35	Mosaic: ElTbr/ElTe	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia brizoides* open hummock grassland / *Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia epactia* open hummock grassland.	277	223
H36	Mosaic: ElTe/ElTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia epactia* open hummock grassland / *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia wiseana* open hummock grassland.	1,572	721
H37	ElTlTw	*Eucalyptus leucophloia* subsp. leucophloia scattered low trees over *Triodia longiceps* and *Triodia wiseana* (*Triodia epactia*) hummock grassland.	128	74
H38	ElTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia wiseana* open hummock grassland.	1,584	838

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
Plains and Valleys				
P1	ElChAtuPlTe	Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana scattered low trees over Acacia tumida var. pilbarensis and Petalostylis labicheoides tall open scrub over Triodia epactia open hummock grassland.	18	9
P2	ElMeTaTw	*Eucalyptus leucophloia* scattered low trees over *Melaleuca eleuterostachya* open shrubland over *Triodia angusta* and *T. wiseana* open hummock grassland.	138	138
P3	AaAbTlTe	*Acacia ancistrocarpa* and *A bivenosa* shrubland to open heath over *Triodia longiceps* hummock grassland.	6	3
P4	ElAaAkApTbTeTw	Eucalyptus leucophloia (Corymbia hamersleyana) low open woodland over Acacia atkinsiana, A. kempeana and A. pruinocarpa shrubland over Triodia brizoides, Triodia epactia and Triodia wiseana hummock grassland.	4	4
P5	ElAatTeTw/ElAbAatTePm	*Eucalyptus leucophloia* scattered low trees over *Acacia atkinsiana* scattered shrubs over *Triodia epactia* open hummock grassland / *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* and *A. atkinsiana* high shrubland over *Triodia epactia* open hummock grassland and *Paraneurachne muelleri* very open tussock grassland.	677	117
P6	ElAbAeTaTw	*Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered tall shrubs over *A. exigua* open shrubland over *Triodia angusta* and *T. wiseana* open hummock grassland.	76	76
P7	AxAanTspp	*Acacia xiphophylla* (*A. 'aneura'*) tall shrubland over *Triodia* spp. very open hummock grassland.	562	366
P8	AxERmaSENspp	*Acacia xiphophylla* scattered shrubs to open shrubland over *Eremophila maculata* subsp. *brevifolia* and *Senna* spp. low shrubland over Mixed bunch grasses and herbs	188	76
P9	AxSlfSENsppTl	*Acacia xiphophylla* tall shrubland over *Sida fibulifera* (*Senna artemisioides* subsp. *oligophylla* x subsp. *helmsii, Senna* sp. Karijini (M.E. Trudgen 1392)) low shrubland over *Triodia longiceps* scattered hummock grasses.	3	0.5
P10	CdExAanAatAbTeTHt	Corymbia deserticola subsp. deserticola and Eucalyptus xerothermica scattered mallees over Acacia 'aneura', A. atkinsiana and A. bivenosa high shrubland	1,932	1,606

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
		over Triodia epactia open hummock grassland and Themeda triandra very open tussock grassland.		
P11	ChElAbAsynAancTw	Corymbia hamersleyana and Eucalyptus leucophloia subsp. leucophloia open woodland over Acacia bivenosa, A. synchronicia and A. ancistrocarpa scattered tall shrubs to high open shrubland over Triodia wiseana open hummock grassland.	168	85
P12	EgAatAbAeTeTw	Eucalyptus gamophylla scattered mallees over Acacia atkinsiana, A. bivenosa and A. exigua tall open shrubland over Triodia epactia and T. wiseana hummock grassland.	33	22
P13	ElAeTl	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia exigua* shrubland over *Triodia longiceps* tall hummock grassland.	159	159
P14	ElAtAbAsyAtenTbas	Eucalyptus leucophloia scattered low trees over Acacia tetragonophylla, A. bivenosa, A. synchronicia and A. tenuissima open shrubland over Triodia basedowii hummock grassland with mixed herbs.	441	414
P15	ElAxAsiAtMeTa	Eucalyptus leucophloia scattered low trees over Acacia xiphophylla, A. sibirica, A. tetragonophylla and Melaleuca eleuterostachya scattered shrubs over Triodia angusta hummock grassland.	179	154
P16	ElCdEgAatAeTwTe	Eucalyptus leucophloia subsp. leucophloia and Corymbia deserticola subsp. deserticola scattered low trees over Eucalyptus gamophylla scattered low mallees over Acacia atkinsiana and A. exigua tall open shrubland over Triodia wiseana and/or T. epactia hummock grassland	2,605	1,274
P17	ElEgAatAeAbTeTw	Eucalyptus leucophloia subsp. leucophloia (Corymbia deserticola subsp. deserticola and C. hamersleyana) scattered low trees and/or E. gamophylla scattered low mallees over Acacia atkinsiana, A. exigua and A. bivenosa shrubland over Triodia epactia and/or T. wiseana hummock grassland.	11,958	7,410
P18	ElAsyAbSENsppTbr	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia synchronicia*, *A. bivenosa* and *Senna* spp. scattered shrubs over *Triodia brizoides* open hummock grassland.	187	53
P19	ElEsAbTw	*Eucalyptus socialis* subsp. *eucentrica* low open mallee woodland to low mallee woodland over *Acacia bivenosa* scattered shrubs over *Triodia wiseana* open hummock grassland.	1,025	928

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
P20	ElEsMeAeTlTw	Eucalyptus leucophloia subsp. leucophloia low open woodland over E. socialis subsp. eucentrica very open mallee over Melaleuca eleuterostachya and Acacia exigua shrubland over Triodia longiceps and T. wiseana hummock grassland.	670	570
P21	ExEsAbAsyTw	*Eucalyptus xerothermica* and *E. socialis* subsp. *eucentrica* low open mallee woodland over *Acacia bivenosa* and *A. synchronicia* tall open shrubland over *Triodia wiseana* low hummock grassland.	36	13
P23	ElAeAsiTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia exigua* and *A. sibirica* scattered tall shrubs to tall open shrubland over *Triodia wiseana* hummock grassland.	103	97
P24	CdEgAeAatTeTe	*Corymbia deserticola* subsp. *deserticola* scattered low trees to low open woodland over *Eucalyptus gamophylla* low open mallee woodland over *Acacia exigua* and *A. atkinsiana* (*A. kempeana*) tall open shrubland over *Triodia wiseana* and *T. epactia* open hummock grassland.	2,986	2,920
P25	ElAbCAPuTspp	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia bivenosa* scattered tall shrubs over *Capparis umbonata* scattered shrubs over *Triodia epactia* open hummock grassland.	16	16
P26	ElGsGOOsTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Grevillea saxicola* scattered tall shrubs over *Triodia wiseana* very open hummock grassland and *Goodenia stobbsiana* very open herbland.	2	2
P27	ARlCHfERAxASe	Aristida latifolia and Chrysopogon fallax (Eragrostis xerophila and Astrebla elymoides) tussock grassland.	265	217
P30	ERb	*Eriachne benthamii* tussock grassland.	35	3
P33	ASlASp	Astrebla lappacea and A. pectinata tussock grassland	95	40
P35	Herb	Mixed herbland.	47	13
P37	ElExAiTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Eucalyptus xerothermica* scattered low mallees to low open mallee woodland over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* open hummock grassland.	82	28
G1	CfAanAciPROaPToCYaTHtARb	Corymbia ferriticola, Acacia ‘aneura’ woodland over A. citrinoviridis tall shrubland over Eremophila latrobei subsp. latrobei, Santalum lanceolatum,	0.8	0.8

Vegetation Type	Vegetation Code	Description	Total Extent in Survey Area (ha)*	Total Extent in Closure Boundary (ha)*
		Dodonaea pachyneura, (Gossypium robinsonii) tall open shrubland over Prostanthera albiflora, Ptilotus obovatus subsp. obovatus, (Corchorus crozophorifolius) low shrubland over Cymbopogon ambiguus (Themeda triandra and Aristida burbidgeae) open tussock grassland.		
G2	ChAsppTHtTeTw	*Corymbia hamersleyana* low open woodland over *Acacia* spp. tall shrubland over *Themeda triandra* very open tussock grassland over *Triodia epactia* and *T. wiseana* open hummock grassland.	66	43
G3	ElCfAprAanDpERImTe	Eucalyptus leucophloia subsp. leucophloia, Corymbia ferriticola, Acacia pruinocarpa and A. ‘aneura’ low open woodland over Dodonaea pachyneura scattered tall shrubs over Triodia epactia very open hummock grassland with Eriachne mucronata open tussock grassland.	994	415
G4	ElCfAciAanGbDpTe	Eucalyptus leucophloia subsp. leucophloia, Corymbia ferriticola, Acacia citrinoviridis, A. ‘aneura’, (Grevillea berryana) low woodland over Dodonaea pachyneura tall over Triodia epactia very open hummock grassland.	39	20
**Area rounded up to the nearest ha*				

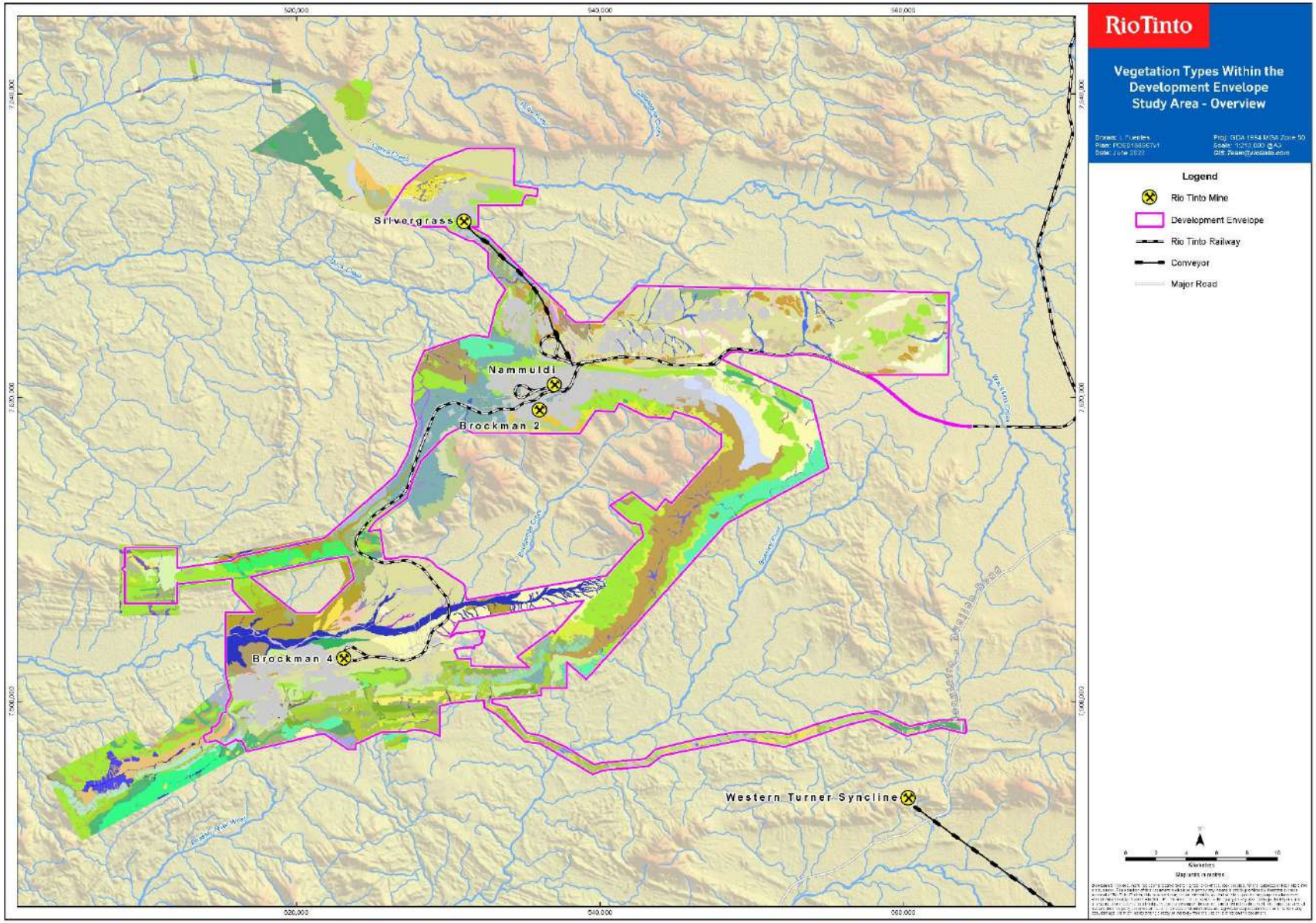


Figure 4-2: Vegetation types within the BSP Development Envelope

4.2.3 Vegetation Condition

The condition of native vegetation within the Development Envelope ranges from Excellent to Completely Degraded (cleared) (Plate 4-2 ;Stantec 2021). Vegetation condition within the Development Envelope is considered consistent with that observed locally and within the Pilbara region (Stantec 2019). Riparian vegetation types were typically observed to be in poorer condition than upland areas due to weed infestation and cattle grazing pressure (Stantec 2019; Biologic 2020a; Biologic 2021a).



Plate 4-2: Riparian Vegetation (Acacia low open woodland) Condition (Duck Creek (left), Boolgeeda Creek (Right) (Source: Biologic 2021a;b)

4.2.4 Riparian Vegetation

Riparian vegetation occurs in the major creeklines that intersect the Development Envelope (Boolgeeda Creek, Duck Creek and Caves Creek) as well as the minor tributaries of these creeklines.

Nineteen vegetation types were identified that support riparian vegetation within the Development Envelope (Table 4-3; Figure 4-3) (Stantec 2021). Riparian vegetation types have also been mapped beyond the Development Envelope to the proposed wetting fronts in Boolgeeda Creek and Duck Creek, as well as Caves Creek west of SGE to the confluence with Duck Creek (Stantec 2021).

Table 4-3: Vegetation Types Identified to Support Riparian Vegetation

Vegetation Type	Vegetation Code	Drainage System	Extent within Survey Area (ha)	Extent within Closure Boundary (ha)*
High Local Significance				
C3(DkCk)	EcGOrSsANlTErTHtTe	Major	27	25
C6	EvEcChAcEUa	Major	124	56
C28	EcFgFbTYdPLr	Moderate	<1	<1
Moderate Local Significance				
C1	EvAciGOrSsAbApyTrFTeCc	Moderate	122	69
C3	EcGOrSsANlTErTHtTe		28	26
C27	ExEvMgAciAcpAbTaTeTHtCc		137	106
Low Local Significance				
C5	EvAciTeCc	Minor local	2	<1
C7	AciAbTe		49	38
C8	AciAtuAbTe		10	9
C9	CdEgAatAeTw		85	9
C10	ChAciGOsSsVfCcTHt		91	15
C11	ChAncAmonAbAciSaoTeTHtERmCc		5	<1
C12	ChAncAmonAbAciSaoTeTHtERmCc/Tw		131	3
C15	ChElGwGOrTsMBEUaPmTe		119	93
C20	ElChGOrApyTHtTe		24	23
C23	ExAciSsAbElTe		100	67
C24	ExAciTeCc		313	228
C25	ExChAbAcAelaAeTeEUa		110	99
C26	ExChAsppGgTe		156	81

All numbers have been rounded to the nearest whole ha

The riparian vegetation supported by Boolgeeda Duck Creek and Caves Creek is of high local significance. It has a higher diversity of species than other riparian vegetation units and several Priority flora species (discussed further in Section 4.3.1). The vegetation types along these creeks are dominated by species that are known to have the potential of being ground water dependent (*Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix*); this is discussed in Section 4.2.5. These species are common to riparian vegetation units throughout the Pilbara bioregion. The effects of weeds and cattle grazing are impacting some of these riparian vegetation units. (Biologic 2020c) (Biologic 2021a).

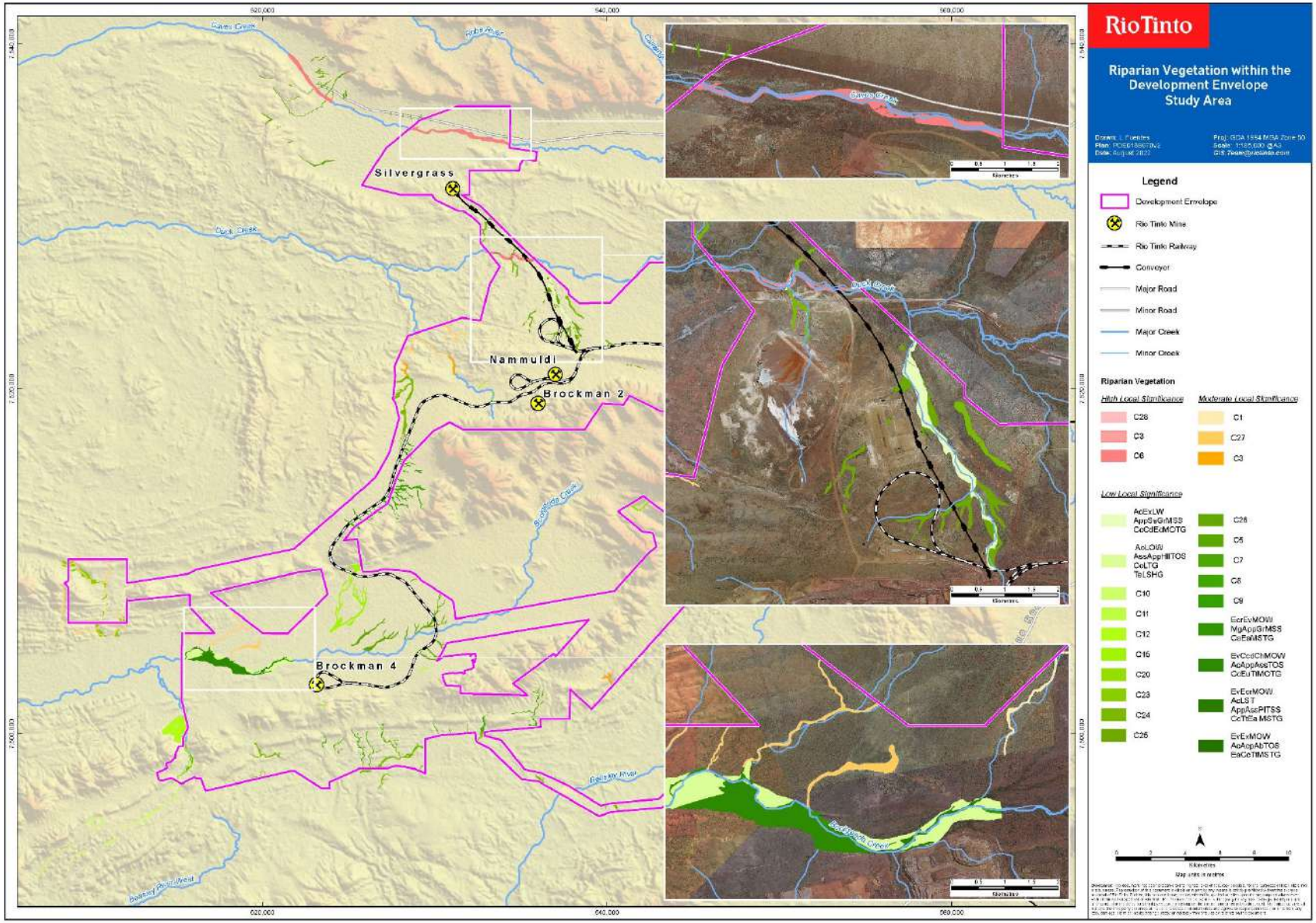


Figure 4-3: Riparian Vegetation within the BSP Development Envelope

4.2.5 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are terrestrial, aquatic or subterranean ecosystems that require access to groundwater to persist in the landscape (Biologic 2021b) and, therefore only occur where the water table is shallow. Aquatic fauna that may inhabit groundwater dependent waterbodies is addressed in Section 6.2. Subterranean ecosystems dependent on groundwater are addressed in relation to stygofauna in Section 7. This chapter focuses on groundwater dependent vegetation (GDV) and the ecosystems they support.

Terrestrial GDEs rely on shallow groundwater typified by GDV species, called phreatophytes. Phreatophytes may be classified as either obligate or facultative depending on their reliance on groundwater (Eamus et al. 2016 cited in Biologic 2021b). Obligate phreatophytes are confined to habitats with access to, and are highly dependent on, groundwater. Facultative phreatophytes will use groundwater where it is available but can also exist in environments without access to groundwater. Not all riparian vegetation is groundwater dependent; vadophytes are commonly associated with drainage lines and rely on moisture in the soil profile, independent of groundwater (Biologic 2020b; 2021a).

Three tree species considered keystone Pilbara phreatophytes are *Melaleuca argentea* (obligate phreatophyte), and *Eucalyptus camaldulensis* subsp. *refulgens* (facultative phreatophyte) and *Eucalyptus victrix* (facultative phreatophyte or a vadophyte) (Biologic 2020a; Biologic 2021a; Biologic 2021b).

The depth to groundwater in the Development Envelope is generally well beyond the rooting depth of vegetation (approximately 20 mbgl), limiting the potential for groundwater dependence to low-lying areas. A GDE assessment was conducted to identify areas of vegetation that are potentially groundwater dependent (Biologic 2021b) within a ‘broad hydrological development zone’ (Figure 4-4;Plate 4-3), an area of interest developed for the GDE study where aquifers may be connected or are close to those being dewatered for the Brockman Operation (Biologic 2021b). This zone was deliberately larger than the Development Envelope so that any changes to the Brockman Operation and groundwater model would not result in gaps in the GDE study.

Long-term normalised difference vegetation index (NDVI) and normalised difference water index (NDWI) satellite data was used to identify areas with persistent vegetation cover and ‘greenness’ indicating potential additional access to water (Biologic 2021b). These areas were then subject to aerial imagery review of various characteristics such as species composition, vegetation density, landscape position and eco-physical properties to determine areas where vegetation appears to have greater access to water than surrounding areas. This resulted in 54 features identified within the broad hydrological development zone with persistent vegetation and potential for groundwater dependence based on topography and regional groundwater depth.

The likely groundwater dependence of the 54 potential GDE features was assessed and refined:

- Initially using regional hydrogeological information
- Refined using biological survey data and ground truthing at ten sites
- Further refined using project hydrogeological data and pre-mining groundwater levels
- Aerial photo interpretation.

Generally, groundwater levels deeper than 15 m were considered too deep for vegetation to access and were excluded as potential GDE; except where *Eucalyptus camaldulensis* was identified from aerial imagery as this species can sometimes access groundwater beyond 20 m (Plate 4-3; Biologic 2021b).

The process identified 28 features with some potential for groundwater dependence in the broad hydrological development zone and there have been none recorded in the SGE Development area. Mallumallu Springs (Palm Springs) is located outside the Development Envelope located in Caves Creek downstream of SGE, upstream of the Duck Creek confluence and represents a series of groundwater dependent pools. Of the other 28 features with potential groundwater dependence identified:

- Two features were of potential ‘high’ dependence

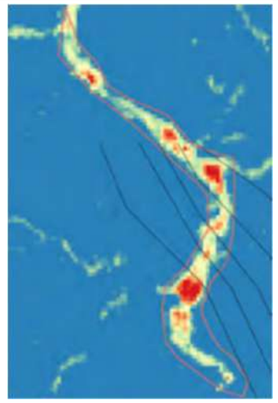
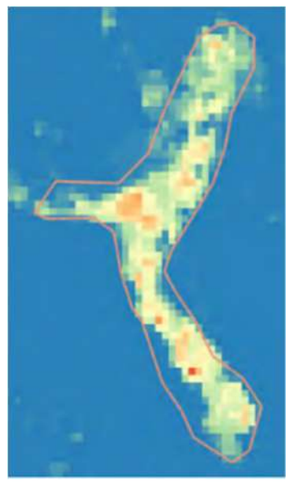
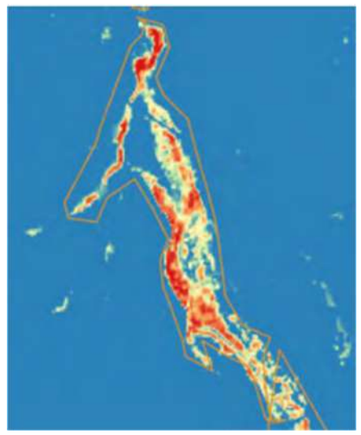
- Nine features were of ‘moderate’ dependence although some features rely on perched groundwater or other water sources
- 17 features were of ‘low’ dependence and are not discussed further.

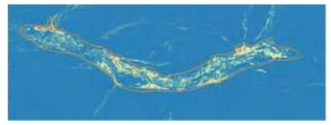
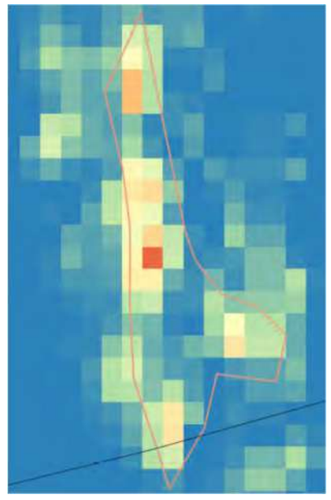
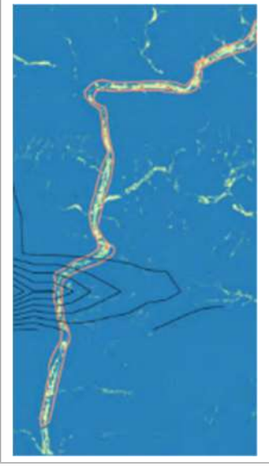
The eleven GDE features of moderate to high potential groundwater dependence are outlined in Table 4-4 and shown in Figure 4-5.

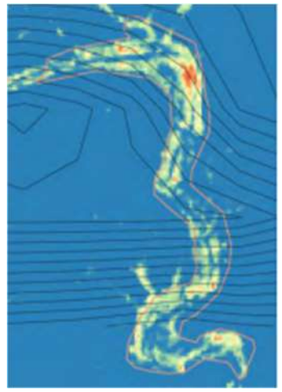
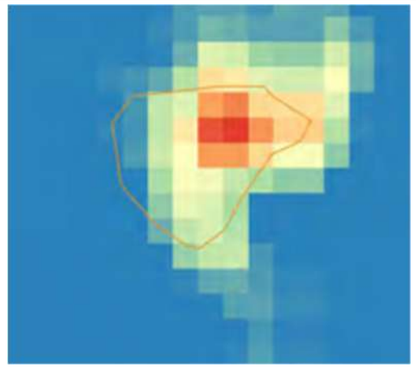
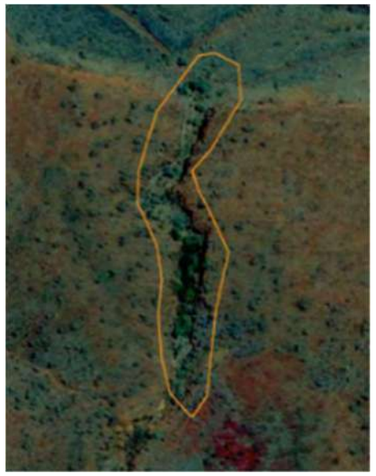
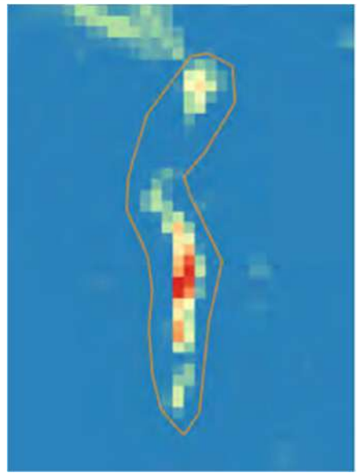


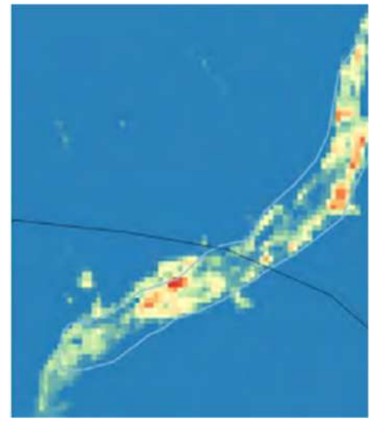
Plate 4-3: Example of *Eucalyptus camaldulensis* (Orange Circles) and *E .victrix* (green Circles) on High-Resolution Aerial Photography Source: Biologic 2021b

Table 4-4: Potential GDE features identified within the BSP Development Envelope

Feature ID	Name/Location	Key Characteristics	Aerial Photo	NDVI Persistence Mapping
109	Duck Creek catchment BS2 approx. 4 km north-west of Pit 3a	GDV present; high NDVI persistence; groundwater potentially within ≤5 m of the surface Likely high dependence		
355	Plunge Pool BS3	GDV present; scattered high NDVI persistence (coinciding with eucalypts). Upper catchment likely to be impacted; groundwater likely within ≤5 m of the surface. Likely high dependence		
130	Duck Creek catchment BS2 west of the existing Nammuldi processing area	Possible minor GDV present; within existing periodic discharge wetting front. Likely moderate dependence		

Feature ID	Name/Location	Key Characteristics	Aerial Photo	NDVI Persistence Mapping
89	Boolgeeda Creek catchment	Within Boolgeeda Creek discharge zone, which is likely to be influencing NDVI persistence. Likely moderate dependence		
90	Ridge Pool Outside of Development Envelope	Known ephemeral pool high in the landscape and not connected to groundwater. Groundwater report concluded likely moderate dependence. However, any groundwater would be perched and therefore this feature is not further assessed.	-	-
108	Duck Creek catchment BS2	Low density of eight *E. camaldulensis* with scattered high NDVI. Likely moderate dependence		
118	Boolgeeda Creek catchment BS1	Long ephemeral creek; coincides with calcrete geology; scattered high NDVI persistence; groundwater likely within ≤15 m of the surface Likely moderate dependence		

Feature ID	Name/Location	Key Characteristics	Aerial Photo	NDVI Persistence Mapping
119	Boolgeeda Creek catchment BS1	Ephemeral creek; coincides with calcrete geology; scattered high NDVI persistence; groundwater likely within ≤15 m of the surface Likely moderate dependence		
93	Beasley River catchment Outside Development Envelope near BS3 and Lens G/Diesel boundary	Possible minor GDV present; groundwater possible within ≤15 m of the surface Likely moderate dependence		
284	Boolgeeda Creek Catchment Outside Development Envelope approx. 5 km west of BS1	Minor GDV likely present; located in a tight gorge. May rely on small perched aquifers. Likely moderate dependence		

Feature ID	Name/Location	Key Characteristics	Aerial Photo	NDVI Persistence Mapping
117	Boolgeeda Creek Catchment BS2 (at BS1 boundary)	Broad ephemeral channel: No GDV present based on field investigation. Calcrete occurs in this area and feature likely to be inflow dependent. Groundwater likely within ≤15 m of the surface so conservatively considered likely moderate dependence.		

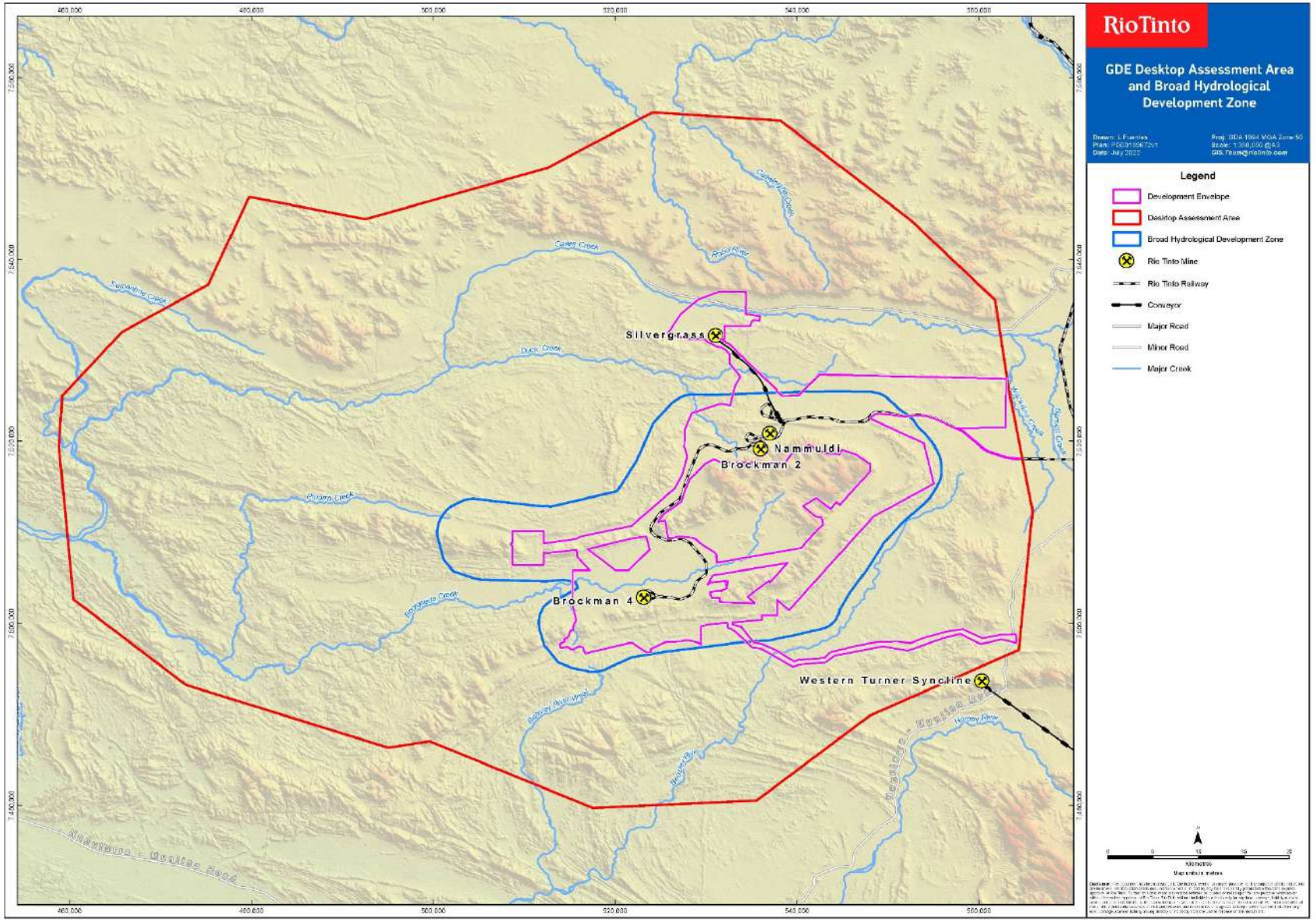


Figure 4-4: GDE Assessment Area and Broad Hydrological Development Zone

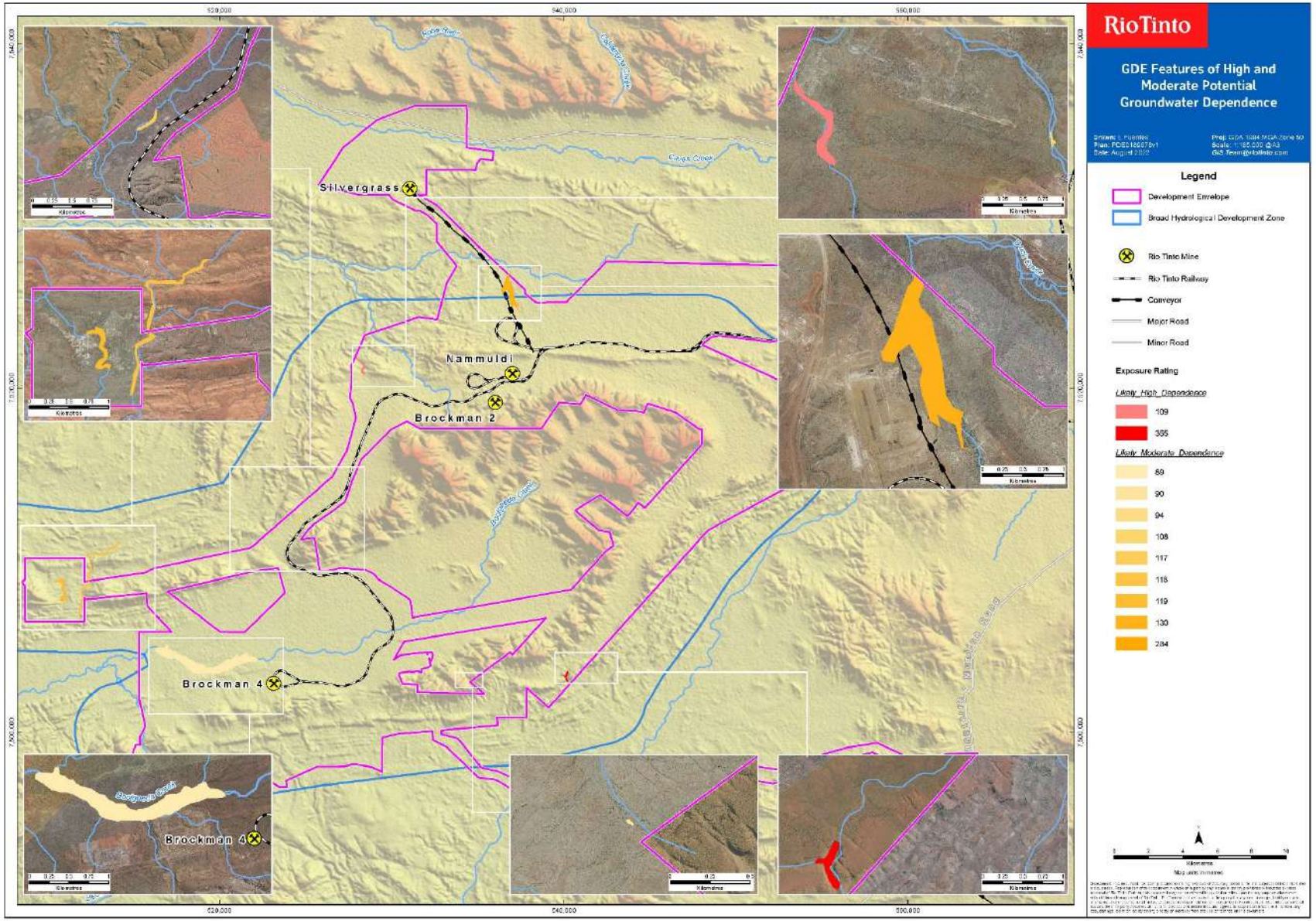


Figure 4-5: Potential GDE Features within the Broad Hydrological Development Zone

4.2.6 Nammuldi Agriculture Project

The Nammuldi Agriculture Project (NAP) was approved under MS 925 and commenced operation in 2014. The project uses centre pivot irrigation systems to deliver water under controlled conditions to provide a beneficial use for excess water from the Nammuldi mining area. A similar system is also in operation at Rio Tinto's Marandoo mine (the Hamersley Agriculture Project). Up to 40 pivots, each approximately 50ha, have been approved for the NAP. As of 2016, 19 pivots have been installed (Rio Tinto 2017). The NAP is located within the Diversification Permit Area.

Crops grown at NAP include *Chloris gayana* (Rhodes Grass), *Avena sativa* (Winter Oats) and *Medicago sativa* (Lucerne). All crops are grown for hay production which is used as a supplementary feed source for cattle and other livestock. Hay is used directly on Rio Tinto owned pastoral stations as well as sold to other pastoral operations. All crops grown at NAP have been listed as permitted plants by the Department of Agriculture and Food and given a low weed rating under the Department of Parks and Wildlife *Environmental Weed Strategy*.

Reviews of the invasive potential of the crop species have been undertaken. The species are not suited to low moisture and low nutrient conditions. Rio Tinto concluded that whilst they may establish occasionally in native vegetation, they are unlikely to persist in non-irrigated areas in the Pilbara except in disturbed and artificially watered environments (e.g. road verges subject to ongoing application of water for the purposes of dust suppression).

Operational management triggers have been developed to ensure that the crop species do not spread beyond a 30 m buffer surrounding the agricultural pivot cells. Management and monitoring programs will continue post-closure for as long as required but are not considered further in this closure plan.

4.3 Flora

A total of 902 flora taxa have been recorded within the Development Envelope, comprising 866 native and 36 introduced species. These represent a total of 76 families and 246 genera with Poaceae, Fabaceae, Malvaceae, Asteraceae and Amaranthaceae the dominant families. *Acacia, Ptilotus, Cenchrus, Side,* and *Senna* were the most dominant genera.

4.3.1 Threatened and Priority Flora

Significant flora includes species listed under the EPBC Act, the BC Act, or Priority species identified by DBCA as requiring further protection (EPA 2016a). Significant flora can also include species that are locally endemic or associated with a restricted habitat type, occur as range extensions, are a new species or have anomalous features that indicate a potential new species, represent a restricted subspecies, varieties or hybrids, or are relictual representatives of taxonomic groups that no longer occur widely in the broader landscape.

No Threatened flora species currently listed under the EP Act or EPBC Act have been recorded within the Development Envelope. However, *Tetratheca butcheriana*, currently identified as Priority 1 by the Department of Biodiversity, Conservation and Attractions (DBCA) and recorded within the Development Envelope, meets International Union for Conservation of Nature (IUCN) criteria to be recognised as Critically Endangered and; therefore, there is potential for it to be formally listed as such under the BC Act in the future.

Five Priority flora species were recorded within earlier iterations of the Development Envelope but have since been excluded from the current Development Envelope, including:

- Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684) (P1)
- Euphorbia australis var. glabra (P3)
- Swainsona thompsoniana (P3).

No species recorded within the Development Envelope were considered to represent potential range extensions or meet other criteria defining them as significant taxa. The following priority species have been recorded within the Development Envelope (Figure 4-6):

- Priority 1 (potential to be listed as critically endangered):
  - *Tetratheca butcheriana*
- Priority 1:
  - *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
- Priority 2:
  - *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
  - *Hibiscus* aff. sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
  - *Ipomoea racemigera*
  - *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
  - *Pentalepis trichodesmoides* subsp. *hispida*
- Priority 3-
  - *Aristida jerichoensis* var. *subspinulifera*
  - *Astrebla lappacea*
  - *Dampiera anonyma*
  - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)
  - *Eremophila magnifica* subsp*. velutina*

- *Grevillea saxicola*
- *Gymnanthera cunninghamii*
- *Indigofera gilesii*
- *Indigofera rivularis*
- *Ptilotus subspinescens*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia basitricha*

- Priority 4:
  - *Acacia bromilowiana*
  - *Eremophila magnifica* subsp*. magnifica*
  - *Goodenia nuda*
  - *Lepidium catapycnon*

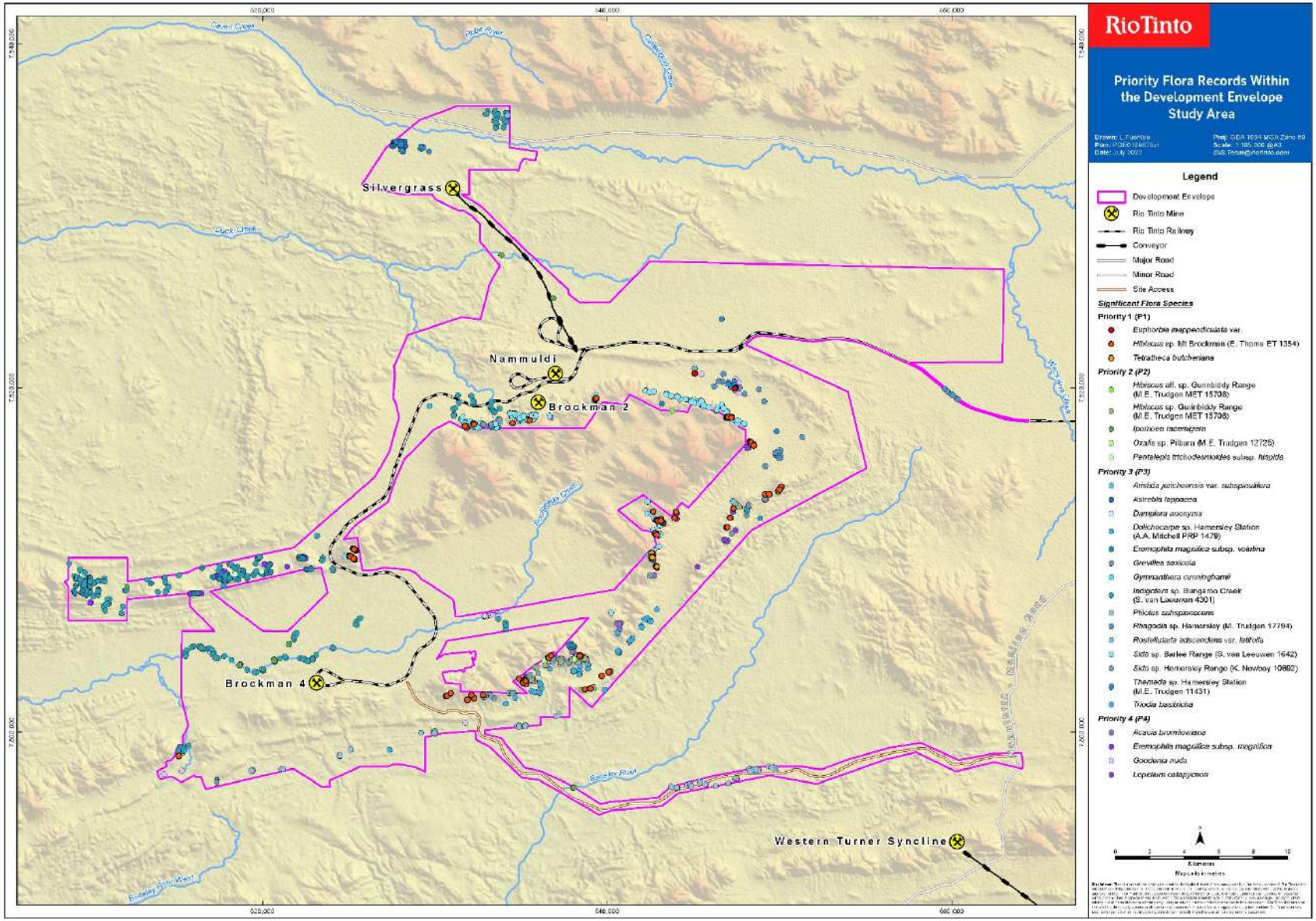


Figure 4-6: Priority Flora records in the BSP Development Envelope

4.4 Introduced Flora (Weeds)

A total of 39 introduced flora species (weeds) have been recorded within the Brockman Operation Development Envelope from multiple surveys (Stantec 2021, Biota 2019a, Mattiske 2019 and Stantec 2019). These species are listed in Table 4-5 and are largely found in low lying areas and along creek lines.

None of these species are listed as Weeds of National Significance or declared plants for the Pilbara region under the *Biosecurity and Agriculture Management Act 2007* (WA) or as a Weed of National Significance (WoNS) on the Western Australian Organism List (WAOL) database.

The Department Biodiversity, Conservation and Attractions (DBCA) Weed Species Ranking for each of these weeds is also detailed in Table 4-5. This ranking system takes into account the potential distribution, current distribution, ecological impact, invasiveness and feasibility of control to derive a final broad qualitative weed species ranking corresponding to specific management actions. Most weed species recorded from the area have a ranking of high. Weeds are managed during operations in accordance with the Iron Ore (WA) Pilbara Weed Management Strategy, which prescribes strategies including periodic spraying and equipment hygiene.

Table 4-5: Weed species recorded within Brockman Operation Development Envelope

Scientific Name	Common Name	Ecological Impact	Invasiveness
Aerva javanica	Kapok	High	Rapid
Aloe vera	Aloe vera	Not Listed	Not Listed
Argemone ochroleuca	Mexican Poppy	Low	Slow
Argemone ochroleuca subsp. *Ochroleuca*	Mexican Poppy	Low	Slow
Avena sativa	Common Oat	Not Listed	Not Listed
Bidens bipinnata	Bipinnate Beggartick	Unknown	Rapid
Cenchrus ciliaris	Buffel Grass	High	Rapid
Cenchrus clandestinus	Kikuyu grass	High	Rapid
Cenchrus setiger	Birdwood Grass	High	Rapid
Cenchrus sp.	-	High	Rapid
Chloris barbata	Purpletop chloris	High	Rapid
Chloris gayana	Rhode Grass	Low	Rapid
Chloris virgata	Feathertop Rhodes Grass	Unknown	Unknown
Citrullus lanatus	Pie Melon	Unknown	Moderate
Citrullus sp.	Pie Melon	Unknown	Moderate
Erigeron bonariensis	Flaxleaf Fleabane	Not Listed	Not Listed
Conyza sp.	Fleabane	Low	Moderate
Cyclospermum leptophyllum	Marsh Parsley	Not Listed	Not Listed
Cynodon dactylon	Couch Grass	High	Rapid
Datura leichhardtii	Native Thornapple	Not Listed	Not Listed
Digitaria ciliaris	Summer Grass	Unknown	Unknown
Echinochloa colona	Awnless Barnyard Grass	High	Rapid
Eleusine indica	Crowsfoot Grass	Low	Slow
Erigeron bonariensis	Flaxleaf Fleabane	Unknown	Rapid
Euphorbia hirta	Asthma Plant	Low	Slow
Flaveria trinervia	Speedy Weed	Unlisted	Unlisted
Lactuca serriola	Prickly Lettuce	High	Rapid

Scientific Name	Common Name	Ecological Impact	Invasiveness
Lactuca serriola forma serriola	Prickly Lettuce	High	Rapid
Malvastrum americanum	Spiked Malvastrum	High	Rapid
Melochia pyramidata	Pyramid Flower	Not Listed	Not Listed
Portulaca pilosa/filifolia	Djanggara	Not Listed	Not Listed
Rumex vesicarius	Ruby Dock	High	Rapid
Setaria verticillate	Whorled Pigeon Grass	High	Rapid
Sigesbeckia orientalis	Indian Weed	Unknown	Rapid
Solanum nigrum	Black Berry Nightshade	Low	Rapid
Sonchus oleraceus	Common Sowthistle	Low	Rapid
Symphyotrichum squamatum	Bushy Starwort	Medium	Rapid
Tribulus terrestris	Caltrop	Low	Rapid
Tridax procumbens	Tridax	Not Listed	Not Listed
Vachellia farnesiana	Mimosa bush	High	Rapid

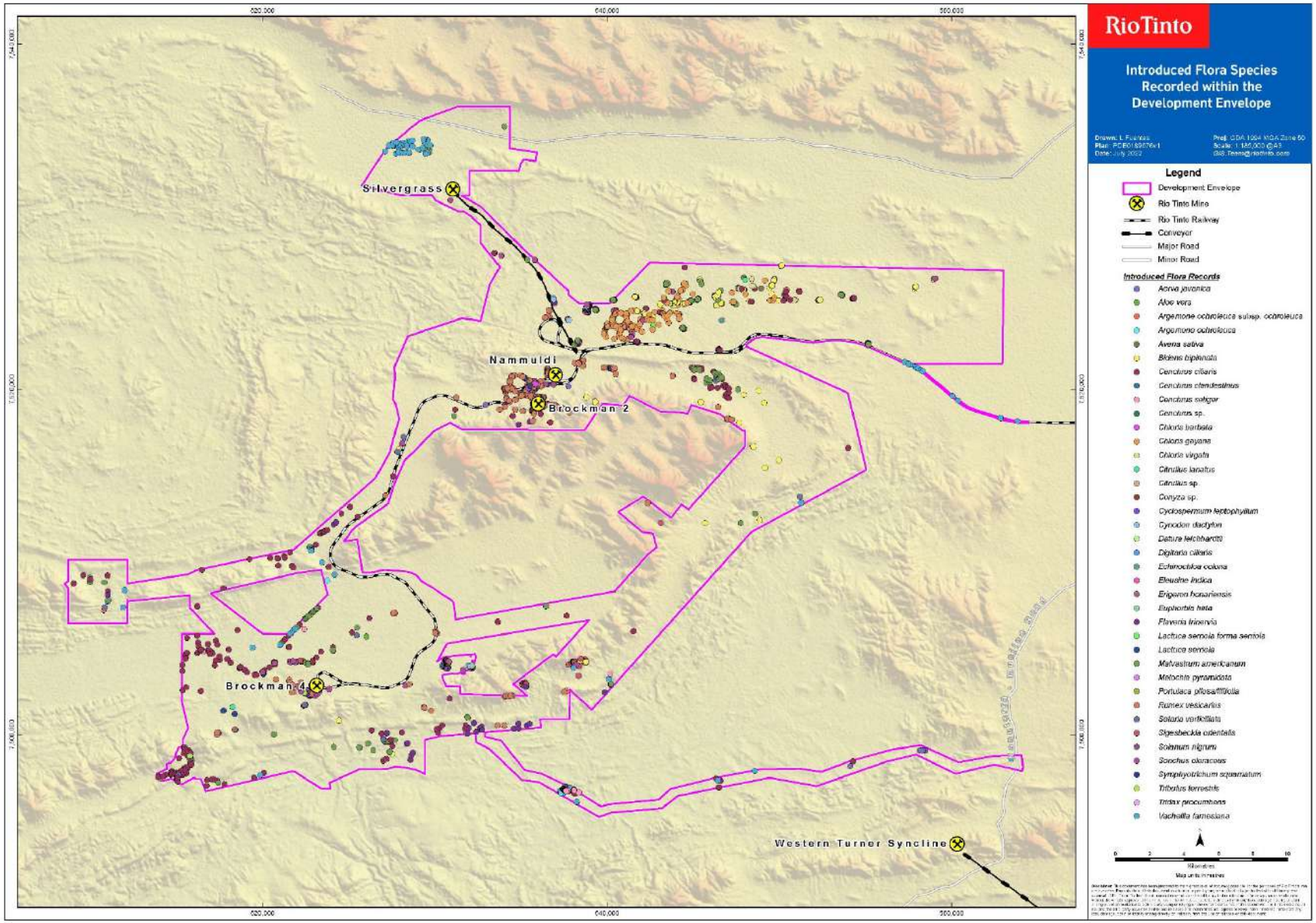


Figure 4-7: Introduced flora species recorded within the BSP Development Envelope

5 TERRESTRIAL FAUNA

The EPA's objective for terrestrial fauna is to *protect terrestrial fauna so that biological diversity and ecological integrity are maintained* (EPA 2021).

The key terrestrial fauna values identified in the Development Envelope include:

- Six Matter of National Environmental Significance (MNES) fauna species (Northern Quoll; Ghost Bat; Pilbara Leaf-nosed Bat; Pilbara Olive Python; Grey Falcon; and Fork-tailed Swift);
- Three WA State level conservation significant species (Peregrine Falcon; Western Pebble-mound Mouse; Lined Soil-crevice Skink);
- Three high significance fauna habitats:
    - Gorge/Gully
    - Debris Slope/Rocky Outcrop
    - Major Creekline
- Six potential Short Range Endemic (SRE) species (not discussed further within Biological Knowledge database)

This section describes the terrestrial fauna that occurs within the Development Envelope and regionally.

5.1 Studies and Survey Effort

Table 5-1 summarises the BSP-specific and other relevant regional surveys and studies undertaken for Terrestrial Fauna at the Brockman Operation. The total survey area refers to a 75,397 ha area and covers the entirety of the Development Envelope (63,343 ha).

To provide context for the habitat values within the Development Envelope, an extrapolated mapping exercise was undertaken up to 10 km from the survey area (Biologic 2021c). The mapped extrapolation area covered approximately 332,568.79 ha (it does not include the Development Envelope).

Table 5-1: Summary of technical reports for Terrestrial Fauna

Study Area, Type and Timing	Consistency with Guidance
Matters of National Environmental Significance Consolidation Report Brockman (Biologic 2022a)	
Survey area: Greater Brockman Operation comprising 75,086 ha **Type:** A literature review to consolidate information on MNES species from previous studies. **Timing:** February 2022	There is no specific guidance for a literature review consolidation report.
Brockman Syncline Stage 1 Cave Sound and Vibration Review (Bat Call WA 2021)	
Survey area: Development Envelope **Type:** Desktop assessment. An assessment of conservation status values and limits of vibration and sound relevant to caves based on their importance as bat roosts. **Timing:** August 2021	There is no specific guidance for a desktop sound and vibration review
Brockman Syncline Proposal Detailed Fauna Survey 2019 (Stantec 2020a).	
Study/Survey area: Brockman 1 and Brockman 3. The survey area comprised 15,455 ha. **Type:** Two-phase detailed fauna survey and Short-Range Endemic (SRE) assessment. The survey method included eight systematic sites with 5,824 trap nights. **Timing:** 16 to 28 May and 8 to 21 September 2019 (Level 2 survey); 13 to 23 August 2019 (Level 1 and Targeted).	Survey meets relevant EPA and EPBC Act policy and guidance. Survey approach and method undertook with consideration of the following: Environmental Factor Guideline: Terrestrial Fauna (EPA 2016f) Technical Guidance: Sampling methods for terrestrial vertebrate fauna (EPA 2016g) Technical Guidance: Terrestrial fauna surveys (EPA 2016h) Technical Guidance: Sampling of short-range endemic invertebrate fauna for environmental impact assessment in WA (EPA 2016i) EPBC Act referral guideline for the endangered Northern Quoll (*Dasyurus hallucatus*) (DoE 2016).
Greater Brockman and Nammuldi-Silvergrass Hub: Consolidated Fauna Habitat Mapping (Stantec 2020b)	
Survey area: Greater Brockman Operation. Consolidated area comprised 75,087 ha. **Type:** Consolidate previous fauna habitat mapping. Includes desktop assessment to consolidate available habitat mapping, ground-truthing to validate or refine the delineation of fauna habitat and refine mapping into a single mapping layer. **Timing:** May, August and September 2019.	There is no specific guidance for desktop fauna habitat consolidation. The desktop assessment consolidates fauna habitat mapping within the whole Development Envelope as originally referred (i.e., the mapping now also extends outside the Development Envelope).
Brockman Syncline Targeted Vertebrate Fauna Survey (Biologic 2020b)	
Survey area: Greater Brockman Operations. The survey area comprised 73,707 ha. **Type:** Targeted vertebrate fauna assessment. **Timing:** 27 August to 09 September 2019, 03 October to 10 October 2019, 04	This survey was conducted following relevant EPA and EPBC Act policy and guidance. Survey approach and method undertaken with consideration of the following: Technical Guidance: Sampling methods for terrestrial vertebrate fauna (EPA 2016g) Technical Guidance: Terrestrial fauna surveys (EPA 2016h)

Study Area, Type and Timing	Consistency with Guidance
November to 12 November 2019 and 19 November 2019 to 27 November 2019.	Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a) Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) Matters of National Environmental Significance – Significant Guidelines 1.1 EPBC Act (DoE 2013) EPBC Act referral guideline for the endangered Northern Quoll (*Dasyurus hallucatus*) (DoE 2016) Survey Guidelines for Australia's Threatened Bats (DEWHA 2010).
Brockman 2 Deposits: Detailed Fauna Survey Phase 1 and 2 (Biota 2019b)	
Survey area: Brockman 2, Brockman 4 and Lens G/Diesel comprising 10,928 ha. **Type:** Two-phase detailed fauna survey and SRE assessment. The sampling effort included systematic trapping at 11 locations, with a total of 2,083 trap nights. **Timing:** 13 to 24 November 2018 and 7 to 18 March 2019.	This survey was conducted following relevant EPA and EPBC Act policy and guidance. Survey approach and method undertaken with consideration of the following: Environmental Factor Guideline: Terrestrial Fauna (EPA 2016f) Technical Guidance: Sampling methods for terrestrial vertebrate fauna (EPA 2016g) Technical Guidance: Terrestrial fauna surveys (EPA 2016h) Technical Guidance: Sampling of short-range endemic invertebrate fauna for environmental impact assessment in WA (EPA 2016i) Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a) Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b).
Brockman Syncline 4 Marra Mambas: Level 2 Fauna Survey (Biota 2016b)	
Survey area: Brockman Syncline 4 Marra Mambas. Covered a 5,806 ha study area, including. 2,436 ha surveyed in 2015 to ensure the total area was surveyed at Level 2 standard (i.e., the remainder was based on previous surveys). **Type:** Single season Level 2 Vertebrate Fauna Survey. The sampling effort included systematic trapping at five locations, with a total of 960 trap nights. **Timing:** 30 July to 9 August 2015.	This survey was conducted following relevant EPA and EPBC Act policy and guidance, including: Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a) Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) Matters of National Environmental Significance – Significant Guidelines 1.1 EPBC Act (DoE 2013).

5.2 Fauna Habitat

The Development Envelope is restricted to mid to lower slopes and valley sections of the Brockman Syncline, avoiding the fauna habitats present in the highest peaks of the Brockman Syncline formation.

Extensive Pilbara fauna species datasets have been used to inform a detailed understanding and assessment of the significance of habitats and impacts at a local and regional level. The detailed understanding of local species occurrence and habitat use in the Development Envelope has been used to assign habitat significance ratings based on their value to threatened fauna species listed under the EPBC Act or BC Act (Biologic 2020a). Table 5-2 describes the criteria used to inform each significance rating in this assessment.

Table 5-2: Fauna habitat significance assessment criteria for Threatened Species

Significance Score	Criteria
High	Habitat provides core shelter (i.e., denning, roosting, or core water resources) for threatened* fauna species
Moderate	Habitat provides foraging and dispersal habitat for threatened* fauna species
Low	Habitat does not directly support any threatened* fauna species but may represent limited foraging and dispersal habitat. The habitat is widespread.
Nil	Cleared areas that do not provide any fauna habitat.
*Source: Biologic 2020 *Threatened species – listed under BC Act or EPBC Act.*	

Twelve broad fauna habitat types were mapped within the Development Envelope (Figure 5-1 and Table 5-3) (Stantec 2020b). For a region context, mapped fauna habitats have been extended to a 15 km buffer surrounding the Development Envelope. These fauna habitats were identified based on observations in the field, vegetation mapping and interpretation of aerial photography (Figure 5-1 and Table 5-3) (Stantec 2020b; Biologic 2022a).

Of the 12 habitat types identified within the survey area, two are considered to provide high significance habitat:

- **Gorge/Gully habitat:** Collectively comprises 1,650 ha (2%) of the survey area, including 880 ha (1%) within the Development Envelope, and is considered the most important fauna habitat at a local scale due to the microhabitats it provides, such as caves, overhangs and crevices (Stantec 2020b; Biologic 2022a). The rocky shelter and retention of surface water and moisture in this habitat type provides refuge for fauna from harsh climatic conditions. This habitat type is suitable for denning, shelter, roosting and foraging for significant fauna species such as the Northern Quoll, Ghost Bat, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Long-tailed Dunnart and Gane's Blind Snake.
- **Debris Slope/Rocky Outcrop habitat**: Collectively comprises 638 ha (1%) of the survey area, including 446 ha (1%) within the Development Envelope, and is considered of high significance as it can form shelters such as caves and alcoves (Biologic 2020b, Stantec 2020b, Biologic 2022a). Rocky outcrops provide denning and foraging habitat for the Northern Quoll and Long-tailed Dunnart. The Pilbara Olive Python may also utilise the habitat, particularly when it occurs near creek lines or Gorge/Gully habitat (Biologic 2020b; Stantec 2020b).

The remaining habitat types are considered to be of moderate to low significance. None of the identified fauna habitats are confined to the Development Envelope and all are widespread throughout the Hamersley subregion (Biota 2019b; e, Biologic 2022a).

In addition to broad-scale fauna habitat mapping, desktop extrapolated fauna habitat mapping was completed within a 10 km buffer of the Development Envelope to define additional potential habitat for significant fauna species (Figure 5-1; Biologic 2021a). The same level of detail was not possible via desktop extrapolation, so changes to scale, nomenclature, and categories of habitat occurred. For the

assessment of the BSP, the definition of critical habitat followed that of DoE (2013), being areas necessary “for activities such as foraging, breeding, roosting, or dispersal” (Figure 5-2).

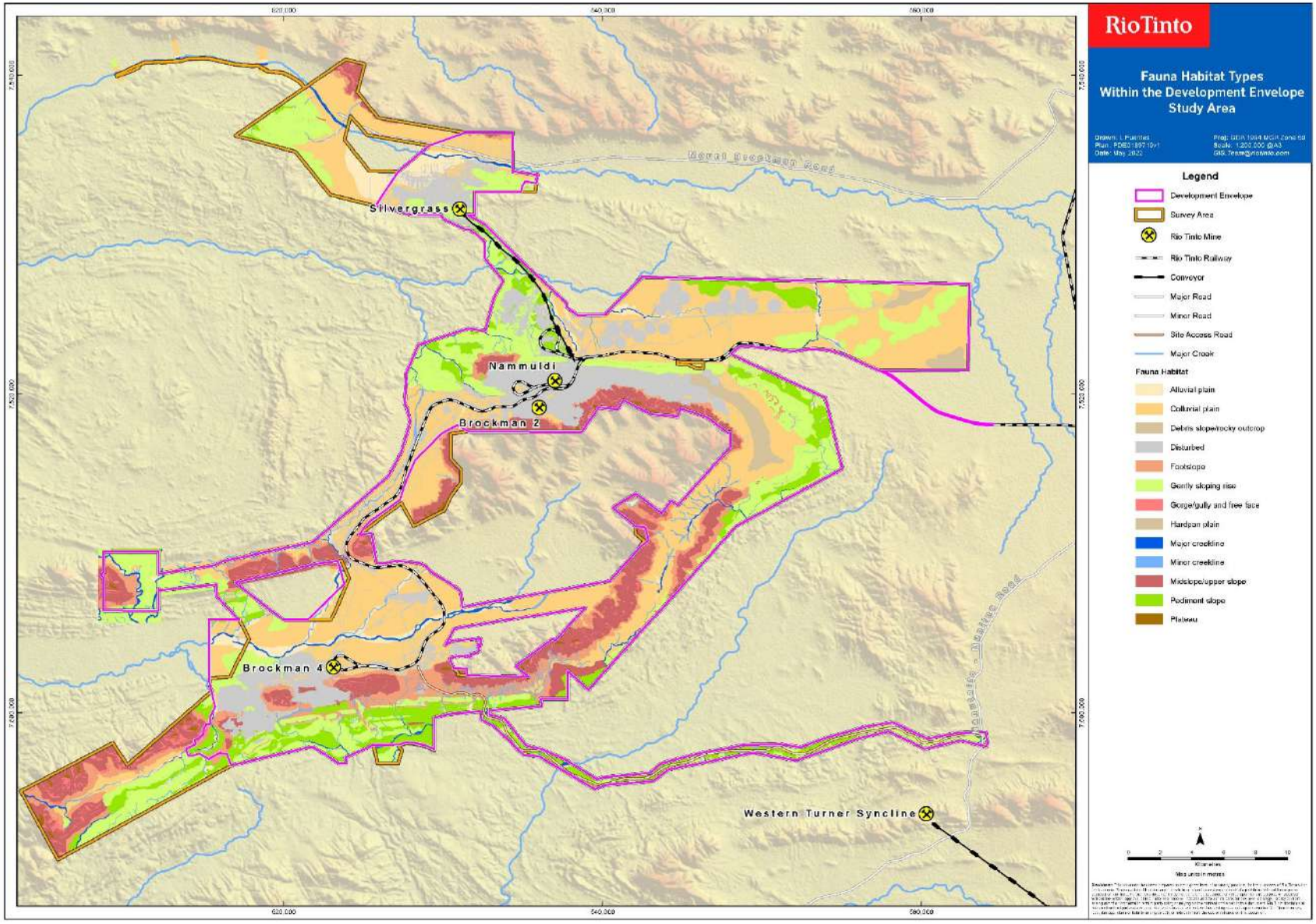


Figure 5-1: Fauna habitat types within the survey area

Table 5-3: Fauna habitat types within the Development Envelope

Habitat Type	Fauna Habitat Description	Related Vegetation Types	Microhabitats	Value for Conservation Significant Fauna	Representative Photograph
High Significance					
Gorge/Gully • Limited extent • Of high significance • High SRE potential	Gorge/Gully habitat is characterised by large rock faces and gorges usually associated with ridges, with high potential to support caves, overhangs, crevices and alcoves. These areas, particularly gorges, also have the potential to hold temporary water sources during inundation owing to the presence of bedrock. This habitat was predominantly located adjacent to the Midslope /upper slope habitats, however also occurred adjacent to the Footslopes and Gently Sloping Rise habitats.	Vegetation within this habitat type tended to include *Eucalyptus* and *Grevillea* species over *Triodia* and tussock grasses.	Microhabitats are provided in this habitat type in the form of rocky crevices, cracks, caves, semi-permanent water sources and dense vegetation.	**Critical habitat for:** • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat • Pilbara Olive Python **Suitable habitat for:** • Long-tailed Dunnart • Gane's Blind Snake	
Debris Slope/Rocky Outcrop • Limited extent • Of high significance • High SRE potential	The Debris Slope/Rocky outcrop habitat comprised rocky areas ranging from large boulders forming crevices and shelters to small rock faces. This habitat contains conglomerates, ironstone and shale, which may form a shelter for fauna, and caves or alcoves; however, not to the extent of the Gorge /Gully habitat. This habitat generally occurred in close proximity to Gently Sloping Rise habitat.	Vegetation within the upper and mid storey contains a low to sparse cover of trees and shrubs, including *Eucalyptus*, *Acacia*, and occasionally *Ficus*. In areas where exposed bedrock is absent, lower vegetation includes *Triodia*. hummock grassland. In shaded areas, this is replaced with sparse cover of *Cymbopogon* tussock grassland.	Microhabitats are provided in this habitat type in the form of rocky crevices and shelters. Leaf litter and woody debris is present within some locations.	**Critical habitat for:** • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat • Pilbara Olive Python **Suitable habitat for:** • Long-tailed Dunnart • Ganes' Blind Snake	
Moderate Significance					
Major Creekline • Limited extent • Of moderate significance • Moderate SRE potential	The major creekline habitat supported an upper story of relatively tall and mature *Eucalyptus* or *Corymbia*. Lower vegetation comprised soft *Triodia* sp. and tussock grasses (e.g. Buffel Grass), which are both considered palatable to livestock, often leading to degradation	Relatively tall and mature *Eucalyptus* or *Corymbia*. Lower strata of soft *Triodia* and tussock grasses (e.g., Buffel Grass).	Semi-permanent and ephemeral water sources are important temporary resources for aquatic and terrestrial fauna. Mature trees would provide shelter and roosting habitat for avifauna, whilst the increased leaf litter and woody debris may also provide shelter for small mammals.	**Critical habitat for:** • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat • Pilbara Olive Python • Grey Falcon **Suitable habitat for:** • Peregrine Falcon	

Habitat Type	Fauna Habitat Description	Related Vegetation Types	Microhabitats	Value for Conservation Significant Fauna	Representative Photograph
Minor Creekline • Limited extent • Of moderate significance • Moderate SRE potential	Minor creekline habitat usually lacked a tall dense upper storey but with a dense mid storey. Substrate was typically sandy channels or clay banks, with relatively dense fringing vegetation including sparse *Eucalyptus* sp., and *Acacia* sp. over tussock grasses including *Cenchrus ciliaris* (Buffel Grass) and *Triodia* sp hummock grasses. Limited extent The substrate typically comprises sandy channels or clay banks with relatively dense fringing vegetation.	A dense mid storey of vegetation, including sparse *Eucalyptus* and *Acacia* over tussock grasses and *Triodia* hummock grasses.	Larger *Eucalyptus* trees may potentially provide hollows and nesting opportunities in Mature trees. Microhabitats would be found in areas that have an abundance of leaf litter and woody debris.	**Critical habitat for:** • Northern Quoll • Pilbara Leaf-nosed Bat • Ghost Bat • Pilbara Olive Python •	
Alluvial Plain • Widespread • Of moderate significance • Low/Moderate SRE potential	The Alluvial Plain habitat occurs in flat areas in association with creeklines and depressions. The habitat generally supports increased shrub cover, tussock grasses and clay-based soils.	Vegetation comprised of Mulga, *Acacia*, *Hakea* and *Eucalyptus*. Areas prone to inundation will support tussock grasses, and hummock grasses dominate the remaining areas.	Woody debris and leaf litter were common within this habitat type compared to others which may result in some microhabitats.	**Critical habitat for:** • Pilbara Leaf-nosed Bat • Ghost Bat **Suitable habitat for:** • Lined Soil-crevice Skink • Short-tailed Mouse	
Colluvial Plain • Widespread • Of moderate significance • Low/Moderate SRE potential	Colluvial Plain habitat is usually associated with Alluvial Plains or drainage lines, which provide depositional surfaces. Substrates within this habitat are typically less stony than that of the adjacent pediment slopes and tend to have a higher shrub cover owing to the increased influence of drainage.	Vegetation comprises *Eucalyptus leucophloia*, or *Corymbia deserticola,* over scattered *Acacia* and a lower story dominated by *Triodia*.	This habitat type may result in some formation of microhabitats due to woody debris and leaf litter availability.	**Critical habitat for:** • Pilbara Leaf-nosed Bat • Ghost Bat **Suitable habitat for:** • Western Pebble-mound Mouse	
Gently Sloping Rise • Widespread • Of moderate significance • Low SRE potential	The Gently Sloping Rise habitat type occurs at the base of the Footslope habitat. Typically, the substrate is dominated by coarse fragments.	Vegetation within this habit type contains sparse *Eucalyptus* and *Corymbia* over shrubs, including *Hakea* and *Acacia* over a high cover of *Triodia* hummock grassland.	As this habitat type contains very little woody debris and leaf litter and only occasionally hosts exposed bedrock it is of limited to no value in the formation of microhabitats.	**Suitable habitat for:** • Western Pebble-mound Mouse	

Habitat Type	Fauna Habitat Description	Related Vegetation Types	Microhabitats	Value for Conservation Significant Fauna	Representative Photograph
Hardpan Plain • Limited extent • Of moderate significance • Low SRE potential	Hardpan habitats comprise flat clay-based plains dominated by stands of mulga, with a high proportion of the substrate comprising bare soil. This habitat type would experience sheet flow following rain.	Vegetation comprises mulga and *Hakea* and a lower storey of shrubs, *Triodia* and tussock grasses.	Due to the large amount of woody debris this habitat type would provide shelter for mammals and reptiles.	**Critical habitat for:** • Pilbara Leaf-nosed Bat • Ghost Bat	
Midslope/ Upper Slope • Widespread • Of moderate significance • Low SRE potential	The Midslope/Upper Slope habitat type comprised steep slopes leading into lower footslopes. This habitat was characterised by steep slopes with a high proportion of coarse fragments dominated by ironstone.	Vegetation within this habitat types comprises a sparse upper storey of *Eucalyptus leucophloia*, over sparse *Grevillea, Hakea* and *Acacia* shrubs, with a high cover of *Triodia* hummock grassland.	The presence of *Eucalyptus leucophloia* occasionally provided small or rarely large hollows, which may be used by nesting or roosting birds. Gullies, crevices, alcoves and outcropping may also provide suitable microhabitats.	**Suitable habitat for:** • Western Pebble-mound Mouse	
Low Significance					
Footslope • Widespread • Of limited Significance • Low SRE potential	The Footslope habitat is typically downslope from the steeper midslope/upper slope habitat. This habitat type is characterised by gently to moderately inclined slopes with coarse fragments dominated by ironstone. Gently to moderately inclined slopes with coarse fragments dominated by ironstone. Aside from reduced slope angle, Footslope habitat differed from midslope/upper slope areas by having less rocky areas and a high *Triodia* cover.	Vegetation in this habitat type tended to comprise a sparse upper story of *Eucalyptus leucophloia* over a low to sparse cover of shrubs and trees, including *Hakea* sp. and *Acacia* sp., over a high cover of *Triodia* hummock grassland.	Microhabitats are generally not found within the habitat type as it contains limited rocky areas and is sparse in tree cover.	**Suitable habitat for:** • Western Pebble-mound Mouse	

Habitat Type	Fauna Habitat Description	Related Vegetation Types	Microhabitats	Value for Conservation Significant Fauna	Representative Photograph
Pediment Slope • Widespread • Of limited significance • Low SRE potential	The Pediment Slope habitat is characterised by gently sloping or flat areas, usually associated with low rises or footslopes. Most areas of this habitat would be influenced by laminar sheet flow but would be unlikely to support ponding.	The upper and mid-story of this habitat type typically contains *Acacia*, *Grevillea* and *Hakea* shrubs over a stony substrate with a high cover of *Triodia*.	Microhabitats tend not to form within this habitat type due to the lack of dense shrubs and stony substrate.	**Suitable habitat for:** • Western Pebble-mound Mouse	
Plateau • Limited extent • Of limited significance • Low SRE potential	The plateau habitat represents the most elevated habitat in the survey area and is either flat or crested, with gently sloping spinifex hummock grasslands over a substrate with coarse fragments dominated by ironstone. This habitat tends to be more exposed and only supports a sparse vegetation cover in the mid and upper stratum, with limited debris for shelter by fauna.	This habitat type is composed of a sparse cover of vegetation in the mid and upper layers with spinifex grasslands covering the lower stratum.	Due to the rocky substrate, which is not conducive to forming crevice's, cracks and caves and the limited woody debris or dense vegetation found within this habitat type it is considered to provide limited to low value to the formation of microhabitats.	**Suitable habitat for:** • Western Pebble-mound Mouse	
Cleared/Disturbed	Historical disturbance, including existing tracks and drill pads.	N/A	None	None	N/A
Approved Footprint	Habitat and disturbed areas within the Approved Footprint.	N/A	N/A	N/A	

** Extent in Development Envelope excludes approved footprint **Areas (ha) are rounded. # Source of photo Stantec 2020*

Summary of Critical Fauna Habitat Types

The habitat types that occur within the survey area and Development Envelope that are considered critical to conservation significant fauna species are summarised in Table 5-4 and shown on Figure 5-2.

Table 5-4: Critical Fauna Habitat within the Survey Area and Surroundings

Species	Critical Habitat	
	High Significance Breeding/Roosting Habitat	**Moderate Significance Foraging/Dispersal Habitat**
Northern Quoll	• Gorge/Gully • Debris Slope/Rocky Outcrop	• Gorge/Gully • Debris Slope/Rocky Outcrop • Major Creekline • Minor Creekline
Pilbara Leaf-nosed Bat		• Major Creekline • Minor Creekline • Alluvial Plain • Colluvial Plain • Hardpan Plain
Ghost Bat		• Major Creekline • Minor Creekline • Alluvial Plain • Colluvial Plain • Hardpan Plain
Pilbara Olive Python		• Gorge/Gully • Major Creekline • Minor Creekline

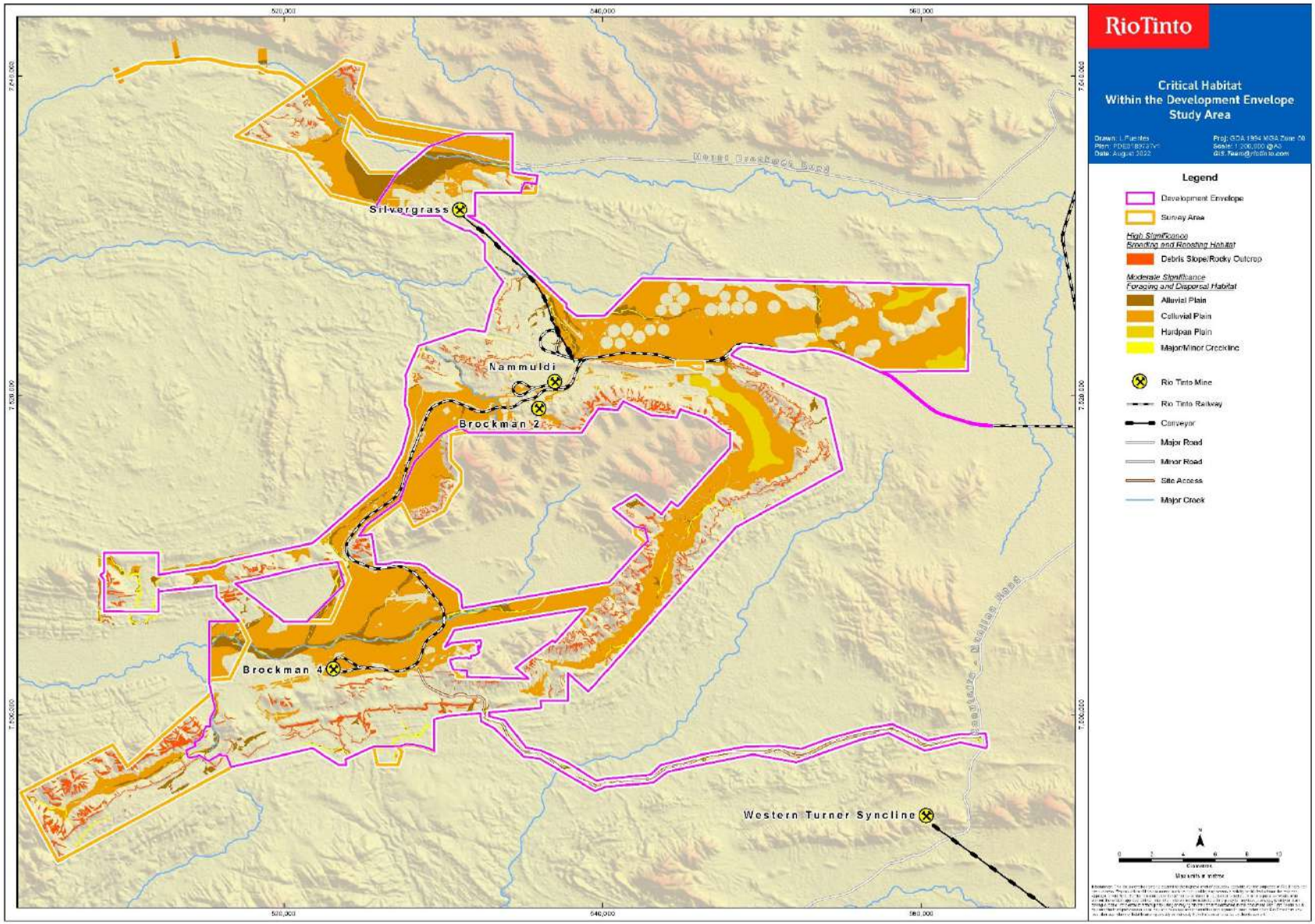


Figure 5-2: Critical Habitat within and surrounding the Brockman Operation

5.3 Species Diversity and Fauna Assemblage

The fauna assemblage in the Development Envelope is considered typical of the Hamersley subregion. A total of 179 vertebrate species have been recorded within the Development Envelope (including two amphibians, 75 bird, 33 mammal and 69 reptile species (Biota 2016b, Biota 2019b, Biologic 2020b, Stantec 2020a).

5.3.1 Feral Animals

Five feral mammal species were recorded and include the Cat (*Felis catus*), Dingo (*Canis familiaris*), European Cattle (*Bos taurus*), Horse (*Equus caballus*) and House Mouse (*Mus musculus*).

5.4 Conservation Significant Fauna

Of the 179 vertebrate fauna species, eight species of significance were recorded within the Development Envelope, whilst an additional four species were considered likely to occur within the Development Envelope (Table 5-5). These are discussed in the further detail in the following subsections.

Table 5-5: Significant Fauna Recorded at or Likely to Occur within the Development Envelope

Species	EPBC Act Listing	BC Act Listing	DBCA Priority Species
Known to Occur within the Development Envelope			
Northern Quoll (*Dasyurus hallucatus*)	Endangered	Endangered	-
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Vulnerable	Vulnerable	-
Ghost Bat (*Macroderma gigas*)	Vulnerable	Vulnerable	-
Pilbara Olive Python (*Liasis olivaceus barroni*)	Vulnerable	Vulnerable	-
Fork-tailed Swift (*Apus pacificus*)	Migratory	Migratory	-
Peregrine Falcon (*Falco peregrinus*)	-	-	Other Specifically Protected
Western Pebble-mound Mouse (*Pseudomys chapmani*)	-	-	Priority 4
Lined Soil-crevice Skink (*Notoscincus butleri*)	-	-	Priority 4
Likely to Occur within the Development Envelope			
Grey Falcon (*Falco hypoleucos*)	Vulnerable	Vulnerable	-
Gane's Blind Snake (*Anilios ganei*)	-	-	Priority 1
Long-tailed Dunnart (*Sminthopsis longicaudata*)	-	-	Priority 4
Short-tailed Mouse (*Leggadina lakedownensis*)	-	-	Priority 4

5.4.1 Northern Quoll (*Dasyurus hallucatus*)

Northern Quolls have been recorded on 62 occasions within the survey area between 2019 and 2021 via a variety of sampling methods, including trapping (24), camera traps (10) and secondary evidence (comprising scats (27) and tracks (1)). Of the 24 captures, 18 were considered unique individuals (seven females, eight males and three unidentified) (Biologic 2022a; Figure 5-3).

The EPBC Act referral guideline (DoE 2016) defines critical habitat for the Northern Quoll as; a habitat within the modelled distribution for the species that provide shelter for breeding, refuge from fire and/or predation and potential predation poisoning from Cane Toad (*Rhinella marina*). Critical denning habitat

within the survey area has been classified by Biologic (2022a) as Gorge/Gully and Debris Slope/Rocky Outcrop habitats (Figure 5-4).

Habitat that is considered critical to the survival of this species also includes dispersal and foraging habitat associated with or connecting populations that are important to the species' long-term survival (DoE 2016). Critical foraging and dispersal habitat has been classified by Biologic (2022a) as Major and Minor Creekline habitats, whilst supporting habitat has been classified as Footslope, Gently Sloping Rise, Midslope/Upper Slope, Pediment Slope and Plateau habitats (Figure 5-4).

Despite considerable sampling effort throughout the survey area to date, records of the species are relatively sparse. The exception to this is the population occurring outside of the Development Envelope at Vivash (southwest of BS4 mining area), which is considered a high density population based on the number of individuals recorded over several sampling events and, therefore, an important population, as defined by DoE (2016). For the remainder of the survey area, the population should be considered a low-density population in accordance with DoE (2016; Biologic 2022a).

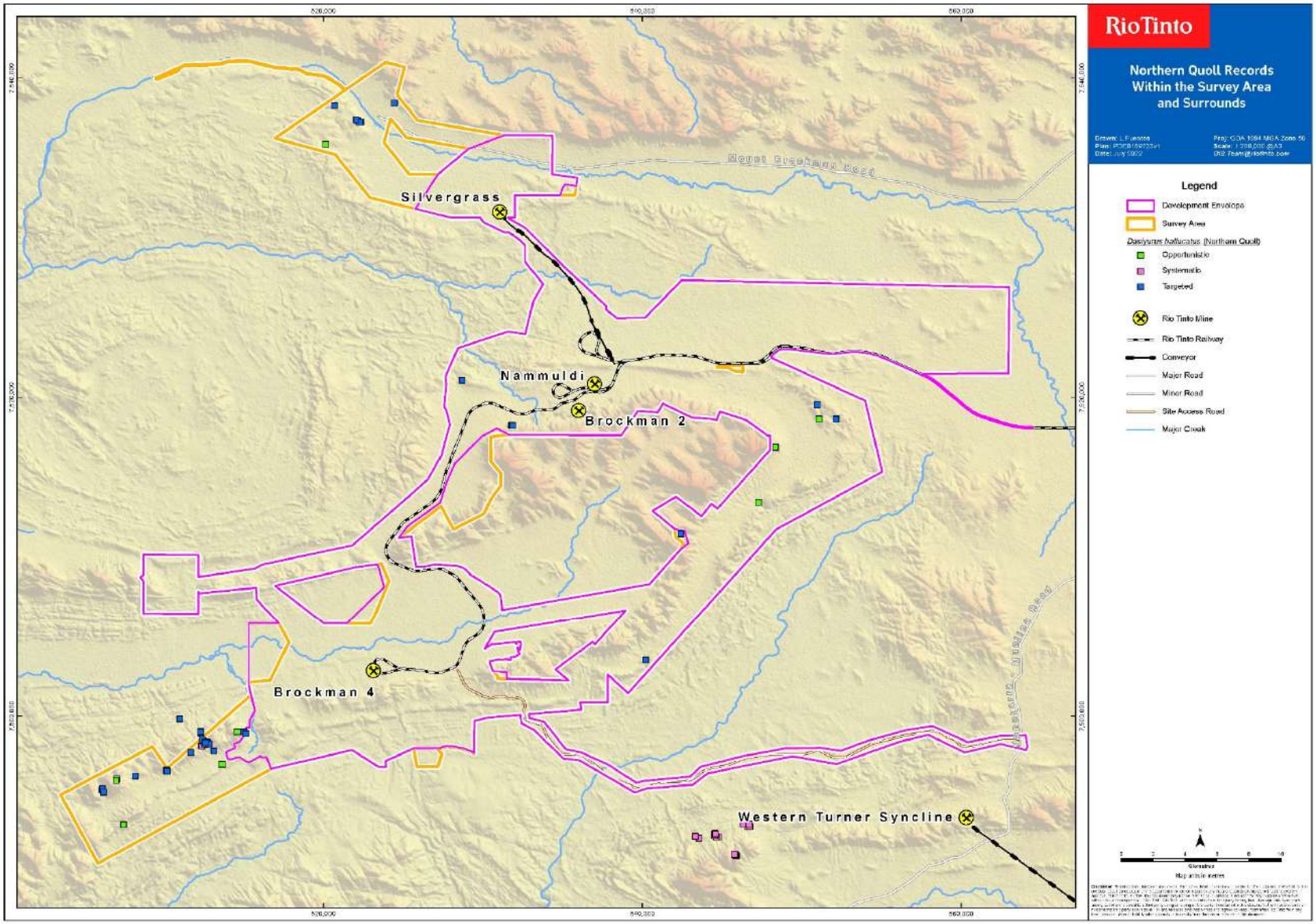


Figure 5-3: Northern Quoll Records Within the Survey Area

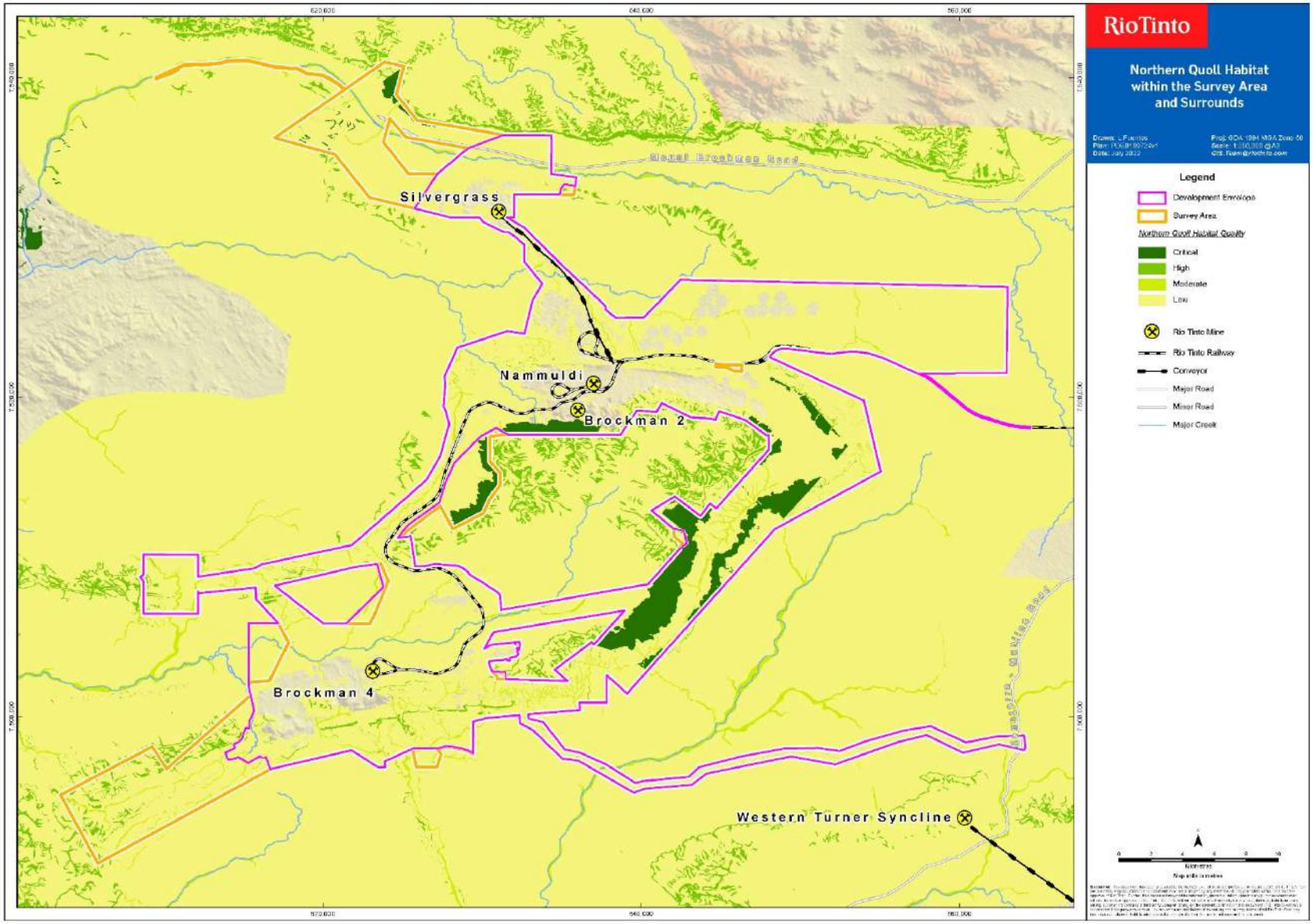


Figure 5-4: Northern Quoll Habitat Within the Survey Area

5.4.2 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

Since sampling for the Pilbara Leaf-nosed Bat began in 2005 within the survey area 70 records of the species within the survey area have been detected by ultrasonic recorder. Additionally, ten individuals tagged by Biologic (2022a) were recorded from 1,972 detections within the survey area by VHF tracking (Biologic 2022a) There have been 97 records of the Pilbara Leaf-nosed Bat within the extrapolated area.

Pilbara Leaf-nosed Bat records were primarily located within the vicinity or entrance of known roosts, particularly the Upper Beasley River Roost complex, a known permanent diurnal roost, located approximately 670 m outside the Development Envelope According to Biologic (2022a), most of the records within the survey area are likely to represent individuals originating and roosting within the Upper Beasley River Roost (Figure 5-5).

Of the 208 caves known from the survey area, one is a potential transitory diurnal roost (category 3 roost according to Bat Call WA (2021), 22 are nocturnal refuges (category 4 roost), 150 are potential nocturnal refuges (category 4 roost), and 35 are not suitable (Figure 5-6) (Bat Call WA (2021). All of the roosts within the Development Envelope have been categorised as category 4 roosts which are not considered critical habitat for the Pilbara Leaf-nosed Bat (Bat Call WA 2021).

Most roosts known from the survey area are located within the Gorge/Gully and Debris Slope/Rocky Outcrop habitat types. For this reason, and because Gorge/Gully and Debris Slopes/Rocky Outcrop habitat types are regarded as priority foraging habitat for the species, they are considered critical habitat for the species. Critical supporting foraging/dispersal habitat is represented by the Major and Minor Creekline habitats and Plains (combined Alluvial, Colluvial and Hardpan Plain habitats) (Figure 5-6).

The population occurring within the survey area is considered an important population “necessary for a species’ long-term survival and recovery” based on the DoE (2013) definition of a key source population either for breeding or dispersal.

Of the 25 known water features within the survey area, all may provide foraging and drinking resources for the species. However, those naturally more persistent and closer to the Upper Beasley River Roost are likely to be of increased significance (i.e. Plunge Pool and Ridge Pool).

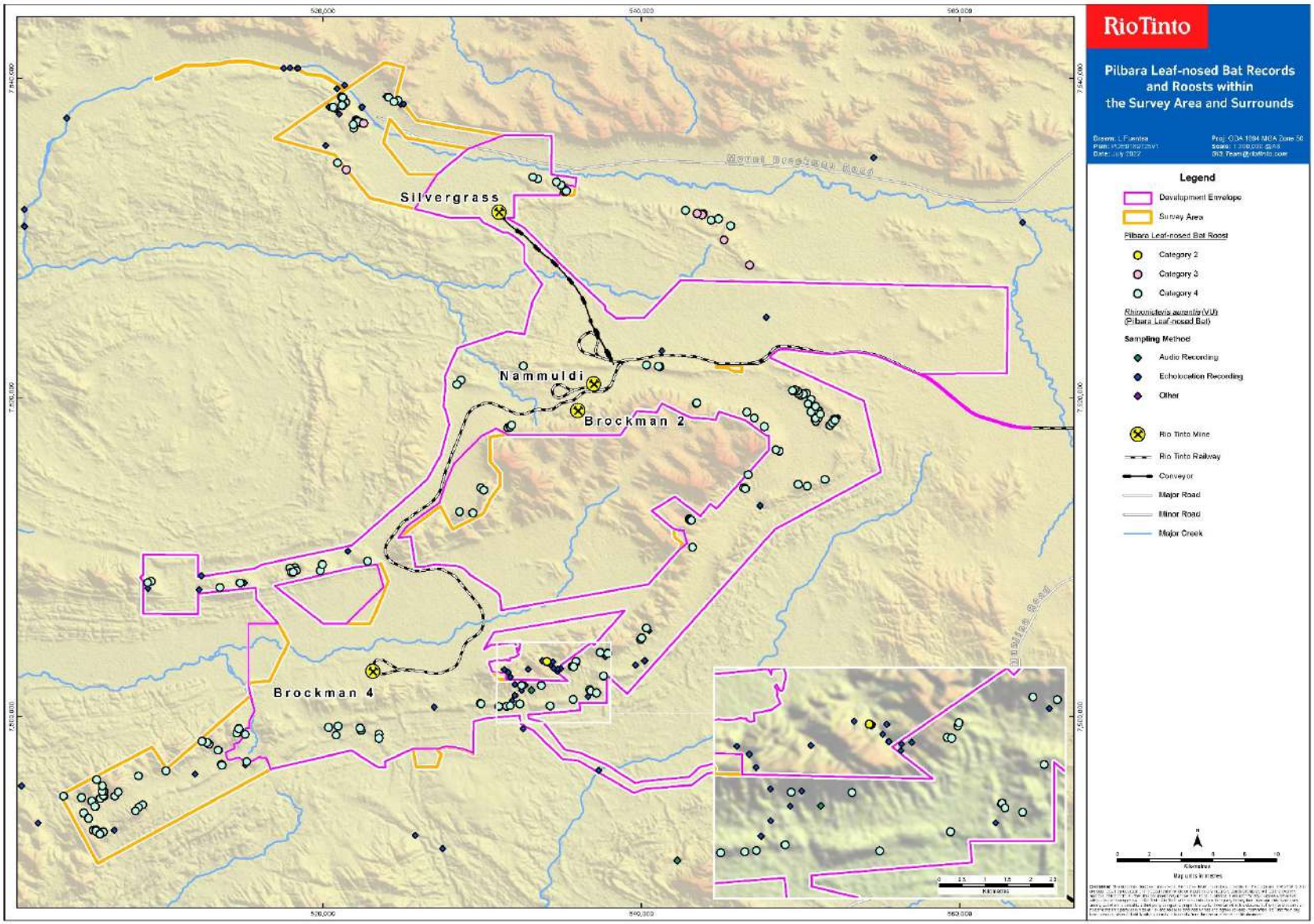


Figure 5-5: Pilbara Leaf-nosed Bat Records within the Survey Area and Surrounds

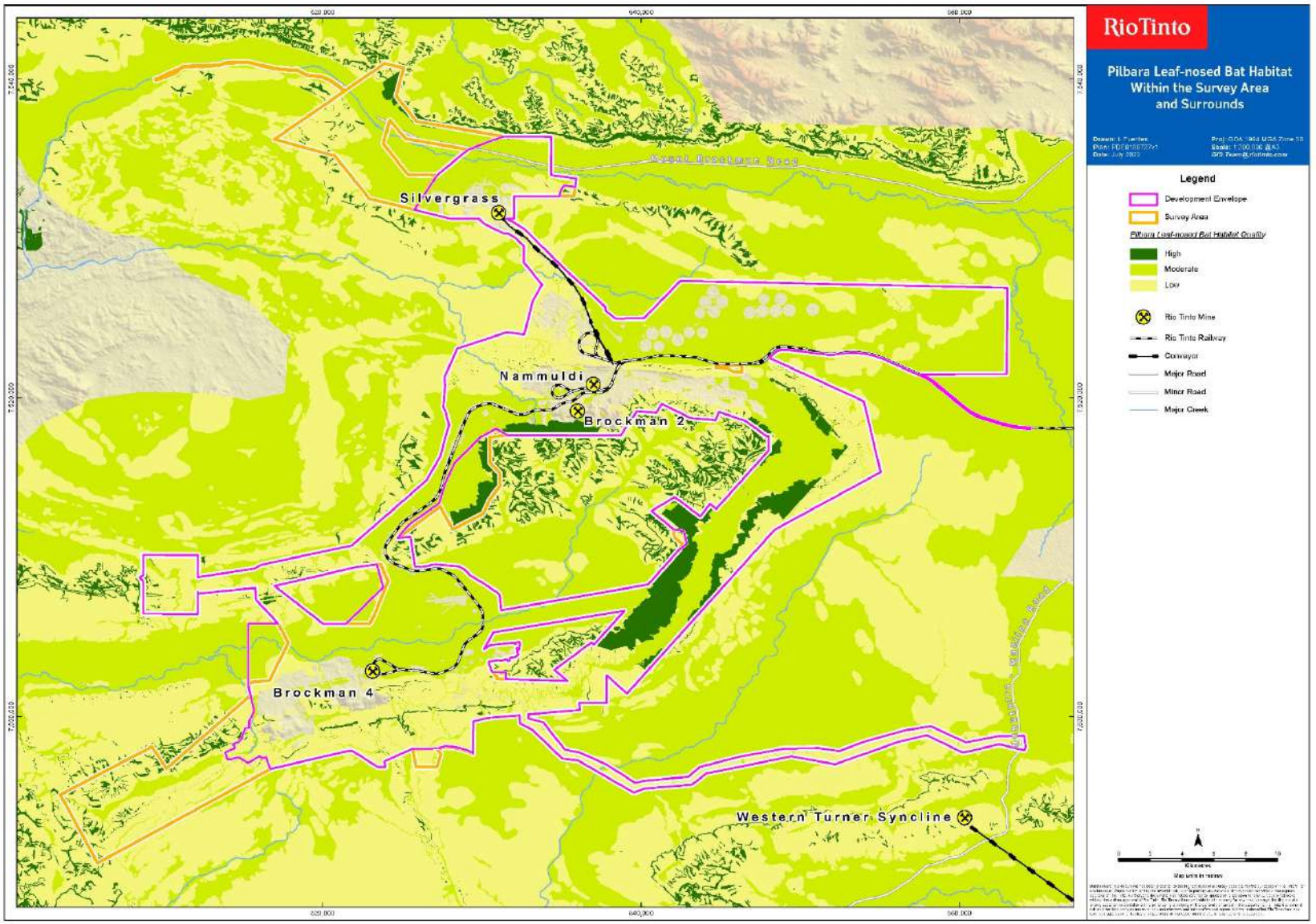


Figure 5-6: Pilbara Leaf-nosed Bat Habitat within the Survey Area and Surrounds

5.4.3 Ghost Bat (*Macroderma gigas*)

A total of 173 records of Ghost Bat individuals have been observed within the survey area through several methods, including ultrasonic recordings (35), trapping using white sheets (9), scats (117) and direct observations (comprising both alive (11) and deceased individuals (1)) (). There have been seven records of the Ghost Bat comprising scats within the extrapolated area (Figure 5-7). Additionally, Biologic (2022a) tagged nine individuals and were recorded from 5,910 detections within the survey area and 29 detections within the extrapolated area by VHF tracking towers.

Genetic analysis of scats identified 75 unique individuals within the survey area, although Biologic (2022a) considers this to be an underestimation of the number of individuals. Out of the individuals identified, there was an even sex ratio, with 29 females and 29 males and 17 unidentified (Biologic 2022b).

Fauna surveys (Biota 2016b, Biologic 2020b and Stantec 2020a) describe roost types using the classifications maternity, day and night roosts. Robert Bullen, a Bat expert (from Bat Call WA), has assessed each cave in the Development Envelope and assigned each roost a category based on the following classifications:

- Category 1 – Maternity/diurnal roost with large and permanent occupancy
- Category 2 – Maternity/diurnal roost with regular occupancy
- Category 3 – Diurnal roost with occasional occupancy
- Category 4 – Nocturnal roost with opportunistic occupancy.

There are no category 1 caves within the survey area. Bat Call WA (2021) assessed all category 2 caves as critical habitat. Groupings of category 3 and 4 caves immediately surrounding higher category caves are also considered critical habitat and described as “apartment blocks” that support the viability of the category 2 caves (Bat Call WA 2021). Bat Call WA 2021) did not consider isolated category 3 and category 4 caves as critical habitat as these isolated caves are used opportunistically according to the methodology described in (Bat Call WA 2021). Examples of each roost category is provided in Plate 5-1.

Of the 208 caves known from within the survey area, three are maternity (category 2) roosts, 16 are potential maternity roosts (category 2), see represent diurnal (category 3) roosts, 86 represent potential diurnal (category 3) roosts, 42 represent night (category 4) roosts, 35 represent potential night (category 4) roosts, and 19 are unknown.

Overall, 12 apartment block roost complexes (comprising a total of 47 roosts) and four isolated category 2 (without a roost complex) were identified within the survey area (Bat Call WA 2021). Of these, six apartment block roost complexes (comprising a total of 20 roosts) and two isolated category 2 roost occur within the Development Envelope.

Apartment Blocks and isolated category 2 caves are displayed on Figure 5-8. Isolated category 3 and category 4 caves are presented on Figure 5-9.

Because the majority of these roosts are located within Gorge/Gully and Debris Slope/Rocky Outcrop habitats, these habitat types are considered to provide critical breeding/roosting habitat for the species. Records, genetic analysis of scats and tracking data obtained from Ghost Bats within the survey area supports the limited amount of published literature on the species' movements and habitat preferences. Specifically, the species commonly forages upon plains, generally within close proximity to category 2 and category 3 roosting sites and most commonly moves small distances (~6 km) between roosting sites. For this reason, critical foraging/dispersal habitat is represented by the Alluvial Plain, Colluvial Plain, Hardpan Plain, Major Creekline and Minor Creekline habitats of the survey area.

The presence of three category 2 and 16 potential category 2 caves within the survey area suggests that the species resides permanently within the survey area and Development Envelope. The population of Ghost Bats within the survey area forms part of a key source population for breeding and dispersal and is, therefore, an ‘important population’ as defined by DoE (2013) (Biologic 2022a).



Plate 5-1: Example of Category 2 (Top), 3 (Middle) and 4 (Bottom) Roosts

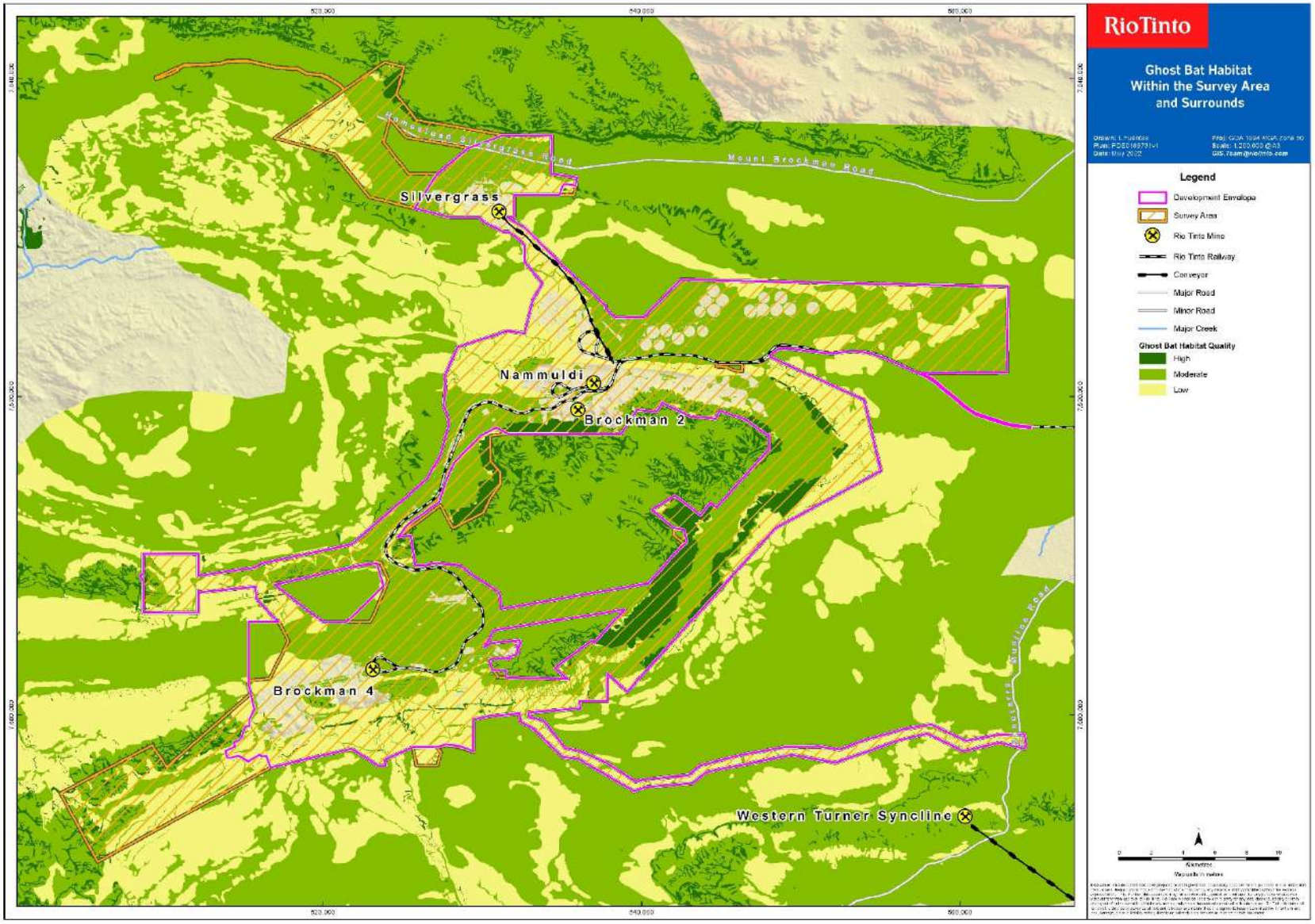


Figure 5-7: Ghost Bat Habitat within the Survey Area and Surroundings

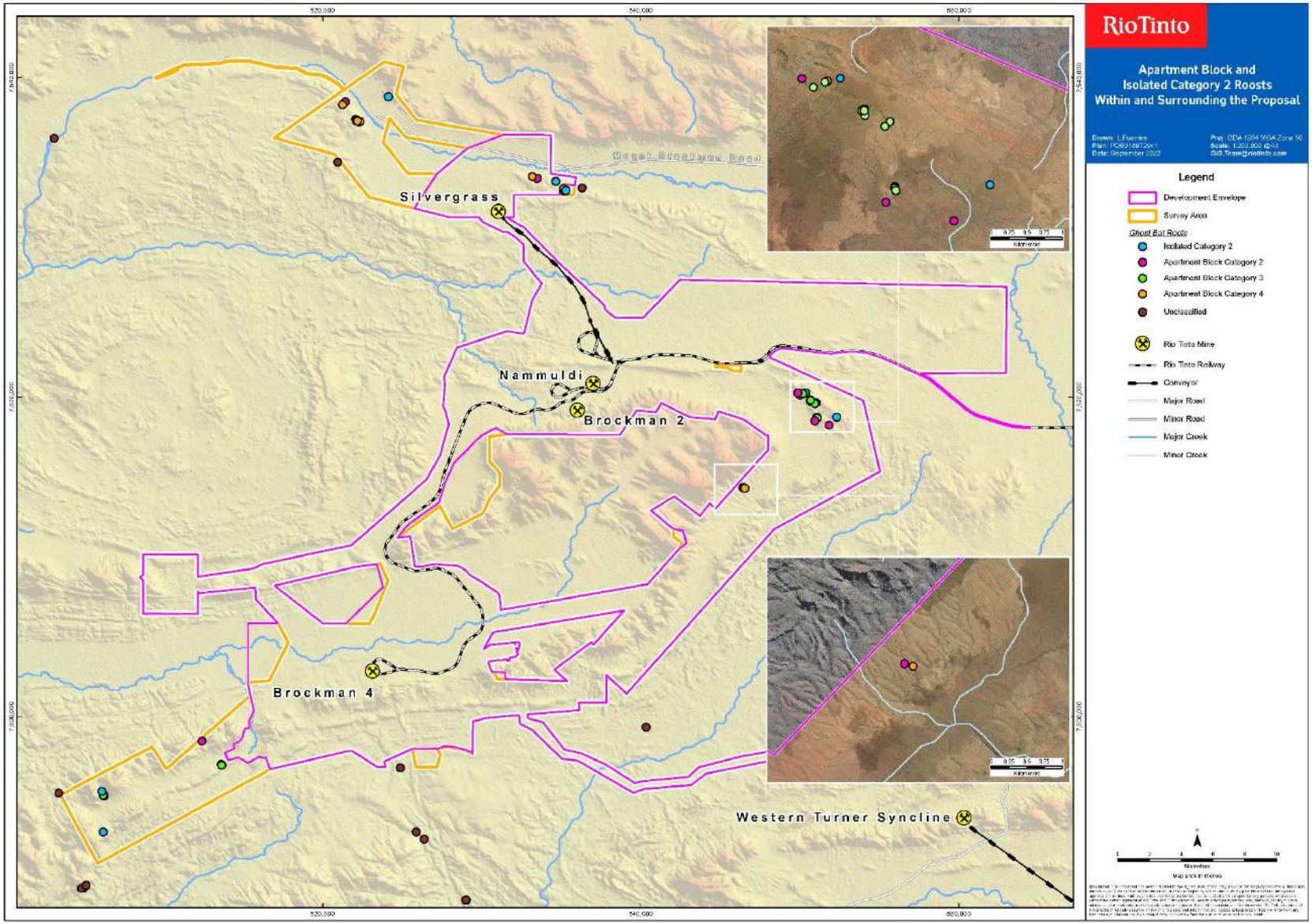


Figure 5-8: Apartment Block and Isolated Category 2 Caves Within the Survey area and Surroundings

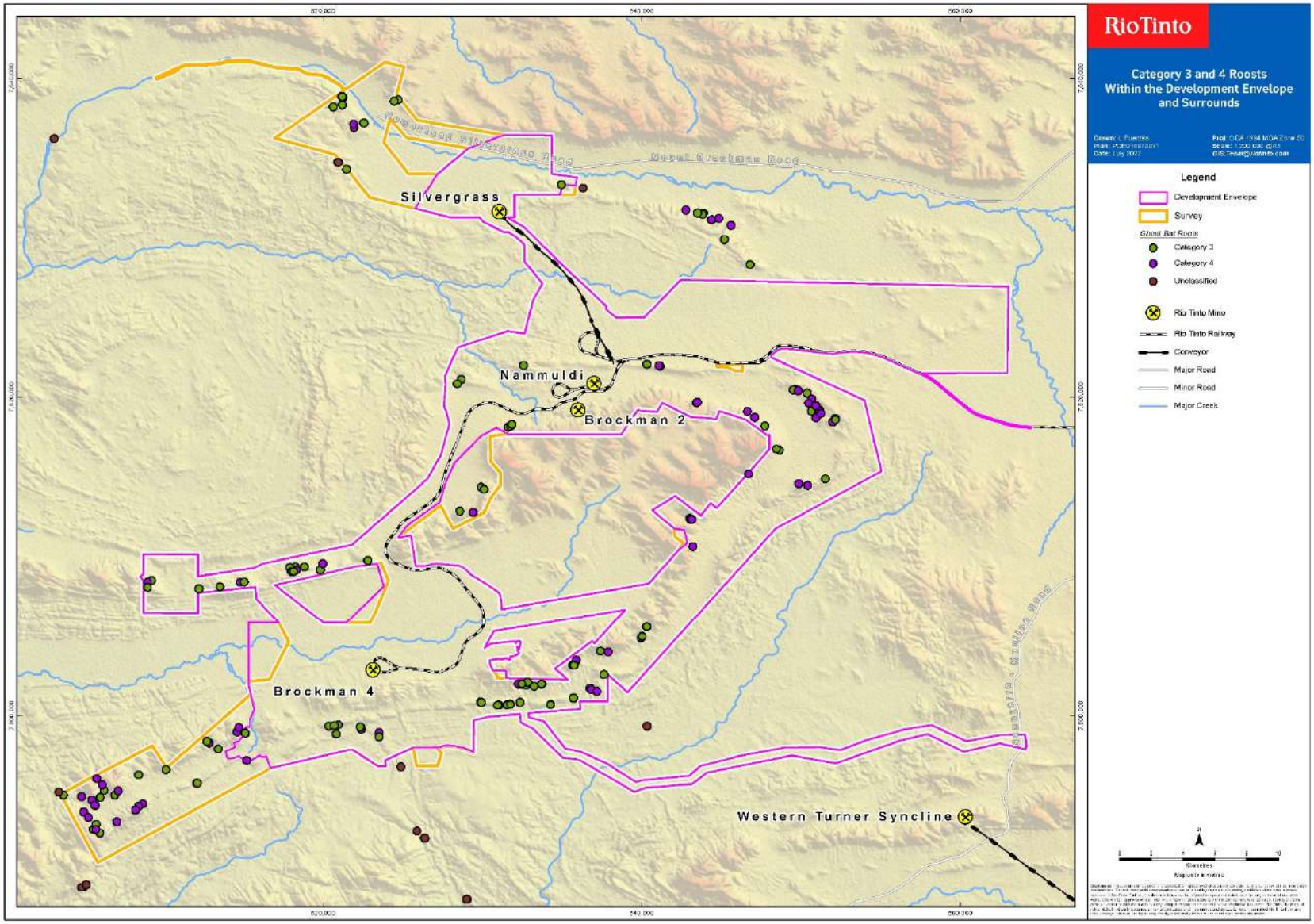


Figure 5-9: Category 3 and 4 Caves within the Survey Area and Surroundings

5.4.4 Pilbara Olive Python (Liasis olivaceus barroni)

Pilbara Olive Pythons have been recorded on 12 occasions within the survey area from 2009 to 2021. Of the 12 records of the species, seven were direct observations (comprising six live individuals and one dead individual), and five were records of secondary evidence, comprising sloughs (3) and scats (2). Five of the live individuals were recorded at Plunge Pool. One additional scat was found 300 m northwest of the survey area. Of the live individuals recorded, one was a juvenile and one was an adult, while the other four individuals' age was not specified (Biologic 2022a) (Figure 5-10).

Despite the low number of records, it is expected that the species will occur throughout the survey area. The survey area supports a healthy breeding population, as evident by the demographic recorded. For this reason, the Pilbara Olive Python population within the survey area is likely to represent a key source population for breeding and dispersal. Therefore, it could be regarded as an ‘important population’ as defined by DoE (2013).

Pilbara Olive Python can be found in a variety of habitats but is found more often in moist habitats such as gorges, rivers, pools, and surrounding hills (Burbidge 2004; DSEWPaC 2011). In the Hamersley region, this species is often noted near permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC 2011). The species is most active in the summer months soon after dark, emerging from daytime shelters and foraging until the early morning hours (DSEWPaC 2011). Individuals spend the cooler winter months within caves and rock crevices away from water sources. Individuals occupy distinct home ranges (87 to 449 ha), and males can travel distances of up to 4 km during the breeding season (June to August) to locate females (DotEE 2019).

The Gorge/Gully and Debris Slope/Rocky Outcrop habitats provide critical breeding and denning habitats. Additionally, Major Creekline and Minor Creekline habitats mapped within the survey area also provide critical foraging and dispersal habitat for the species, particularly in areas adjacent to or providing connectivity between Gorge/Gully and Debris Slope/Rocky Outcrop habitats (Figure 5-11).

Key surface water features (Figure 5-11) associated with gullies and gorges within the survey area include:

- Plunge Pool – a permanent water feature in BS4 mining area
- Ridge Pool – a surface water driven pool (outside the Development Envelope), with reduced evaporation due to shading from a nearby overhanging rock shelf.

Other water features have been recorded within the survey area; however, these are small, ephemeral pools only present after rainfall when water is widely available and therefore not considered critical habitat.

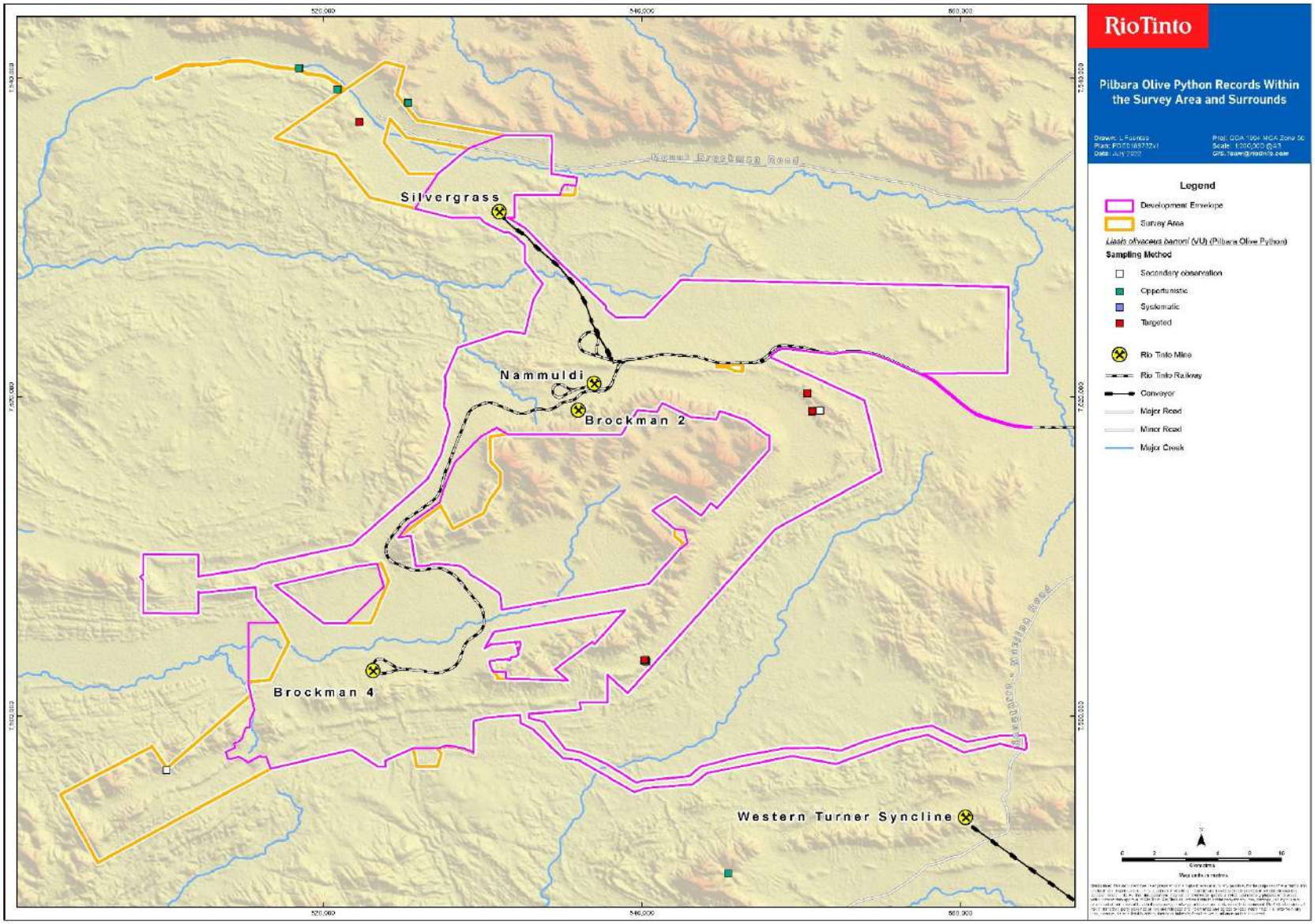


Figure 5-10: Pilbara Olive Python Records Within the Survey Area and Surroundings

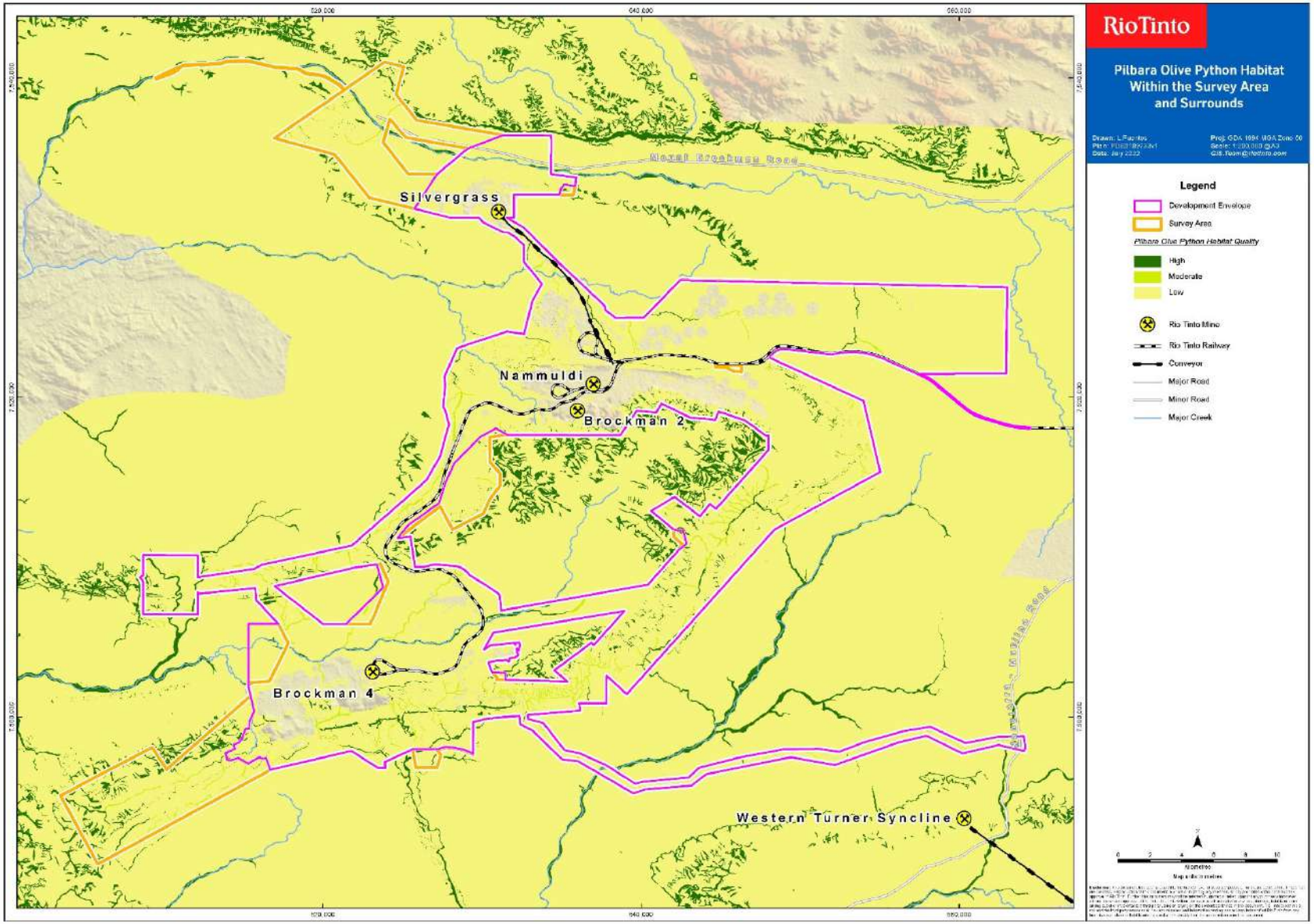


Figure 5-11: Pilbara Olive Python Habitat Within the Survey Area and Surroundings

5.4.5 Grey Falcon (Falco hypoleucos)

Despite at least 448 hours across 22 surveys conducting searches, there have been no Grey Falcon records inside the survey area. However, there is one record of three individuals (two breeding adults with a chick on a nest on top of a power line) within Plains habitat in 2020 approximately 760 m outside the survey area (Biologic 2022a). The next closest record is approximately 37.9 km north-north-west of the survey area (Figure 5-3). There are another four records within 65 km of the survey area.

Given the proximity of records to the survey area, it's highly likely that the species regularly utilises the survey area to forage and/or disperse. The species may also nest within the survey area where suitable nesting sites are present (i.e. large tall trees and/or tall infrastructures such as power lines and transmission towers). The Major Creekline and, to a lesser extent, Minor Creekline within the survey area represent potential critical breeding/nesting habitat, particularly where suitably sized trees are present, and critical foraging/dispersal habitat for the species. Alluvial, Colluvial and Hardpan Plain habitats represent critical foraging and dispersal habitat for the Grey Falcon; however, the species could forage within all habitat types throughout the Development Envelope and survey area.

5.4.6 Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is listed as migratory under the BC Act and EPBC Act. The Fork-tailed Swift occurs across much of the Australian continent from September to April, particularly in the continent's northern half. The species is most common closer to the coast but occurs over much of the Pilbara.

The species is entirely aerial in Australia, foraging for flying insects and even sleeping on the wing. The species has been recorded once flying over Minor Creekline habitat within the survey area (Biota 2016b)

5.4.7 Priority Fauna

A summary of the significant species, as listed by DBCA, recorded within the survey area is presented in Table 5-6 and Figure 5-12, whilst significant fauna that were not recorded within the survey area but have the potential to occur are presented in Table 5-7.

Table 5-6: DBCA listed significant fauna records within the Development Envelope

Species	DBCA Listing	Broad Habitat Type	Presence within Development Envelope	Representative Photo
Birds				
Peregrine Falcon (*Falco peregrinus*)	Other Specially Protected Fauna	Inhabits various habitats, including forest, woodlands, wetlands and open country.	This species has been recorded within Gorge/Gully habitat within Brockman 2 (Biota 2019e). It was also recorded nearby (outside Development Envelope) along Caves Creek (Biota 2019d). Suitable nesting and foraging habitat are present within the Development Envelope.	 *Source: Birdlife 2021*
Mammals				
Western Pebble-mound Mouse (*Pseudomys chapmani*)	Priority 4	Gentle slopes of rocky ranges are covered by stony mulch and vegetated by hard spinifex, with a sparse overstorey of eucalypts and scattered shrubs.	This species was recorded from numerous locations during the 2019 fauna surveys within the following habitat types: Colluvial Plain, Debris Slope/Rocky Outcrop, Footslope, Gently Sloping Rise, Midslope/Upper Slope, Minor Creekline and Pediment Slope and Plateau habitat. The species was recorded throughout the Development Envelope in all mining areas (Biota 2019b; Biota2019e; Stantec 2020). Historical records of this species also exist from previous surveys, with over 107 pebble mounds recorded at Brockman 2 (Biota 2019b). Populations of this species are widespread throughout the ranges of the central and southern Pilbara region (Stantec 2020a).	 *Source CALM 1997*
Reptiles				

Species	DBCA Listing	Broad Habitat Type	Presence within Development Envelope	Representative Photo
Lined Soil-crevice Skink (*Notoscincus butleri*)	Priority 4	Spinifex areas near creek and river margins.	The Lined Soil-crevice Skink was recorded once within the Development Envelope during the 2019 fauna surveys. This species has been recorded multiple times in previous surveys in 2012 and 2017 (Stantec 2020a). This species was recorded during the 2019 surveys within the Alluvial Plain habitat in Brockman 1 (Stantec 2020a). It has also been recorded along Caves Creek and in Colluvial Plain and Minor Creekline near Brockman 4 (Outside the Development Envelope) (Biota 2019e).	 *Source: Stantec 2020a*

Table 5-7: DBCA listed significant fauna species with the potential to occur within the Development Envelope

Species	DBCA Listing	Broad Habitat Type	Discussion
Mammals			
Long-tailed Dunnart (*Sminthopsis longicaudata*)	Priority 4	The Long-tailed Dunnart inhabits rocky, rugged habitat within the Pilbara. Core habitat in the form of Gorge/Gully and Debris Slope/Rocky Outcrop for this species occurs within the survey area	The Long-tailed Dunnart has been recorded on multiple occasions in the vicinity of the BSP (nearest 3 km away from the Development Envelope), and suitable habitat is present within and surrounding the Development Envelope. The species has been recorded in Major Creekline habitat in the vicinity of Silvergrass (just outside the Development Envelope) and within 3 km northwest of BS2 and recorded multiple times within 15 km of the Development Envelope (Biota 2019b, e, Stantec 2020a). Given the proximity of recent records and suitable habitat within the Development Envelope, this species is considered likely to occur.
Short-tailed Mouse (Lakelands Downs Mouse) (*Leggadina lakedownensis*)	Priority 4	The Short-tailed Mouse occupies diverse habitat types, including stony spinifex and tussock grasslands, samphire and sedgelands, sandy soils, and cracking clays. It shelters in burrows during the day.	The Short-tailed Mouse was recorded within the survey area near Silvergrass within Alluvial Plain habitat in 2009 but not within the Development Envelope (Biota 2009). This species was also recorded in 2011 on gilgai clay habitat within a nearby floodplain (Biota 2019b). This species' population fluctuates throughout the year and peaks towards the end of Spring.
Reptiles			
Gane's Blind Snake (*Anilios ganei*)	Priority 1	The ecology and habitat preference of the Gane's Blind Snake is poorly known. Records collected suggest that these species are likely to occur within gorges and gullies, mulga woodlands, and rocky slopes (Biota 2019[48]).	The Gane's Blind Snake was recorded within the survey area near Silvergrass and Caves Creek. However, no species records occur within the Development Envelope (Biota 2019b). This species occurs naturally in low densities and has an elusive nature.

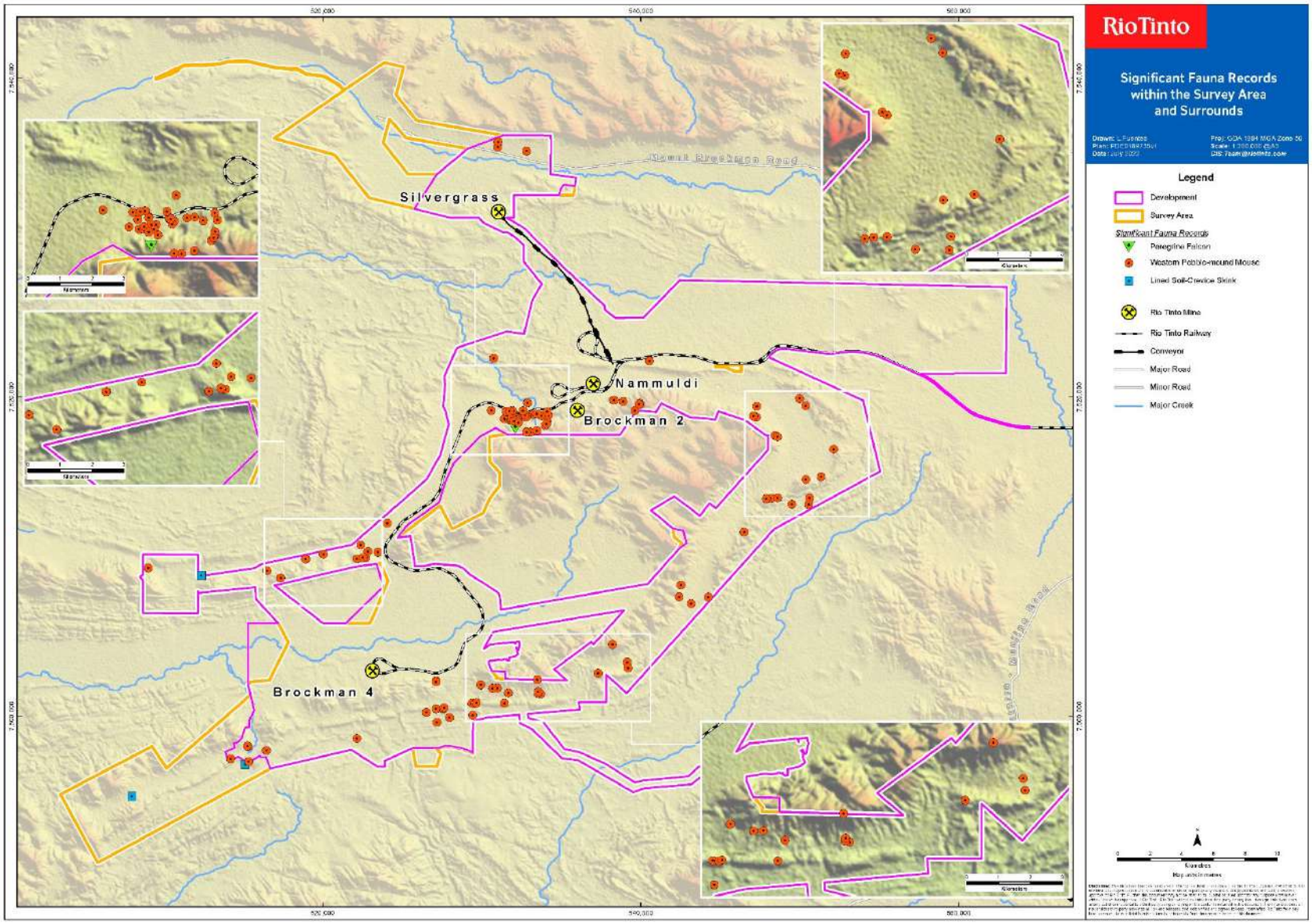


Figure 5-12: Significant Fauna Records within the Survey Area and Surroundings

5.5 Short range endemic fauna

Short-range Endemic (SRE) invertebrate fauna are invertebrates that, as a result of evolutionary isolation, have naturally small distributions (below 10,000 km2) and are often characterised by low fecundity, confinement to disjunct habitats and poor dispersal capabilities (Harvey 2002). Some better-known SRE species have been listed under State or Commonwealth legislation or as Priority species by the DBCA; however, most SRE species have not been listed under the legislation, often due to lack of knowledge or scarcity of data.

5.5.1 Short-Range Endemic Habitat

Of the twelve habitat types mapped within the survey area, six were identified as being of moderate to high suitability to SRE species (Table 5-8 and Figure 5-13). This was based on the presence of microhabitats and whether the habitat was restricted and/or isolated within the landscape (Biota 2019b), Stantec 2020a). All habitat types identified are not confined to the survey area, are common within the Pilbara region and appear to be contiguous (Biota 2016b; 2019b).

Table 5-8: Suitability of Habitat Types Likely to Support Short-Range Endemic Species Within the Survey Area and Surroundings

Habitat Type	SRE Habitat Description
High Significance	
Gorge/Gully	The Gorge/Gully habitat is considered highly suitable for SRE species (Stantec 2020a) as these habitats include restricted landforms, moist leaf litter and rock piles.
Debris Slope/ Rocky Outcrop	The habitat is considered highly suitable for SRE species (Stantec 2020a) as these habitats include restricted landforms, moist leaf litter and rock piles.
Moderate Significance	
Major Creekline	This habitat is considered as having moderate suitability for SRE species due to the increased level of vegetation and moisture in these areas compared to surrounding habitats (pers comms J. Trainer [Rio Tinto] 2020; Stantec 2020a).
Minor Creekline	This habitat is considered as having moderate suitability for SRE species due to the increased level of vegetation and moisture in these areas compared to surrounding habitats (pers comms J. Trainer [Rio Tinto] 2020; Stantec 2020a).
Alluvial Plain	Alluvial Plain habitat is considered as typically low suitability for SRE species; however, it can be characterised as moderate suitability in isolated patches where cracking clays (or similar substrate) occur (pers comms J. Trainer [Rio Tinto] 2020).
Colluvial Plain	The Colluvial Plain habitat is considered as typically low suitability for SRE species; however, it can be characterised as moderate suitability in isolated patches where cracking clays (or similar substrate) occur (pers comms J. Trainer [Rio Tinto] 2020).
Low Significance	
Footslope Gently Sloping Rise Hardpan Plain Midslope/Upper Slope Pediment Plateau	These habitats are considered low suitability for SRE species as, typically, microhabitats are scarce, and the habitat is not restricted or isolated.

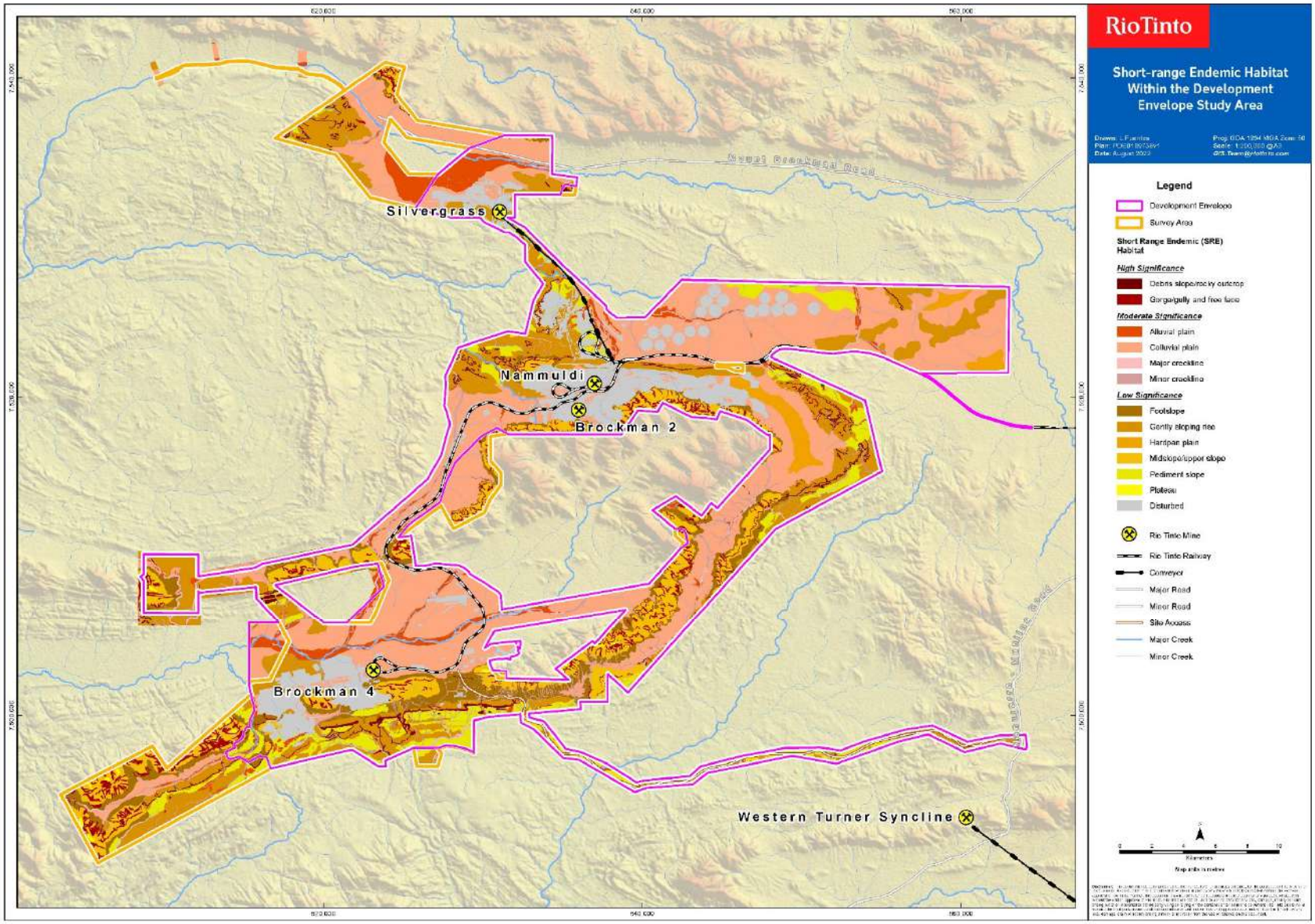


Figure 5-13: Short-Range Endemic Habitat from within the Survey Areas and Surrounds

5.5.2 Short-Range Endemic Assemblage

A total of 90 invertebrate species from six orders and 17 families have been identified within the survey area from surveys dating back to 2005 (Biota 2005, 2006, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016b, 2019b, Stantec 2020b). Of these, 42 species have the potential to be short-range endemic (SRE) species (Table 5-9) No confirmed SRE species were recorded within the Development Envelope.

Identification of species involved the use of both morphological and DNA sequencing. The distribution of potential SRE species within the survey area is shown in Figure 5-14. All of these species were recorded from habitat types that were observed outside of but in proximity to the survey area, suggesting they may not be restricted to the survey area.

Table 5-9: Potential SRE Species Recorded within the Development Envelope

Class	Order	Family	Species
Arachnidae	Pseudoscorpiones	Olpiidae	*Beierolpium* `sp. 7/3 small`
			Beierolpium `sp. 8/4 lge`
			Beierolpium `sp. 8/4 small`
			Indolpium sp. indet.
			Olpiidae sp. indet.
			Xenolpium sp. indet.
			Austrohorus sp. Indet.
		Chthoniidae	*Lagynochthonius* sp. indet.
		Garypidae	*Synsphyronus* sp. indet.
		Indet	Pseudoscorpiones sp. Indet
	Scorpiones	Buthidae	*Lychas* `bituberculatus complex`
			Lychas `hairy tail complex`
			Lychas sp. indet.
		Urodacidae	*Urodacus* sp.B
			Urodacus sp.A
	Araneae	Anamidae	*Aname* `sp. 1`
			Aname `sp. N126`
			Aname `sp. N19`
			Aname sp. indet.
			Aname sp.
			Anamidae sp. indet.
			Kwonkan sp. indet.
		Barychelidae	*Barychelida*e sp. indet.
			I*diommata* sp. indet.
			Synothele `sp. B1`
			Synothele `sp. B35`
		Halonoproctidae	*Conothele* `sp. C8`

		Selenopidae	*Karaops* sp. indet.
		Actinopodidae	*Missulena* sp. indet.
		Nemesiidae	*Nemesiidae* `sp. sock`
Malacostraca	Isopoda	Armadillidae	*Buddelundia* `47ts`
			Buddelundia `sp. 36`
			Buddelundia `sp. 63`
		Indet	Isopoda Gen. nov. `sp. 1`
			Isopoda Gen nov. `sp. 3`
Mollusca	Eupulmonata	Camaenidae	*Camaenidae* sp. indet.
			Rhagada `Pilbara banded complex`
			Rhagada `sp. small banded`
			Rhagada sp. indet.
			Quistrachia sp. indet.
		Succineidae	*Succinea* sp. indet.
Diplopoda	Spirobolida	Trigoniulidae	*Austrostrophus stictopygus*

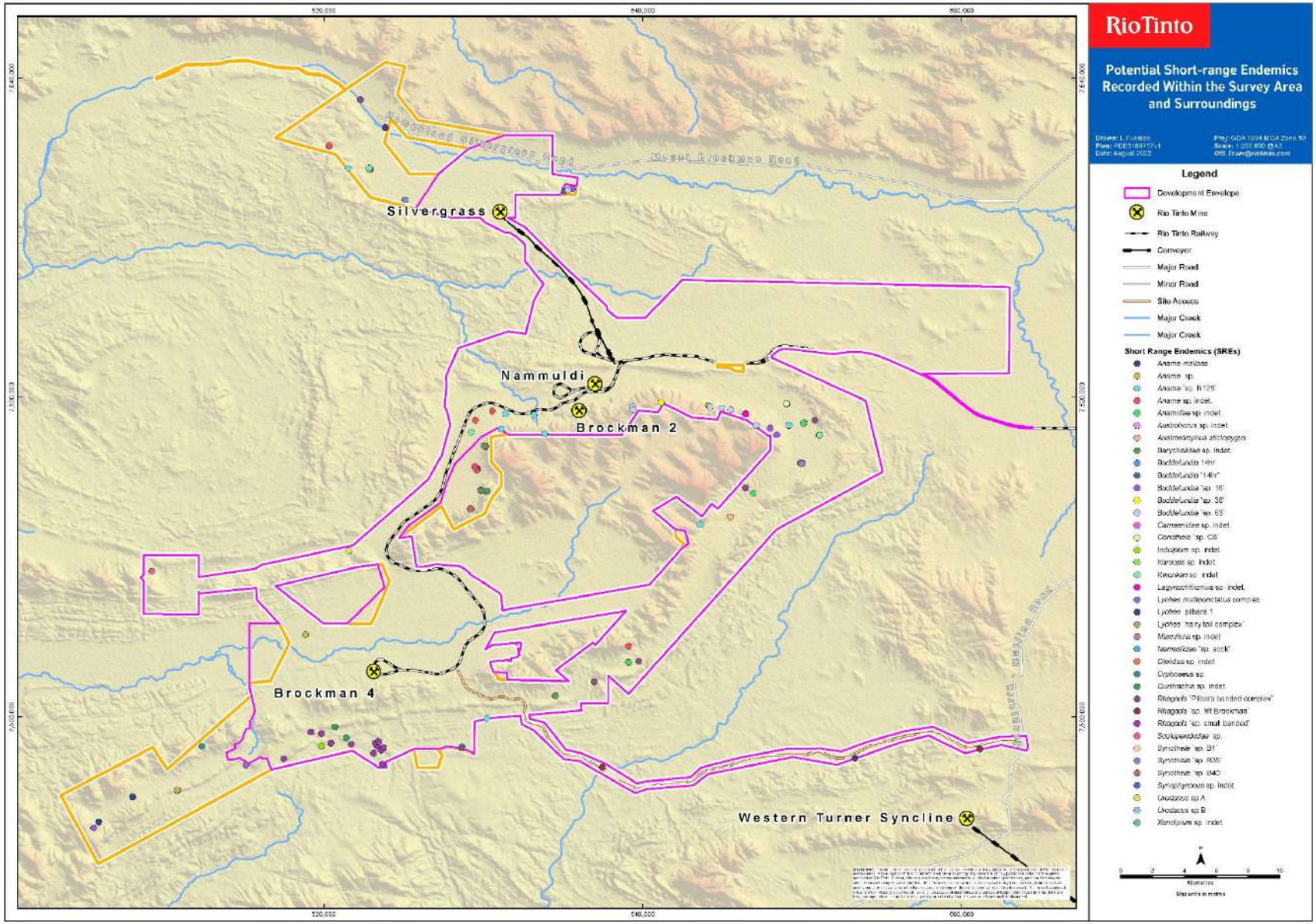


Figure 5-14: Potential Short-range Endemics Recorded within the BSP Development Envelope and Surroundings

6 INLAND WATERS

The EPA's objective for Inland waters is *to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* (EPA 2021).

The key environmental values associated with Inland Waters include:

- Plunge Pool – a permanent pool with:
  - Cultural significance for Eastern Guruma
  - High value to fauna
  - GDE's associated with Plunge Pool
- Boolgeeda and Duck Creeks, including riparian vegetation
- Kurwillinha and Ridge Pools – ephemeral pools with:
  - Cultural significance to Eastern Guruma
  - Moderate value to fauna
- Aquifers supporting stygofauna
- Aquifers supporting groundwater dependent vegetation
- Culturally important mulga communities in the BS2 assessment area.

6.1 Studies and Survey Effort

Table 6-1 summarises the relevant regional surveys and studies undertaken for Inland waters addressing aquatic fauna. Key study/survey reports are referenced.

Table 6-1: Summary of assessments within surrounding the Development Envelope

Survey Area, Type and Timing	Consistency with Guidance
Hazard Analysis and Risk Assessment for Dewatering Discharge to Duck Creek and Boolgeeda Creek (WRM 2020)	
Study/Survey area: Brockman Syncline region, specifically Duck Creek and Boolgeeda Creek. **Type:** Hazard analysis and risk assessment for dewatering discharge to Duck Creek and Boolgeeda Creek. **Timing:** Water sampling undertaken between 2016 and 2019, with aquatic ecosystem surveys undertaken between 2009 and 2019.	Prepared in accordance with the information requirements in the EPA Inland Water factor guideline.
Brockman Syncline Proposal Aquatic Ecological Values Desktop Review Final (WRM 2019a)	
Study/Survey area: Caves Creek, Duck Creek and Boolgeeda Creek. **Type:** Summary of known aquatic ecological values collated from historic baseline and other monitoring associated with the Brockman Syncline Development Proposal. **Timing:** Presentation of data collected since 2009.	There is no specific guidance on aquatic fauna sampling. In accordance with the Water Quality Management Framework, water quality (physical and chemical stressors and toxicants) and several aquatic fauna receptors (hyporheos fauna, macroinvertebrates, and fish) are currently used to characterise and monitor ecosystem health condition.
Brockman Baseline Aquatic Fauna Water Quality Survey Dry-19 Tech Report Final (WRM 2019b)	

Survey Area, Type and Timing	Consistency with Guidance
Study/Survey area: Caves Creek, Duck Creek and Boolgeeda Creek. **Type:** Summarises results of the dry season 2019 (dry-19) baseline sampling of aquatic ecosystems in the Brockman Syncline Proposal. **Timing:** Presentation of data collected during sampling round in 2019.	There is no specific guidance on aquatic fauna sampling. In accordance with the Water Quality Management Framework, water quality (physical and chemical stressors and toxicants) and several aquatic fauna receptors (hyporheos fauna, macroinvertebrates, and fish) are currently used to characterise and monitor ecosystem health condition.

6.2 Aquatic Fauna

6.2.1 Species Assemblage

The Pilbara provides a range of aquatic habitats from fresh to hypersaline and has high biological diversity. The region is temporally complex as watercourses expand during the wet season and contract during the dry season depending on the magnitude of wet season rainfall and degree of flushing and recharge from year to year (WRM 2019b). The aquatic fauna habitats of Duck Creek and Boolgeeda Creek are described in WRM (2019b).

More than 200 zooplankton species, 80 hyporheic species, and 300 macroinvertebrate species have been recorded from within and adjacent to the Brockman Operation during aquatic ecosystem surveys from November 2009 to November 2019 (WRM 2020). This includes four conservation listed species, eight stygal taxa of conservation interest and five zooplankton species (rotifers) which are potentially new to science. A summary of aquatic organisms of international, national and State significance collected from the Development Envelope and the approximate local and regional distribution of these species is provided in Table 6-2.

The IUCN conservation listings for the Pilbara pin damselfly *Eurysticta coolawanyah* and the Pilbara emerald dragonfly *Hemicodulia koomina* have only recently been upgraded from Near Threatened to Vulnerable, because the perceived ‘risk of extinction’ has increased as a result of continuing habitat loss due to dams, water abstraction and severe weather associated with climate change. Both species have been recorded from numerous ephemeral and semi-permanent pools along Duck Creek and Boolgeeda Creek and are known to occur widely across the Pilbara.

The IUCN listing for the copepod *Eodiaptomus lumholtzi* is based on a 1996 assessment and needs updating. This species is now known to occur in ephemeral and permanent pools at numerous locations across the Pilbara (Table 6-2) as well as the Northern Territory, Queensland and Papua New Guinea (WRM 2020).

The rotifer species that are potentially new to science belong to known genera with Australia-wide or world-wide distributions. The fact they have only recently been discovered is probably due to the paucity of historical surveys for Australian freshwater zooplankton rather than restricted distributions (WRM 2020).

Table 6-2: Summary of Aquatic Species of Significance and/or Scientific Value

Species	Common Name	Conservation Significance	Occurrence within Survey Area	Regional Distribution
Micro invertebrates				
***Ceriodaphnia* n. sp.**	Cladocera	New species record; undescribed	Duck Creek	Likely a Western Australian endemic species, undescribed (WRM 2019b).
Eodiaptomus lumholtzi	Calanoid copepod	IUCN Vulnerable (**VU**)	Caves Creek and Duck Creek	Gudai Darri Spring, Mindy Creek, Coondiner Creek, Kalgan Creek, Weeli Wolli Creek, Cane River, Fortescue River, Northern Territory, Queensland and Papua New Guinea.
***Lecane* 'bulloid' n. sp.**	Rotifer	Undescribed species	Duck Creek, Palm Spring, Homestead Reaches of Caves Creek	Marillana Creek, Weeli Wolli Creek, Plunge Pool.
***Proales* n. sp.**	Rotifer	Potentially new species record; undescribed	Duck Creek	None known but likely occurs elsewhere (WRM 2020).
cf. Resticula n. sp	Rotifer	Potentially new species	Duck Creek	None known but likely occurs elsewhere (WRM 2020)
***Hexarthra* sp. A n. sp.** ***Eosphora* nr *najas* n. sp.**	Rotifer	New species records from baseline sampling at Duck Creek and Caves Creek	Duck Creek	Unknown regional distribution. First record of species within Australia (WRM 2019a).
Stygal / SRE invertebrates in alluvial aquifers				
***Syncarida* sp. (including Bathynellidae sp.**	Stygal crustacea	Potential SREs (data deficient); immature specimens previously collected	Duck Creek (DCU), Boolgeeda Creek	They are known from groundwater environments and hyporheic zones across the Pilbara, species may have restricted distributions
Paramelitidae sp.	Stygal amphipod	Potential SRE (data deficient)	Duck Creek (DCD)	Known to be restricted to; Weeli Wolli and Marillana Creeks (i.e., *Maarrka* spp.); Weeli Wolli Creek, Marillana Creek and the Coondewanna Flats Catchment (i.e., Paramelitidae sp. D and Paramelitidae sp. B); or Weeli Wolli Creek, Marillana Creek, Coondiner Creek and Mindy Creek (i.e., *Chydaekata* sp.; WRM unpub. data, Finston et al. 2011).

Species	Common Name	Conservation Significance	Occurrence within Survey Area	Regional Distribution
***Chydaekata* sp.**	Stygal amphipod	LIkely SRE (data deficient)	Palm Springs along Caves Creek, both pre and post discharge	Genus known from Marillana Creek, Weeli Wolli Creek, Mindy Creek, Kalgan Creek (distinct lineages in separate catchments (WRM 2020).
***Maarka* sp.**	Stygal amphipod	Likely SRE (data deficient)	Duck Creek	
***Nedsia* sp.**	Stygal amphipod	Likely SRE (data deficient)	Duck Creek	Known from Palm Springs, Beasley River, elsewhere uncertain. Genus known from groundwaters across the Robe River catchment, Bungaroo Creek, Cape Range and Barrow Island catchments
Melitidae sp.	Stygal amphipod	Likely SRE (data deficient)	Duck Creek (DCD), Boolgeeda Creek	They are known from the Robe River catchment,
***Pygolabis* sp.**	Stygal isopod	Likely SRE (data deficient; restricted distribution)	Duck Creek, Boolgeeda Creek	Species of *Pygolabis* usually restricted to individual creeklines, for example the Fortescue, Ashburton or Robe River catchments) (WRM 2019a).
cf. *Areacandona* sp. [juvenile]	Ostracoda	Potential SRE species, stygal undescribed ostracod	Duck Creek (DCT)	Known from Robe River, Weeli Wolli Creek, and Marillana Creek catchments. The genus *Areacandona* is endemic to the Pilbara region, with many species confined to single localities associated with one or two surface sub-catchments of tributaries flowing into major rivers.
Macroinvertebrates				
Eurysticta coolawanyah	Pilbara pin damselfly	IUCN Vulnerable (**VU**), Pilbara endemic	Duck Creek (DCU and DCD) and Boolgeeda Creek	Known from multiple locations across the Pilbara (e.g., Coondinder Creek, Kalgan Creek, Weeli Wolli Creek, Fortescue Falls, Millstream, Robe River).
Hemicordulia koomina	Pilbara emerald dragonfly	IUCN Vulnerable, (**VU**), Pilbara endemic	Duck Creek (DCU and DCD and DCT) and Boolgeeda Creek	Known from multiple locations across the Pilbara (e.g., Coondiner Creek, Kalgan Creek, Weeli Wolli Creek, Fortescue Falls, Robe River).
Fish				

Species	Common Name	Conservation Significance	Occurrence within Survey Area	Regional Distribution
Leiopotherapon aheneus	Fortescue grunter	IUCN Endangered (**EN**), DBCA Priority 4, Pilbara endemic	Duck Creek and Boolgeeda Creek.	Known from multiple locations across Pilbara; Robe River catchment, Fortescue River (below Fortescue Marsh); Ashburton River.

*Sampling location codes: DCU = Duck Creek Upstream, DCD = Duck Creek Downstream, DCT = Duck Creek Tributaries, HS = Homestead (Caves Creek), Palm Springs Source: WRM 2019b and 2020

6.2.2 Wetland Habitat Types

Drainage Systems in the Pilbara are generally characterised by intermittent and highly variable flows, similar to other arid zones across Australia (WRM 2019a). Creek and river pools of varying types are the dominant wetland habitat type in the Pilbara, which if supported by groundwater are considered GDEs. Permanent river pools support a high degree of habitat and aquatic species diversity, which provide refugia for resident species (WRM 2019a). Permanent 'river' pools are predominantly associated with the lower reaches of Caves Creek and Duck Creek and are outside of the Development Envelope. Ephemeral pools are more common within the creeks and tributaries and therefore this type of aquatic habitat occurs within the Development Envelope. There are three major creeklines which intersect the Development Envelope, these include:

- Duck Creek
- Boolgeeda Creek
- Caves Creek

Historic sampling of riverine pools along Duck, Boolgeeda Creeks and Caves Creek has enabled the characterisation of associated wetland habitat types and the overall ecological value of these rivers within the Development Envelope (WRM 2019a).

Duck Creek

The micro and macroinvertebrate assemblages vary between the upstream and downstream pools in Duck Creek; likely driven by differences in water quality, habitat complexity and fish predation over time. The ephemeral pools in Duck Creek support a similar diversity of aquatic fauna to the semi-permanent and permanent pools in Duck Creek, Caves Creek, Beasley River and the upper Ashburton River. Most taxa of conservation and/or scientific interest in Duck Creek occur in both the ephemeral and semi-permanent/permanent pools. The more permanent pools support refugia for a greater diversity of fauna during dry periods, which are then able to colonise the ephemeral waterbodies following inundation events. Three fish species were recorded in ephemeral pools in Duck Creek and seven within the semi-permanent pool in Duck Creek (WRM 2020). This diversity is consistent with other ephemeral and semi-permanent pools in the area.

Boolgeeda Creek

When inundated, Boolgeeda Creek ephemeral pools support a relatively high diversity of aquatic invertebrate species (WRM 2020). Most of these species are widespread throughout the Pilbara. Fewer taxa of conservation and/or scientific interest are known from surface waters and hyporheic zones of Boolgeeda Creek, compared to Duck Creek, likely because of the shorter hydroperiod of Boolgeeda Creek.

Caves Creek

Caves Creek is largely ephemeral, though there are well-shaded deeper pools along the drainage system, occurring on clay sediments that persist in the dry season after intense rainfall during the wet season. Palm Springs on the lower reach of Caves Creek before the confluence with Duck Creek supports a series of groundwater dependent pools supported by the underlying aquifer. Palm Springs consists of distinct species assemblages across seasons. The Palm Springs Wetland system is one of four significant wetland systems for biodiversity conservation in the Hamersley Interim Biogeographic Regionalisation for Australia (IBRA) subregion (WRM 2019).

Palm Springs, though it has not been classified as a PEC, could be classified within the Priority 2 PEC 'Riparian flora and plant communities of springs and river pools with high water permanence of the Pilbara Region' (DBCA 2019c). Palm Springs is lined with dense riparian woodland and surrounding gorge landscapes and has the capacity to provide optimal foraging habitat for conservation significant bat species in the Pilbara.

7 SUBTERRANEAN FAUNA

The EPA's objective for Subterranean Fauna is *to protect subterranean Fauna so that biological diversity and ecological integrity are maintained* (EPA 2021).

The Key Subterranean Fauna values identified in the Development Envelope include:

- A total of 665 Styofauna specimens representing 75 stygofauna taxa; and
- A total of 350 troglofauna specimens representing 164 troglofauna taxa were recorded within the Development Envelope.

This section describes the Subterranean Fauna that occurs within the Development Envelope and regionally.

7.1 Studies and Survey Effort

Table 7-1 summarises the relevant regional surveys and studies undertaken for Subterranean Fauna. Key study/survey reports are referenced. represents the survey coverage.

Table 7-1: Summary of Technical Studies undertaken for Subterranean Fauna

Study Area, Type and Timing	Consistency with Guidance
Greater Brockman Subterranean Fauna Survey Report (Biologic 2022b)	
Study/Survey area: Brockman Syncline, Particularly Brockman Syncline 1 (BS1), BS2, BS3 and BS4 **Type:** Desktop review of previous subterranean fauna records/surveys in the vicinity of the BSP (Biota 2005, Biota 2007, Biota 2009, Biota 2010, Biota 2011, Biota 2016a and Biota 2016b, WRM 2016). Two-phase level 2 stygofauna and troglofauna survey throughout the study area and wider local area, including morphological and molecular identifications. Two phase targeted survey throughout the study area (primarily in relation to stygofauna) including morphological and molecular identifications. DNA Analysis Report as an appendix. **Timing:** Level 2 Survey Phase 1: 3 – 14 October 2018, 29 November 2018 – 7 December 2018, 10 – 18 April 2019 and 5 – 11 June 2019 (4 trips) Level 2 Survey Phase 2: 9 - 18 April 2019, 6 – 14 June 2019, 18 – 27 June 2019 and 12 – 22 August 2019 (4 trips) Targeted Survey Phase 1: 15 – 21 October 2020 (2 teams). Targeted Survey Phase 2: 20 – 25 February 2021 (2 teams). Targeted Survey Phase 3: 19-25 August 2021 (2 teams).	*Surveys met the relevant EPA Act Policy and guidance at the time of completion.*
Habitat Assessment and Modelling Report (Biologic 2022c). Prepared for Rio Tinto.	
Survey area: Greater Brockman Operation. Consolidated area comprised 75,087 ha.	There is no specific guidance for subterranean fauna habitat categorisation or modelling. The assessment includes a quantitative assessment of the physicochemical and

Study Area, Type and Timing	Consistency with Guidance
Type: Desktop assessment and integration of: 2D surface geology for suitable habitat 3D habitat modelling from drill hole information Above water table (AWT) and Below Water Table (BWT). Groundwater geochemical profiling of stygofauna habitats BWT. **Timing:** 2018 -2022	geological parameters within the Brockman Syncline in order to determine suitable geological habitat for subterranean fauna in and surrounding the BSP.
Brockman Syncline Regional Groundwater Model – Cumulative Impact Assessment (RPS 2021). Prepared for Rio Tinto	
Study/Survey area: Brockman Syncline deposits region, including current B2N and Brockman Syncline 4 (BS4) operations. **Type:** Groundwater modelling study to assess cumulative impacts arising from proposed Brockman Syncline mining. **Timing:** Assessment undertaken November 2021.	Prepared in accordance with the information requirements in the EPA Inland Water factor guideline.
Brockman Syncline: Hydrogeological Assessment (Rio Tinto 2022)	
Study/Survey area: Brockman Syncline deposits region (including BS2, BS4 and Nammuldi operations). **Type**: Hydrogeological Assessment of the Brockman Syncline region with conceptual hydrogeological modelling, groundwater flow modelling and assessment of impacts. **Timing**: Data and results presented as of 2022.	Prepared in accordance with information requirements in the EPA Inland Water factor guideline and the Department of Water and Environmental Regulation's (DWER) Operational policy no. 5.12 – Hydrogeological reporting associated with a groundwater well licence.

7.2 Subterranean Fauna Habitat

The geological and hydrogeological setting of the Development Envelope is dominated by the mountainous Brockman Range and the synclinal valley (the Brockman Syncline) surrounding it. The main geological/ hydrogeological formations which provide habitat for subterranean fauna comprise:

- Bedded ironstone ranges occurring as ridges around the outer rim of the Syncline formed in the Brockman Iron Formation (BrIF) and Marra Mamba Iron Formation (MMIF). Highly suitable subterranean fauna habitats (AWT and BWT) are prevalent in:
    - Weathered and fractured Dales Gorge and Joffre Members of the BrIF,
    - Mt Newman Member of the MMIF, and pisolitic duricrust/ hardcap on the flanks of the ranges.
    - Other members of the BrIF and MMIF also provide similar habitat values where suitably weathered/ fractured.
- The synclinal valley features suitable habitats (AWT/BWT) within:
    - Unconsolidated and porous alluvial/ colluvial detritals
    - Secondarily weathered deposits of calcrete and pisolitic channel iron deposits (CID) occurring in patches throughout the valley detritals
    - Weathered/ fractured Wittenoom Dolomite Formation occurring throughout the valley (typically below the detritals and BWT).

Habitat complexity is increased in many sections of the Brockman Syncline by numerous geological structures such as faults and transverse dykes, which partly compartmentalise the bedrock habitats. Although detrital habitats occur largely above the dykes and are not subject to the same faulting/ disconformities as the bedrock, the detrital habitats are also conceptualised as complex and variably porous/ weathered at local scales.

Groundwater tables are also highly variable in depth from surface, size/ extent, and degree of connectivity between various compartments occurring throughout the Synclinal valley. Some, but not all of the aforementioned dykes appear to constrain hydrogeological connectivity, with significant changes in the depth of the water table, between various sections of the Brockman Syncline.

Subterranean fauna habitat of the Caves Creek and Silvergrass areas is likely to have more widespread connectivity given the detrital and alluvial geological extents. This geological and hydrogeological setting of Caves Creek and has greater potential for wider distribution of species than the Brockman Syncline, given spatial connection of suitable geology without constraining features such as dykes.

7.2.1 Brockman Syncline Subterranean Fauna Habitat Modelling

The 3D modelling of prospective subterranean habitats within the Brockman Syncline is based mainly on lithology information from drill-hole logging data and bore logs, alongside diamond drill cores, hydrogeological information, geophysical information, and structural information, targeted at detecting the most likely geological and hydrogeological strata where suitable cavities, fractures and porous zones occur, providing habitat for subterranean fauna.

These sources are independently validated, integrated, and cross checked against subterranean fauna records from sampling throughout the Development Envelope and the immediate local context. Further details of the habitat modelling methodology are available in Biologic (2022c), based upon Rio Tinto and Biologic's peer reviewed 3D habitat modelling framework. Subterranean fauna habitats were modelled in two distinct zones; the upper part of the geological strata nearer to surface which has been extensively drilled and lower geological strata below which is reliant upon a lower density of information.

7.2.2 Stygofauna Habitat

Suitable habitats for stygofauna occur mainly within the synclinal valley in Tertiary detrital aquifers and fractured/ weathered rock aquifers at varying depths from surface. The Tertiary detrital aquifers are composed of colluvial and alluvial sediments of variable porosity, and patches of secondarily weathered calcrete and CID, which provide highly suitable stygofauna habitats. Deeper fractured/ weathered rock aquifers occur in the BrIF, MMIF, and Wittenoom Dolomite (particularly but not exclusively within the Dales Gorge Member, Mt Newman Member, and Bee Gorge/ Paraburdoo Members where saturated).

Numerous dykes, sills and structures within the bedrock constrain groundwater around the various sections of the syncline and create multiple hydrogeological compartments. However, the dykes are not considered to restrict groundwater flows and habitat connectivity within the overlying detrital aquifers unless corresponding to a significant change in water levels between compartments. Dykes that do not correspond to a significant change in water levels may allow connectivity due to faults and fracturing or periodic overtopping through the overlying detritals.

Local variability in the thickness, extent, and continuity of BWT habitats is attributed to the local hydrostratigraphic context, the occurrence of transverse dykes and geological structures, and the bathymetric form of the aquifer basement within each section or area of the synclinal valley.

7.2.3 Troglofauna Habitat

3D habitat modelling (Biologic 2022c) showed that suitable AWT habitats for troglofauna occur widely throughout the Brockman Syncline, hosted within a variety of geological settings. The BrIF and MMIF ranges encircling the Brockman Syncline host the majority of suitable troglofauna habitat as they commonly feature highly suitable fractured and weathered rock habitats created by supergene (secondary) weathering processes. Suitable troglofauna habitats also extend along the flanks of the BrIF and MMIF ranges, hosted by hematite-goethite-martite hardcap (pisolitic duricrust). The valleys

between the BrIF and MMIF ranges provide further troglofauna habitats within Robe Pisolite (Channel Iron Deposits), karstic calcrete deposits, and weathered Wittenoom Dolomite Formation. Unconsolidated alluvial and colluvial detrital layers in the valleys provide further suitable AWT habitats for troglofauna where sufficient pore spaces occur.

Geological structures such as dykes, sills, faults and shears are very common throughout the Development Envelope and mainly strike in a north-west to south-east direction. These structures may influence local habitat connectivity either by increasing fracturing within the base rock or by providing impermeable/ fresh rock barriers. Nevertheless, AWT habitat connectivity along the syncline is likely maintained via a thin layer of detrital material within the synclinal valley which lies atop the numerous Subterranean Fauna Assemblage

7.3 Subterranean Fauna Sampling

7.3.1 Stygofauna

A total of 665 stygofauna specimens representing 75 stygofauna taxa (species or operational taxonomic units [OTUs]) were recorded within the Development Envelope and immediate vicinity (Biologic 2022a). The number of stygofauna taxa recorded at Greater Brockman is comparatively high, i.e. subterranean fauna surveys at the nearest mining project at Eliwana recorded 15 stygofauna taxa (Biologic 2018).

Figure 7-1 displays the spatial extent and location of Stygofauna sampling completed across the Brockman Operation.

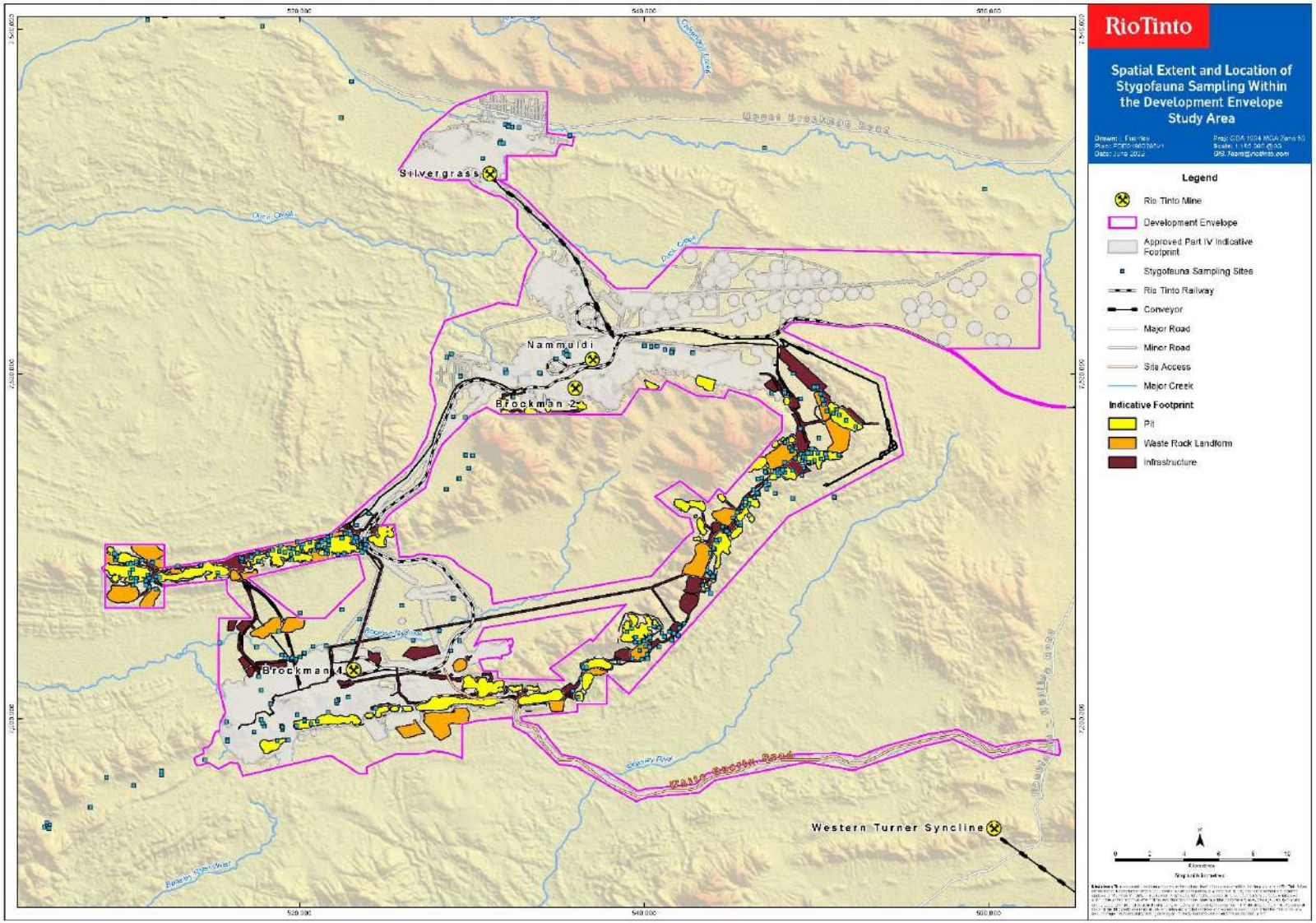
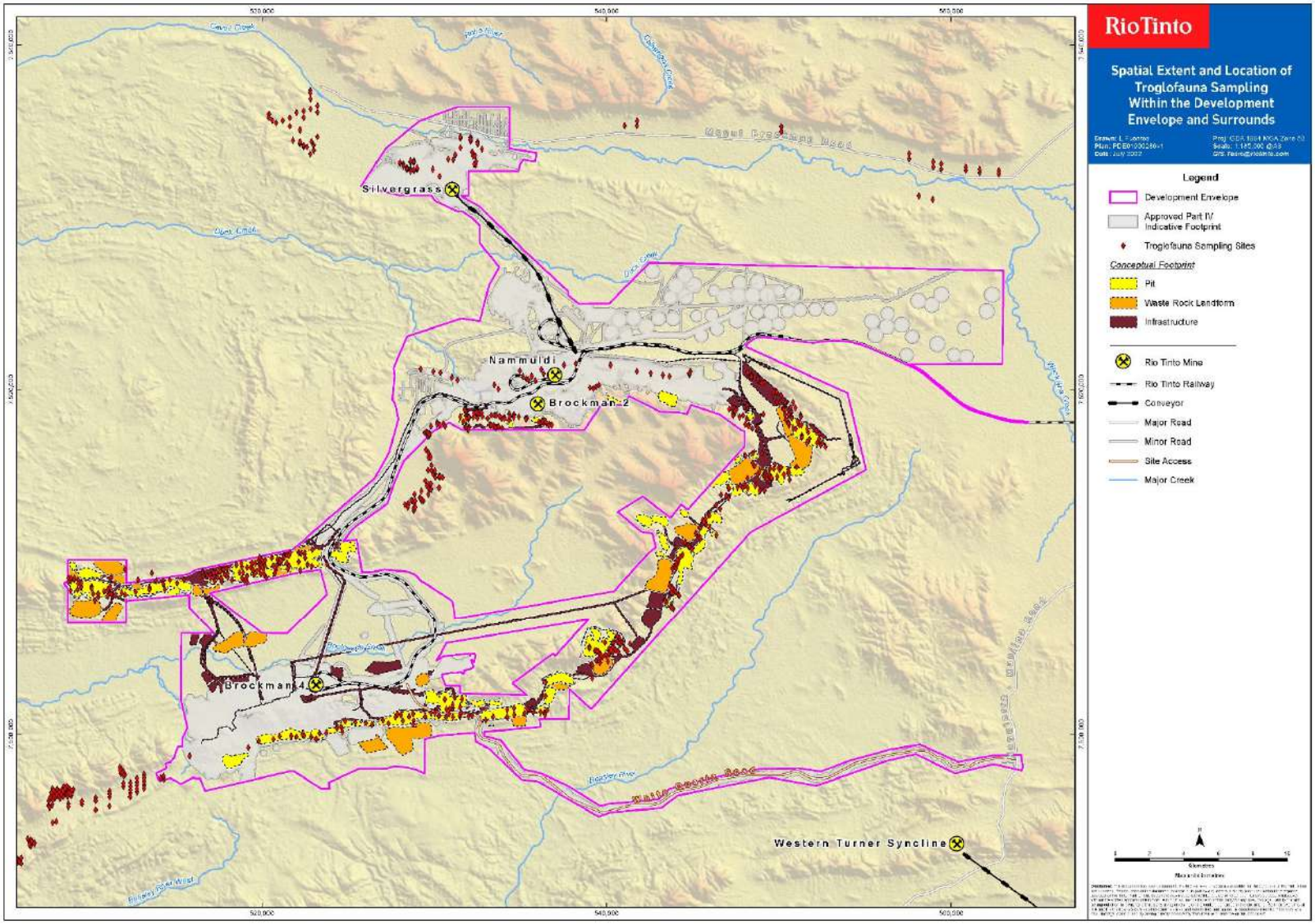


Figure 7-1: Spatial extent and location of Stygofauna sampling completed across the Brockman Operation

7.3.2 Troglofauna

A total of 350 troglofauna specimens representing 164 troglofauna taxa (species or operational taxonomic units) were recorded within the Development Envelope and the immediate vicinity representing 16 higher level taxonomic groups comprising Araneae, *Palpigradi, Pseudoscorpiones, Schizomida, Scorpiones, Isopoda, Chilopoda, Pauropoda, Polydesmida, Polyxenida, Symphyla, Diplura, Blattodea, Coleoptera, Hemiptera* and *Zygentoma* (Biologic 2022a).

Figure 7-2 displays the spatial extent and location of Troglofauna sampling completed across the Brockman Operation.


RioTinto
Spatial Extent and Location of Troglofauna Sampling Within the Development Envelope and Surrounds
Legend
Development Envelope
Approved Part IV Indicative Footprint
Troglofauna Sampling Sites
Conceptual Footprint
Pit
Waste Rock Landform
Infrastructure
Rio Tinto Mine
Rio Tinto Railway
Conveyor
Major Road
Minor Road
Site Access
Major Creek
Silvergrass
Nammuldi
Brockman 2
Brockman 4
Western Turner Syncline
Major Eroded Area
Major Eroded Area
Major Eroded Area

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Appendix 8: Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, BS4

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15 May 2022

2079.20f (Rev 1)

Attn: Kjestine McNamara – Rehabilitation Advisor, Studies, Rehab and Closure

Memorandum: Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, Brockman 4

1. Introduction

1.1 Regulatory expectations

Across Australia, mining regulatory bodies provide guidance on the required state of rehabilitated landforms. In Western Australia the Department of Mines, Industry Regulation and Safety (DMIRS) define land rehabilitation as the "return of disturbed land to a safe, stable, non-polluting/non-contaminating landform in an ecologically sustainable manner that is productive and/or self-sustaining and is consistent with the agreed post-mining land use"[1]. In their guidance note on waste rock dumps, DMIRS also state that the geometry of waste dump batter slopes should be designed such that they are not prone to significant erosion[2].

Therefore, fundamental to creating safe, stable, and non-polluting landforms is the development of land surfaces that:

- do not erode at rates likely to be unstable in the long-term;
- are sufficiently stable such that vegetation can establish;
- erode such that the agreed post-mining land use can be achieved; and
- generate sediment levels consistent with those of the surrounding landscape.

1.2 Rio Tinto's historical involvement in erodibility testing and erosion modelling

Rio Tinto Iron Ore (WA) has been involved in the development of erosion assessment methods for mining waste landforms for a long time, with the first application of material erodibility

[1] Department of Mines, Industry Regulation and Safety (2020) *Mine Closure Plan Guidance - How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans*, Version 3.0, Government of Western Australia, https://www.dmp.wa.gov.au/Documents/Environment/REC-EC-112D.pdf, accessed 29 November 2021.
[2] Department of Mines, Industry Regulation and Safety (2021) *Waste Rock Dumps*, Version 2.1, Government of Western Australia, https://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-223.pdf, accessed 29 November 2021.

testing and erosion models to mining landforms occurring in 1998. Since that time, the use of models has improved and been refined to the point where final landform shapes can be informed through models calibrated using site-specific material erodibility and climate data.

Between 1998 and 2006, Rio Tinto Iron Ore (WA) completed numerous erosion studies, including field-based studies at Tom Price, Paraburdoo, West Angelas, and Nammuldi, and laboratory-based studies for materials from Tom Price, Channar, and Marandoo. Between 2010 and 2021 they have continued to undertake a program of works to generate erodibility data for a range of mineral waste materials from their iron ore mine sites in the Pilbara. Most recently for Brockman 4, data for materials were collected in 2021.

These erodibility data have been used to establish a way for a material's erosion characteristics to directly inform rehabilitation planning. Erodibility is defined differently depending on the erosion prediction tool being used. Erodibility has been considered in two ways.

First, material erodibility from the Revised Universal Soil Loss Equation (RUSLE) [3] has been used to rank each mineral waste type into groups that help to broadly consider erosion risk. Erodibility from the RUSLE is linked to a material's particle size distribution (PSD), and when linked with a measure of surface rock cover level, can be used to rank materials into one of three levels of erodibility – low, medium, or high. Second, erodibility has been considered within the WEPP[4] runoff/erosion model to define material-specific landform designs for each mineral waste type. WEPP erodibility parameters are directly related to material erodibility and provide a more robust means of assessing erosion risk.

1.3 Erodibility ranking system using the RUSLE

The erodibility ranking system developed using the RUSLE seeks to broadly rank mineral wastes into one of three levels of erodibility – low, medium, or high. The RUSLE is an empirical equation that calculates long-term annual erosion using five factors that are multiplied together[5]. Two of these factors, erodibility (K-factor) and cover (C-factor), are specifically related to the material. The remaining three factors describe rainfall, batter geometry, and slope conditions.

The K-factor is calculated from a material's fine fraction PSD (<2mm diameter), excluding the coarse fraction (>2mm). The standard procedure for its calculation is detailed by Rosewell and Loch (2002)[6]. The C-factor describes the impact of different cover elements on erosion. For this ranking system, surface rock cover is important in reducing erosion potential. Rock cover is the percentage of the rain-armoured surface that is covered by rock particles. Other cover elements such as litter and vegetation surface cover were not considered as they are typically low in the Pilbara (vegetation surface cover levels are typically <5%).

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[3] Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., and Yoder, D.C., *Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE)*, Agricultural Handbook Number 703, US Department of Agriculture.

[4] Water Erosion Prediction Project

[5] $A = R \times K \times LS \times P \times C$ where A is average annual erosion (t/ha/y), R is rainfall erosivity (MJ.mm/ha.h.y), K is soil erodibility (t.ha.h/ha.MJ.mm), LS is the slope length and steepness factor (ratio), P is the support practice factor (ratio), and C in the cover management factor (ratio).

[6] Rosewell, C.J. and Loch, R.J. (2002) *Estimation of the RUSLE soil erodibility factor*, in N. McKenzie, K. Coughlan, and H. Cresswell (eds), Soil Physical Measurement and Interpretation for Land Evaluation, CSIRO Publishing, Collingwood.

Simanton *et al.* (1984)[7], reporting results from their study and two others (Meyer *et al.* (1972)[8]; Box (1981)[9]), found that the RUSLE C-factor can be used to account for changes in rock cover and offer a conservative means of estimating its ability to reduce erosion potential (Figure 1). It was calculated using the RUSLE software (version 1.06) supplied by the US Department of Agriculture.

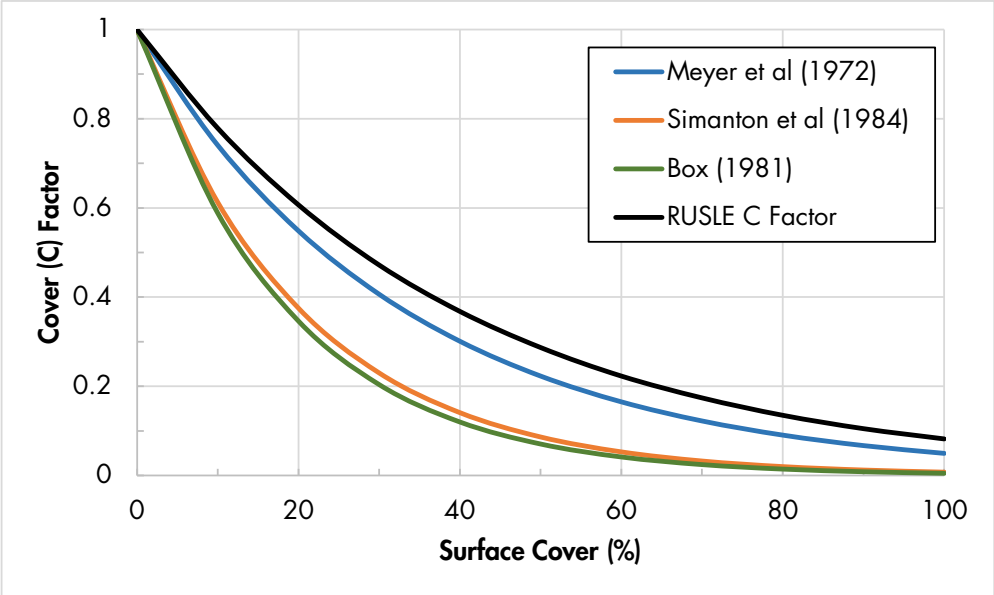


Figure 1: Rock cover and C-factors reported for three studies compared to the RUSLE C-factor relationship (Source: Simanton *et al.* (1984)).

The ranking system was developed using PSD and rain-armoured rock cover levels measured for 36 different mineral wastes sourced from across Rio Tinto's Pilbara iron ore mine sites, including Brockman 4, Hope Downs 1, Mesa A, Mesa J, Nammuldi, Paraburdoo, Tom Price, West Angelas, Western Turner Syncline, and Yandicoogina. The samples had a wide range of PSD and rock cover levels (10-90%). Analysis of the data showed that all K-factors were consistent with highly and very highly erodible materials. By themselves, the K-factors did not explain the observed differences in erosion potential of the wastes. However, when the impact of rock cover was included using the C-factor, it was shown that rock cover strongly influenced erodibility and could explain the observed differences in erosion potential between materials. Mineral wastes that had rock cover levels >70% were ranked as low erodibility and had an erodibility factor (K-factor X C-factor) of <0.001. Materials with rock cover levels of 30-70% were ranked as medium erodibility and had an erodibility factor of 0.02-0.001. Materials with rock cover levels <30% were ranked as high erodibility and had an erodibility factor >0.02.

The erosion that occurs for a material is dependent not only on the material's erodibility, but also on the climate and how the materials are placed (batter geometry). A material that has a

[7] Simanton, J.R., Rawitz, E. and Shirley, E.D. (1984) *Effects of rock fragments on erosion of semiarid rangeland soils*, in 'Erosion and productivity of soils containing rock fragments', Special Publication 13, pp. 65–72, Soil Science Society of America, Madison, WI.
[8] Meyer, L.D., Johnson, C.B., Foster, G.R. (1972) *Stone and woodchip mulches for erosion control on construction sites*, J. Soil Water Conserv., 27(6): 264-269.
[9] Box, J.E. Jr (1981) *The effects of surface slaty fragments on soil erosion by water*, Soil Sci. Am. J., 45:111-116.

low erodibility ranking can be made to erode at high rates if the batter gradients used are too steep or the slope lengths are too long. Vice versa, a material that has a high erodibility ranking can be used to produce stable batter profiles if an appropriate slope geometry is adopted. Therefore, the actual erosion potential of a material is not defined by this erodibility ranking, but by the results of the WEPP erosion modelling, as it considers all the relevant factors (material erodibility, climate, and batter geometry).

1.4 Landform design database

An outcome of the erodibility studies has been the generation of erodibility parameters for a wide range of Rio Tinto's mineral wastes. These erodibility parameters have been used to parameterise the WEPP runoff/erosion model with material-specific parameters. The WEPP model has in turn been used to generate a database of erosionally stable landform batter geometries (combinations of lift height, gradient and profile shape) for Rio Tinto's key mineral wastes. This database is also called the Batter Selector Tool, or BST. Rio Tinto use these batter geometries to develop 3D landform designs that will satisfy long-term erosional stability requirements.

The key mineral wastes were identified by assessment of Rio Tinto's waste drilling records for active mining operations across the Pilbara. Erodibility parameters for these key waste types were then gathered using simulated rainfall and overland flow testing techniques. Site-specific climate sequences were developed using site data and data from nearby Bureau of Meteorology climate stations. WEPP was run using the site-specific climate sequence and material erodibility parameters to develop the database of erosionally stable batter geometries. This process is described in more detail below.

2. WEPP erosion modelling

2.1 The WEPP runoff and erosion model

The WEPP model was used to simulate annual runoff and erosion. It was developed by the United States Department of Agriculture (USDA) and can predict runoff, erosion, and deposition for hillslopes. WEPP has a daily input time step, although sub-daily storm parameters are used to describe the intensity and duration of daily storm events, enabling more accurate estimation of runoff and erosion potential than is generally achievable with daily time step models. When rainfall occurs, soil characteristics are considered to determine the likelihood of runoff. If runoff is predicted to occur, WEPP computes sediment detachment, transport, and deposition along the inputted slope geometry. In this way, WEPP is able to give average erosion over an entire slope length, and erosion rates at any point along the slope (peak erosion rates are calculated using this information).

The model's erosion component uses a steady-state sediment continuity equation as the basis for the erosion computations. Soil detachment in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate. Soil detachment in rills is predicted to occur if the runoff hydraulic shear stress is greater than the critical shear stress at which rilling is initiated, and when the sediment load of the runoff is below its capacity to transport sediment. Deposition in rills is computed when the sediment load of the runoff is greater than the capacity of the runoff to transport it.

Climate data

All WEPP simulations use a 100-year stochastic climate sequence derived from data observed at Rio Tinto's sites and from nearby Bureau of Meteorology climate stations. A total of 9 climate sequences were created to represent 15 mine sites:

- Brockman 4, Brockman 2, and Nammuldi;
- Tom Price and Western Turner Syncline;
- West Angelas;
- Channar, Eastern Range, and Paraburdoo;
- Marandoo;
- Hope Downs 1/2;
- Hope Downs 4;
- Mesa J and Mesa A; and
- Yandicoogina.

Each of the 9 climate sequences contain 36,525 daily climate data sets that describe rainfall, storm duration and intensity, temperature, solar radiation, and wind. The sequences contain a wide range of rainfall events, including several extreme events. Each climate sequence was assessed against the Bureau of Meteorology's Design Rainfall Data System[10] to consider the Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI) of the larger rainfall events within the sequence. The findings for the Brockman 4 climate sequence are given in Table 1. The rarest event within the Brockman 4 climate sequence has an AEP of <0.05%, equivalent to a storm with an ARI of >2,000 years. This storm is defined within the Australian Rainfall and Runoff Guideline (AR&R) as 'extreme'. For Brockman 4, the second rarest rainfall event also has an AEP of 0.07% (1,500 year ARI) and the third rarest event has an AEP of 0.1% (1,000 year ARI). These are both defined as 'very rare' events.

The Brockman 4 climate sequence is consistent with long-term averages and includes multiple very rare and rare rainfall events. Therefore, the resultant erosion modelling is also consistent with long-term averages, including the erosion that would occur from multiple very rare events.

Table 1: The Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI) values of the three rarest rainfall events within the Brockman 4 climate sequence.

Rainfall Event Details					
Rarest		2nd Rarest		3rd Rarest	
Total & Duration	AEP (%) & ARI (years	Total & Duration	AEP (%) & ARI (years	Total & Duration	AEP (%) & ARI (years
268mm 5 hours	<0.05% >2,000 years	175mm 5 hours	0.07% 1,500 years	171mm 4 hours	0.1% 1,000 years

[10] http://www.bom.gov.au/water/designRainfalls/revised-ifd/

Validation of WEPP modelling

WEPP model validation data are provided to demonstrate that the model is able to adequately predict erosion in a mining context. WEPP has been extensively validated by Landloch for mine site batters (Figure 2).

The data presented were sourced from 27 locations on 12 waste landforms on mine sites in Western Australia. Several sites were located at Rio Tinto's Pilbara iron ore sites. The observed erosion data were collected using 30-50 m wide cross-slope erosion transects located on upper and lower sections of waste dump batters. Batter geometries include both linear and concave cross-sectional profiles. Gradients assessed are consistent with the slopes commonly used for mining landforms (12-20°). Surfaces assessed include loamy soils, clay soils, and rocky soils. The ages of the batters range from 3-8 years. Slope conditions range from minimally eroded to heavily eroded.

The observed cumulative erosion rates show good agreement with rates predicted by WEPP. Given that these data include predictions from both the upper and lower sections of landform batters, WEPP is shown to be able to suitably predict changes in erosion rates with changing slope lengths and gradients. The model can adequately represent both runoff accumulation down the slope and flow concentration across the slope. The accuracy of the predictions shown in Figure 2 also indicates that the methods used to derive the model parameters produce accurate model results. This gives confidence that accurate calibration of the WEPP model can be achieved, provided suitable testing methods are used.

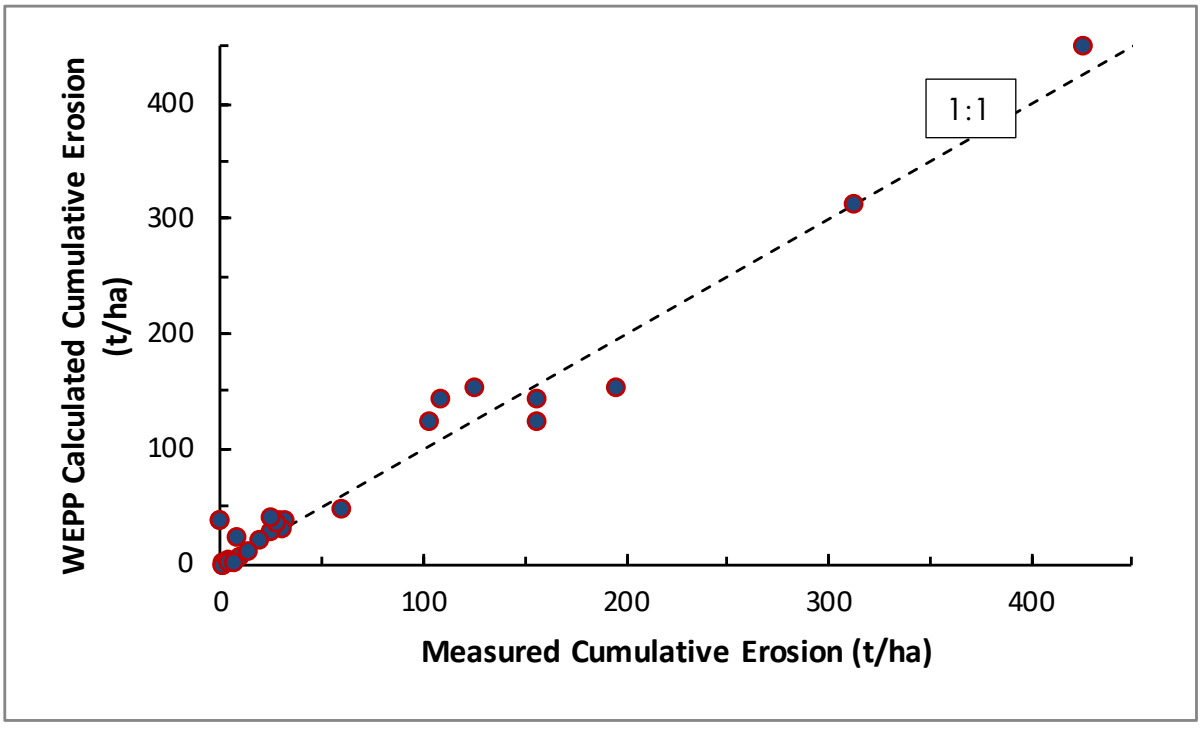


Figure 2: WEPP-predicted cumulative erosion and observed cumulative erosion for 27 locations from Western Australian mine sites.

Establishing acceptable long-term erosion rates

The suitability of the batter geometries found within the Rio Tinto Iron Ore Batter Selector Tool is determined by comparison of the modelled long-term average erosion rates with rates that have been demonstrated to be acceptable. Historically, the acceptable long-term erosion rate has been set based on a desire to limit the initiation of rill erosion. A value of 5t/ha/y was used. More recently, a review of acceptable erosion rate values for the Pilbara region[11] considered acceptability using six different concepts:

- Rates of soil renewal (soil formation and deposition by dust);
- Maintenance of surface soil/growth media quality;
- Rates of naturally occurring erosion in the Pilbara;
- Rates that increase the potential for gully development;
- Water quality and off site impacts; and
- Impacts on vegetation.

The review found that the acceptable rates of long-term erosion were similar regardless of the concept considered. A value of 6t/ha/y for long term average slope erosion was found to be consistent with rates of soil renewal and naturally occurring erosion, and consistent with a surface with a low tendency for rill and gully erosion. Given that the erosionally stable batter geometries adopted by Rio Tinto prior to the more recent review are modelled to erode at rates less than 5t/ha/y, it is concluded by Landloch that the slopes currently within the Batter Selector Tool are suitable, provided surface water control from the dump top and berms, and around the landform are also suitably managed.

2.2 Landform evolution modelling

Other erosion models exist that can be usefully deployed as part of the landform design process at different phases of mining operations. WEPP is used to define erosionally stable two-dimensional landform batter designs. Landform evolution models (LEMs) can be used to consider landforms in three dimensions.

SIBERIA is the most widely adopted LEM for use in mining, particularly in Australia. It is a model tailored to the consideration of the impacts of the 3D shape on the long-term stability of a landform. SIBERIA modifies the 3D shape of a landform in response to erosion and deposition. It is different to a surface water model in that it does not predict or route runoff over the surface. Rather it uses relationships between surface hydrology (contributing areas and discharge rates) and erosion to predict changes in 3D landform shape.

Within the context of mining landforms, SIBERIA has been used to consider the:

- likelihood of the development of rill or gully erosion over time;
- breaching of surface layers designed to encapsulate underlying problematic wastes;
- erosion risk at the interface between a waste dump and adjacent undisturbed land; and
- erosional impact of placement of different materials over the land surface.

[11] Howard, E.J. and Loch, R.J. (2019) *Acceptable erosion rates for mine waste landform rehabilitation modelling in the Pilbara, Western Australia*, in AB Fourie & M Tibbett (eds), Proceedings of the 13th International Conference on Mine Closure, Australian Centre for Geomechanics, Perth, pp. 1545-1560.

SIBERIA is more complex to parametrise than WEPP. It requires parameterisation with time series data of runoff and erosion for a specific combination of material and landform shape. Because it is fitted to time series data for runoff and erosion (not rainfall), SIBERIA cannot easily be used to predict erosion for a single rainfall event. For example, it is not able to be used to predict land changes in response to a single extreme event. The most appropriate use of SIBERIA is to assess long-term changes in landform shape (over decades or hundreds of years).

Given that final 3D landform shapes are not exactly known during the early phases of mining (i.e. feasibility or approvals stage), the usefulness of SIBERIA in these early stages is limited. Two dimensional batter erosion models such as WEPP provide sufficient information in order for the broad shape of a rehabilitation landform to be defined. For example, the erosionally stable slope lengths, heights, and gradients, the batter profile shape (linear, concave etc.), and the required capacity of cross-slope berms and crest bunding, can all be derived from WEPP modelling without the need for SIBERIA modelling. If the broad shape of the landform batter is set based on stable batter geometries defined by WEPP, the resultant 3D landform is likely stable, provided it is coupled with an investigation of surface water flows to account for risks such as flood flows (which SIBERIA is not equipped to do) and intentional flow concentrations (as can occur in more complex 3D shapes).

SIBERIA modelling becomes increasingly useful closer to the point of rehabilitation when more detailed designs are available and where it can address risks associated with how the landform ultimately meshes into the surrounding landscape.

3. Material abundance

Table 2 provides a summary of the percentage of each waste type for Brockman 4. The proportions are from the 2018 life of mine data (approved tonnes excluding proposed tonnes) as provided by Rio Tinto (pers. comm. C. Dodge, 17 August 2020).

Table 2: Waste material summary for Brockman 4 (2018 LOM data)

Waste material type	Erodibility Ranking	Total waste (kt)	Total waste (%)
Detritals	High	100,724	29
Joffre	Low	70,370	20
Wittenoom Formation	High	35,636	10
Dales Gorge	Low	35,507	10
Whaleback Shale	Medium	31,156	9
Dolerite	High	16,799	5
Hydrated Zone	Low	18,152	5
Mt Newman Member	Low	12,695	4
Foot Wall Zone	Low	6,988	2
McRae Shale	Medium	3,953	1
MacLeod Member	Low	4,392	1
Nammuldi	Medium	352	0
Mount Sylvia	Medium	13	0
Others	Medium	9,285	3

Detritals and Joffre are the dominant waste at Brockman 4. Wittenoom Formation, Dales Gorge, Whaleback Shale, Dolerite, and Hydrated Zone are also present in appreciable proportions. Several other waste types are present but in small proportions (<5%); they have either low or medium erodibility rankings. Erodibility studies have been carried out on 90 waste samples from Rio Tinto's Pilbara iron ore mines. Of these 90 samples, 4 were sourced specifically from Brockman 4, namely:

- Joffre (1 sample),
- Wittenoom Formation (1 sample),
- Whaleback Shale (1 sample), and
- Hydrated Zone (1 sample).

These samples cover the main wastes from Brockman 4 and account for 68% of the waste at Brockman 4. More widely, there exists data for 3 Detritals samples[12], 1 Joffre sample[13], 1 Wittenoom Formation sample[14], 3 Dales Gorge sample[15], 1 Whaleback Shale[16], and 2 Hydrated Zone samples[17]. These materials are sourced from Brockman 2 and Nammuldi, Tom Price, and Western Turner Syncline. Including these, 83% of the Brockman 4 waste types have been broadly characterised for erodibility. No data exists for the Dolerite waste materials.

Plant growth data for 76 samples of similar materials are available for Brockman 4 and other Pilbara iron ore sites:

- Brockman 2/Nammuldi (4 Detritals, 2 Dales Gorge samples);
- Brockman 4 (3 Detritals, 2 Joffre, 1 Wittenoom Formation, 3 Whaleback Shale, 1 Hydrated Zone samples);
- Greater Paraburdoo (3 Detritals, 4 Joffre, 7 Dales Gorge, 1 Whaleback Shale, 6 Hydrated Zone samples);
- Gudai-Darri (1 Detritals sample);
- Hope Downs 1/2 (6 Detritals, 1 Wittenoom Formation, 1 Hydrated Zone samples);
- Hope Downs 4 (3 Detritals, 1 Wittenoom samples);
- Marandoo (6 Detritals samples);
- Tom Price (1 Detritals, 2 Joffre, 1 Wittenoom Formation, 5 Dales Gorge, 2 Whaleback Shale, 1 Mt Newman Member, 1 Hydrated Zone samples); and
- Western Turner Syncline (3 Detritals, 2 Joffre, 4 Dales Gorge, 1 Whaleback Shale, 1 Hydrated Zone samples).

Data for these materials will be used to discuss plant growth and erosion potential below.

[12] Brockman 2 and Nammuldi, Western Turner Syncline
[13] Tom Price
[14] Tom Price
[15] Tom Price, Western Turner Syncline
[16] Tom Price
[17] Tom Price, Western Turner Syncline

4. Material testing methods

4.1 Plant growth potential

Samples of the fine component (<2mm) of some of these materials were analysed for soil $pH_{1:5}$ (water), $EC_{1:5}$ as a measure of salinity, Exchangeable Sodium Percentage (ESP), and particle size distribution (coarse sand, fine sand, silt, and clay). These properties were used to define risks to vegetation growth inherent in the wastes (e.g. salinity and poor structure). The coarse components (>16mm) were also assessed for properties that indicate their likely durability, tendency to weather, and usefulness as an armour material. Properties assessed include coarse fraction content, rock particle density, and rock water absorption.

4.2 Material erodibility

Assessment of long-term erosion potential for each of the materials was assessed using the WEPP model. WEPP describes erodibility using a number of specific parameters:

- Interrill Erodibility (K_i);
- Rill Erodibility (K_R);
- Critical Shear for Rill Initiation (τ_c); and
- Effective Hydraulic Conductivity (K_e).

These erodibility parameters were derived from data collected using application of:

- Simulated rain to test surfaces and measurement of runoff and sediment in runoff to obtain estimates of K_i and K_e; and
- Simulated overland water flows and measurement of runoff, sediment, and rill characteristics, to obtain estimates of K_R and τ_c.

Simulated rainfall and overland flows

Rainfall and overland flow simulations have been widely used to define the erodibility of mine wastes. The process is briefly described below.

For rainfall simulation, flat fan nozzles mounted on an oscillating manifold positioned ~2m above a test surface produce the simulated rain (Figure 3). The kinetic energy generated by the nozzles is consistent with the energy of natural rainfall at intensities >40mm/hr. The nozzles sweep back and forth across the test surfaces, achieving high spatial distribution uniformity (<10% coefficient of variation). For each material tested, triplicate plots (0.75m square) are subjected to a rainfall event sufficiently intense to ensure runoff occurs (usually 80-100mm/hr). This allows measurement of K_i and K_e.

For overland flow simulations, rill erodibility parameters are derived by applying overland flows at various rates to flumes 0.4m wide and 2.0m long set at gradients ranging from 10-30% (Figure 4). K_R and τ_c are derived based on relationships between flow shear stress and sediment detachment rates measured from these flumes.

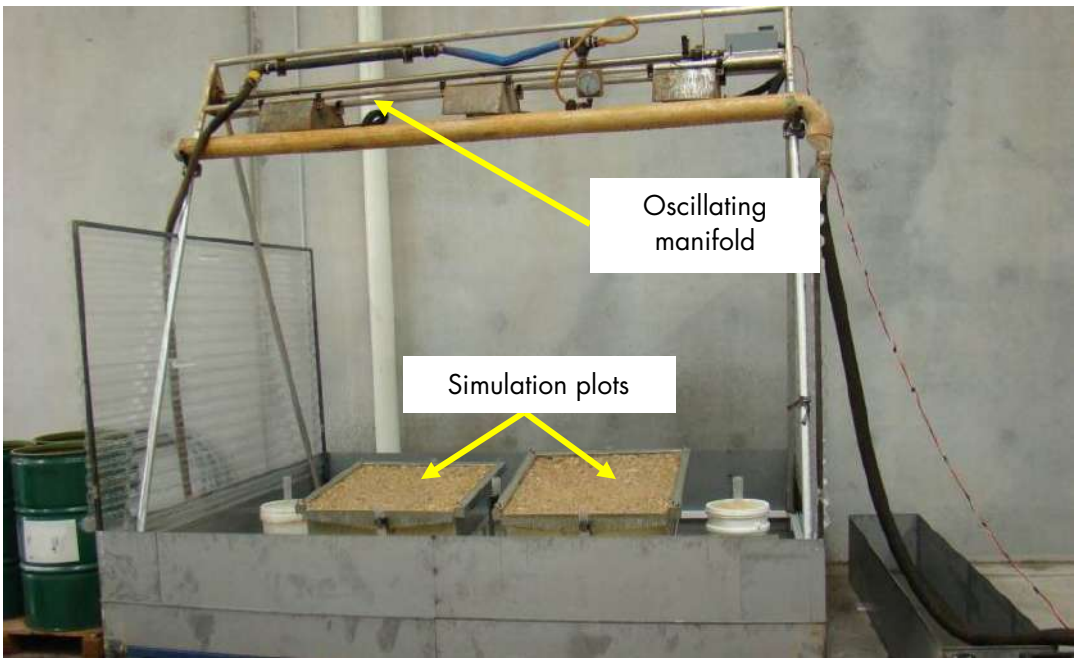
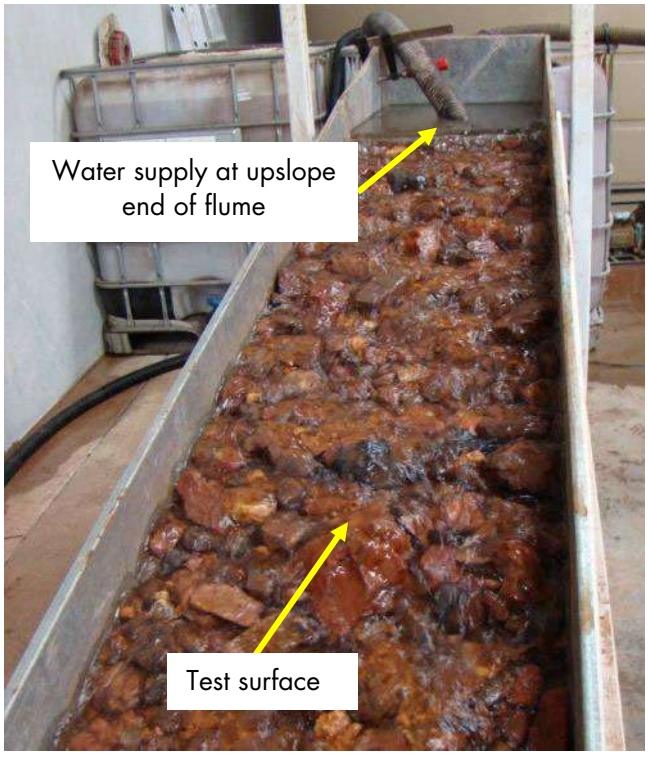


Figure 3: Typical laboratory-based rainfall simulator installation.



Figure 4: Example of flume setup used to simulate overland flows.



5. Materials of Brockman 4

5.1 Plant growth potential

A summary of waste characterisation data relevant to plant growth are given in Tables 3 (fines fraction) and 4 (coarse fraction). Data are provided for materials from both Brockman 4 and other sites that have the same materials. The results would be broadly consistent with those from Brockman 4.

Table 3: Characteristics of the soil fraction (<2mm) of Brockman 4 materials, and similar materials from other sites.

Geology	Particle Size Distribution (Fine Fraction)				Soil Texture	$pH_{1:5}$ (Water)	$EC_{1:5}$	ESP
	Coarse Sand	Fine Sand	Silt	Clay				
	%	%	%	%		pH Units	dS/m	%
Brockman 4								
Detritals	50.2	31.6	11.2	7.0	LS	8.0	0.25	-
	47.6	30.6	4.0	17.8	SL	7.0	0.05	-
	48.8	25.7	6.0	19.5	SL	7.8	0.23	-
Joffre	39.0	35.8	18.2	6.9	LS	7.5	0.08	-
	49.0	29.0	15.0	9.0	LS	7.5	0.02	14.9
Wittenoom	35.6	15.8	11.3	37.3	C	8.0	2.65	7.0
Whaleback Shale	46.3	30.7	14.9	8.1	LS	8.5	0.10	-
	50.5	24.4	5.9	19.2	SL	7.5	0.12	-
	44.3	32.7	2.2	20.5	SCL	7.0	0.59	11
Hydrated Zone	54.0	28.0	9.0	9.0	LS	7.5	0.16	5.7
Brockman 2 and Nammuldi								
Detritals	35.9	34.7	11.3	18.2	L	8.7	0.16	1.5
	39.2	31.9	9.4	19.5	L	6.0	0.07	-
	41.0	35.1	9.2	14.7	SL	8.0	0.12	-
	-	-	-	-	-	6.5	0.06	3.4
Dales Gorge	53.9	33.0	4.6	8.5	LS	8.0	0.34	-
	46.2	34.6	10.6	8.5	LS	7.5	0.27	-
Gudai-Darri								
Detritals	51.6	33.2	5.9	9.3	LS	7.5	0.08	-
Hope Downs 1/2								
Detritals	39.5	32.8	6.6	21.0	SL	7.0	0.06	-
	30.2	19.6	11.8	38.4	C	8.0	0.29	-
	59.0	24.0	0.0	16.0	SL	7.4	1.06	8.6
	61.4	7.4	7.6	23.6	CL	6.1	0.07	5.1
	56.2	18.9	9.9	14.9	L	7.6	0.07	1.6
Wittenoom	26.7	22.5	15.8	35.0	CL	7.7	0.19	4.9
Hope Downs 4								
Detritals	5.8	62.9	5.9	25.4	CL	7.4	0.02	4.9
	34.3	34.1	6.5	25.2	CL	8.0	0.08	-
	63.2	24.4	2.2	10.1	SL	7.5	0.04	-
Wittenoom	20.6	38.1	40.4	0.8	ZL	7.1	0.06	10
Marandoo								
Detritals	51.7	29.1	6.4	12.9	SL	8.3	0.40	6.3
	57.7	25.9	3.0	13.4	SL	8.1	0.11	4.3
	59.6	23.4	2.9	14.1	SL	8.5	0.36	7.8
	24.3		27.9	47.8	ZC	6.6	0.07	<0.1
	19.1		24.3	56.6	C	8.2	0.18	<0.1
	45.0	32.3	13.0	9.8	LS	8.2	0.02	1.5
Greater Paraburdoo								
Detritals	49.4	31.5	6.6	12.5	SL	7.9	0.02	6.8
	59.0	27.0	7.0	7.0	L	8.0	0.05	16
	70.0	18.0	6.0	6.0	LC	8.0	0.04	16

Geology	Particle Size Distribution (Fine Fraction)				Soil Texture	$pH_{1:5}$ (Water)	$EC_{1:5}$	ESP
	Coarse Sand	Fine Sand	Silt	Clay				
	%	%	%	%		pH Units	dS/m	%
Joffre	35.9	24.0	26.0	14.0	ZL	5.9	0.08	17
	28.0	41.0	5.0	26.0	SCL	6.1	0.30	29
	40.5	23.0	18.1	18.4	L	8.0	0.08	-
	43.0	37.0	19.0	1.0	LS	6.1	0.28	23
Dales Gorge	63.9	15.8	6.7	13.5	SL	7.0	0.04	-
	45.8	26.7	15.3	12.2	LS	6.5	0.04	-
	42.5	38.5	10.0	9.0	LS	8.0	0.04	-
	34.8	42.8	16.8	5.6	LS	8.0	0.06	-
	37.3	40.0	15.3	7.4	LS	8.0	0.20	-
	44.0	27.0	6.0	23.0	SCL	8.1	0.14	1.2
	46.7	30.3	12.9	10.2	LS	6.7	0.14	14
Whaleback Shale	46.0	23.0	6.0	25.0	SCL	5.6	0.10	20
Hydrated Zone	45.0	23.0	3.0	29.0	SCL	5.6	0.10	31
	58.8	19.0	9.7	12.5	SL	7.6	1.04	13
	38.9	32.7	18.3	10.2	LS	6.6	0.12	22
	49.9	28.7	5.6	15.9	SL	6.6	0.18	6.5
	42.2	28.7	11.2	17.8	L	6.6	0.10	14
Tom Price								
Detritals	64.9	23.3	5.7	6.0	LS	6.5	0.03	-
Joffre	36.0	37.8	9.2	17.0	L	8.0	0.25	-
	51.0	26.0	3.0	20.0	SL	5.2	0.08	10
Wittenoom	47.5	30.2	8.8	13.5	SL	7.1	0.40	4.0
Dales Gorge	42.7	37.2	10.8	9.3	LS	7.0	0.04	-
	41.2	38.8	14.3	5.7	LS	6.5	0.06	-
	54.3	28.8	9.3	7.7	LS	7.5	0.11	-
	22.0	24.0	25.0	29.0	CL	-	-	-
	23.0	20.0	35.0	22.0	ZL	-	-	-
Whaleback Shale	37.0	35.4	21.9	5.7	LS	7.0	0.06	-
	39.0	25.0	8.0	28.0	CL	4.8	0.06	14
Hydrated Zone	59.0	27.0	1.0	12.0	SL	8.1	0.55	6.3
Western Turner Syncline								
Detritals	33.7	38.0	9.6	18.7	L	8.0	0.08	-
	59.2	28.5	6.8	5.5	LS	8.5	0.06	-
	47.0	25.0	1.0	27.0	SCL	6.1	0.20	8.5
Joffre	38.6	32.6	16.4	12.4	LS	6.5	0.35	-
	46.4	31.4	13.5	8.7	LS	7.5	0.17	-
Dales Gorge	54.3	31.3	11.1	3.3	LS	7.0	0.08	-
	47.7	30.4	15.1	6.8	LS	7.5	0.11	-
	64.9	23.4	4.5	7.1	LS	8.0	0.06	-
	24.0	2.0	38.0	34.0	ZCL	8.5	0.08	1.6
Whaleback Shale	30.1	36.3	18.9	14.7	L	7.3	0.38	-
Hydrated Zone	59.0	25.0	1.0	15.0	SL	6.9	0.29	26

Notes: Coarse sand: 2.0-0.2mm; Fine sand: 0.2-0.02mm; Silt: 0.02-0.002mm; Clay <0.002mm. Texture: SL: Sandy Loam; LS: Loamy Sand; CL: Clay Loam; L: Loam; C: Clay; ZCL: Silty Clay Loam. '-' indicates that no data are available for this parameters. Those samples with no baseline data shown here are included for completeness as they are present in the erodibility testing results.

Table 4: Characteristics of the coarse fraction (>2mm) of Brockman 4, and similar materials from other sites.

Geology	Full Particle Size Distribution				Coarse Fraction Content	Rock Particle Density	Rock Water Absorption
	Rock	Pebble	Gravel	Fines			
	%	%	%	%	%	%	g/cm³
Brockman 4							
Detritals	8	10	57	25	75	-	-
	6	3	76	15	85	-	-
	1	13	59	27	73	-	-
Joffre	9	16	45	31	69	-	-
	11	0	26	63	37	3.8	3.7
Wittenoom	2	4	55	39	61	3.1	5.3
Whaleback Shale	0	1	48	51	49	-	-
	7	7	43	43	57	-	-
	48	17	27	8	92	3.6	4.5
Hydrated Zone	2	0	26	72	28	3.4	3.3
Brockman 2 and Nammuldi							
Detritals	38	13	35	14	86	2.5	4.0
	0	36	38	26	74	-	-
	2	47	17	34	66	-	-
	0	0	43	57	43	-	-
Dales Gorge	45	42	5	9	91	-	-
	18	56	8	18	82	-	-
Gudai-Darri							
Detritals	0	5	56	39	61	-	-
Hope Downs 1/2							
Detritals	4	6	55	34	66	-	-
	5	5	33	57	43	-	-
	7	6	42	45	55	2.9	5.3
	29	15	35	21	79	-	-
	12	32	32	24	76	3.2	1.4
	20	25	25	31	69	2.3	12.5
Wittenoom	7	6	37	50	50	3.1	4.9
Hope Downs 4							
Detritals	2	2	49	47	53	2.6	8.1
	0	20	20	59	41	-	-
	0	14	36	50	50	-	-
Wittenoom	-	-	-	-	-	3.1	1.5
Marandoo							
Detritals	6	45	17	32	68	3.5	4.8
	17	34	16	33	67	2.4	11.4
	7	46	18	29	71	2.9	10.5
	8	11	56	26	74	-	-
	-	-	-	55	45	-	-
	-	-	-	45	55	-	-
	31	39	8	22	78	3.2	3.1
Greater Paraburdoo							
Detritals	8	18	56	18	82	2.7	4.3

Geology	Full Particle Size Distribution				Coarse Fraction Content	Rock Particle Density	Rock Water Absorption
	Rock	Pebble	Gravel	Fines			
	%	%	%	%	%	%	g/cm³
Joffre	11	65	8	16	84	3.5	1.7
	12	14	39	35	65	4.2	13.5
	9	19	53	19	81	-	-
	21	11	42	26	74	3.5	3.5
Dales Gorge	4	16	65	14	86	-	-
	8	15	54	23	77	-	-
	9	16	47	28	72	-	-
	10	5	39	46	54	-	-
	1	3	46	50	50	-	-
	35	26	32	7	93	2.9	1.0
	19	40	13	28	72	3	8.9
Whaleback Shale	37	27	32	4	96	3	6
Hydrated Zone	7	22	57	14	86	3.4	4.6
	-	-	-	52	48	-	-
	28	37	11	24	76	-	-
	28	36	11	24	76	2.9	3.5
	14	50	12	24	77	3.1	6.1
	0	58	14	28	72	3.3	2.4
Tom Price							
Detritals	11	13	52	24	76	-	-
Joffre	77	20	2	1	99	-	-
	15	20	40	25	75	3.9	2
Wittenoom	0	1	48	52	48	1.9	17.4
Dales Gorge	5	16	62	18	82	-	-
	17	11	53	19	81	-	-
	9	17	56	18	82	-	-
	0	19	38	43	57	-	-
	0	32	18	50	50	-	-
Whaleback Shale	6	14	58	22	78	-	-
	0	7	45	48	52	-	-
Hydrated Zone	20	14	42	24	76	2.5	10.5
Western Turner Syncline							
Detritals	6	6	52	35	65	-	-
	0	5	54	41	59	-	-
	0	4	72	24	76	-	-
Joffre	8	16	40	36	64	-	-
	26	16	38	20	80	-	-
Dales Gorge	5	17	50	28	72	-	-
	14	16	43	27	73	-	-
	14	18	47	21	79	-	-
	32	22	33	13	87	2.3	13.2
Whaleback Shale	4	11	45	41	59	-	-
Hydrated Zone	0	0	72	28	72	-	-

Notes: Rock: >45mm; Pebble: 15-45mm; Gravel: 2-15mm; Fines: <2mm.

The materials have the following properties:

- Commonly low salinity (mean 0.21dS/m), with values unlikely to adversely affect plant germination or growth.
- Acidic to alkaline pH values are measured for the materials, though this variation is not likely to significantly limit plant growth.
- High coarse fraction content (mean 69%), ranging from 28% to 92% for the Brockman 4 materials.
- The rock fraction of the samples tested tends to be dense (rock particle density >2.3g/cm^3) and the water absorption rates are low to moderate. These materials are likely to be reasonable for use as armouring in terms of the durability.

Wastes can have elevated (>6%) Exchangeable Sodium Percentage (ESP). Elevated ESP can indicate a clay fraction with a tendency to disperse and become prone to structural decline. However, these materials would still have a low tendency for structural decline because the clay fraction makes up a very small proportion (median 4%) of the entire material mass, with the majority comprised of non-dispersive sands, gravels, pebbles, and rock.

5.2 Erodibility

Table 5 shows the site-specific erodibility parameters for Brockman 4 and nearby sites. Also shown are the aggregated parameter values adopted and used to develop stable batter geometries within the landform design database (i.e. Batter Selector Tool).

The impact of this difference in erodibility parameters was assessed by conducting additional runoff/erosion modelling with the WEPP model. The results of the erosion modelling are given in Table 6.

Predicted erosion for the Detritals using the aggregated parameters indicates that a stable geometry of a batter with a uniform gradient of 20 degrees would be <5m. When compared to the Detritals from Nammuldi, the same height limitation exists. When compared against the Western Turner Syncline Detritals, the stable height indicated by the modelling increases to 20m at 20 degrees. This indicates that the erodibility of the Detritals can be variable.

Predicted erosion for the Joffre and Dale Gorge materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 15m. When compared with the Joffre materials from Brockman 4 and Dales Gorge materials from Western Turner Syncline, heights of 20m are predicted to be acceptably stable.

The Wittenoom Formation materials are highly erodible. This material poses a risk in terms of erosion and will require specific management (i.e. burial) if slope heights greater than 5m are adopted at Brockman 4.

Predicted erosion for the Whaleback Shale materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 5m. When compared with the Whaleback Shale materials from Brockman 4, heights of 10m are predicted to be acceptably stable.

Predicted erosion for the Hydrated Zone materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 20m. When compared with the Hydrated Zone materials from Brockman 4 and Tom Price, heights of 20m are predicted to be acceptably stable.

Table 5: Site specific erodibility parameters and those generally adopted for erosion modelling.

Material	K_e (mm/h)	K_i (kg.s/m^4)	K_R (s/m)	τ_c (Pa)
Detritals				
Aggregated Value	26	236,317	0.0116	28
Nammuldi	12	472,428	0.0122	14
Western Turner Syncline	135	40,605	0.0366	34
Joffre				
Aggregated Value	33	203,540	0.0033	28
Brockman 4	27	133,167	0.0005	29
Wittenoom Formation				
Aggregated Value	Not Currently Included in Batter Selector Tool			
Brockman 4	5	384,891	0.0025	23
Dales Gorge				
Aggregated Value	33	203,540	0.0033	28
Western Turner Syncline	18	128,962	0.0010	45
Whaleback Shale				
Aggregated Value	46	100,207	0.0042	26
Brockman 4	60	97,572	0.0056	25
Hydrated Zone				
Aggregated Value	103	63,860	0.0030	28
Brockman 4	200	50,000	0.00216	23.7

Table 6: Erosionally stable batter heights for the Brockman 4 materials within the BST and calculated using site specific erodibility data. In some cases, data for Brockman 4 are not available. In these instances, data from nearby sites are shown and indicated in brackets.

Material	Erosionally Stable Batter Geometries in the BST	Erosionally Stable Batter Geometries using Site Samples
Detritals	5m, 20°	5m, 20° (Nammuldi)
Joffre	15m, 20°	20m, 20°
Wittenoom Formation	Not currently in BST	5m, 20°
Dales Gorge	15m, 20°	20m, 20° (Western Turner)
Whaleback Shale	5m, 20°	10m, 20°
Hydrated Zone	20m, 20°	20m, 20°

The slope gradients for uniform batters within the Batter Selector Tool range from 14-20°. This range was selected as being the maximum gradient (20°) at which machinery could safely operate on a slope, and the lowest gradient (14°) that is typically considered for rehabilitation by Rio Tinto. Results for the 20° gradient slope have been shown in order to demonstrate whether use of the site specific erodibility data yield significantly different results to those of the aggregated erodibility data used in the Batter Selector Tool. It should not be construed as a recommendation that a 20° slope is preferred to a lower gradient slope. Slopes lower than 14° could also be considered if required.

6. Closing

Erosion modelling has used data collected from 90 samples of key wastes across Rio Tinto's Pilbara operations. These samples have been subjected to testing to measure their erodibility, with these erodibility parameters used to model long-term erosion using the WEPP model. The climate sequences used in the modelling contain a wide range of rainfall events including several extreme and rare events.

The model results have been compared against acceptable erosion rate values consistent with measured erosion for undisturbed land in the Pilbara, soil renewal rates, and rates at which the risk of rill and gully erosion is low. The model output has been validated at 27 locations on mine sites in Western Australia and shown to agree with observed erosion.

An assessment of the samples specific to Brockman 4 (and for other sites with similar waste types) show that the batter geometries generated using the aggregated erodibility parameters will be suitable (and possibly conservative in some cases) for use at Brockman 4, with the exception of Wittenoom Formation materials. This waste was shown to be erodible, and will require specific management (i.e. burial) if batter heights greater than 5m are adopted at Brockman 4.

Continued sampling and erodibility testing of materials is required as mining continues at Brockman 2 & Nammuldi in order to continue to build Rio Tinto's knowledge of wastes on site. Further, when coupled with erosion monitoring of waste dumps that includes a measure of an erosion rate, the erodibility data should be used to undertake periodic verification of the rehabilitation profiles includes within the Batter Selector Tool.

Regards





Mr EVAN HOWARD
PRINCIPAL CONSULTANT

Disclaimer

All care and diligence have been exercised in testing, interpreting data and the development of recommendations presented in this document. The monitoring and testing have been undertaken in a skilled, professional manner, according to accepted practices. Specific circumstances and research findings after the date of publication may influence the accuracy of the data and recommendations within this document.

The landscape is not uniform. Because of this non-uniformity, no monitoring, testing or sampling technique can produce completely precise results for any site. Any conclusions based on the monitoring and/or testing presented in this document can therefore only serve as a 'best' indication of the environmental condition of the site at the time of preparing this document. It should be noted that site conditions can change with time.

The information that comprises this document should only be used within the limitations stipulated herein. Landloch does not accept any risks and responsibilities for losses, damages, costs and other consequences resulting from using any information, material and recommendations in this document.

Appendix 9: Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, B2N

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2079.20f (Rev 1)

Attn: Kjestine McNamara – Rehabilitation Advisor, Studies, Rehab and Closure

Memorandum: Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, Brockman 2 & Nammuldi

1. Introduction

1.1 Regulatory expectations

Across Australia, mining regulatory bodies provide guidance on the required state of rehabilitated landforms. In Western Australia the Department of Mines, Industry Regulation and Safety (DMIRS) define land rehabilitation as the "return of disturbed land to a safe, stable, non-polluting/non-contaminating landform in an ecologically sustainable manner that is productive and/or self-sustaining and is consistent with the agreed post-mining land use"[1]. In their guidance note on waste rock dumps, DMIRS also state that the geometry of waste dump batter slopes should be designed such that they are not prone to significant erosion[2].

Therefore, fundamental to creating safe, stable, and non-polluting landforms is the development of land surfaces that:

- do not erode at rates likely to be unstable in the long-term;
- are sufficiently stable such that vegetation can establish;
- erode such that the agreed post-mining land use can be achieved; and
- generate sediment levels consistent with those of the surrounding landscape.

1.2 Rio Tinto's historical involvement in erodibility testing and erosion modelling

Rio Tinto Iron Ore (WA) has been involved in the development of erosion assessment methods for mining waste landforms for a long time, with the first application of material erodibility

[1] Department of Mines, Industry Regulation and Safety (2020) *Mine Closure Plan Guidance - How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans*, Version 3.0, Government of Western Australia, https://www.dmp.wa.gov.au/Documents/Environment/REC-EC-112D.pdf, accessed 29 November 2021.
[2] Department of Mines, Industry Regulation and Safety (2021) *Waste Rock Dumps*, Version 2.1, Government of Western Australia, https://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-223.pdf, accessed 29 November 2021.

testing and erosion models to mining landforms occurring in 1998. Since that time, the use of models has improved and been refined to the point where final landform shapes can be informed through models calibrated using site-specific material erodibility and climate data.

Between 1998 and 2006, Rio Tinto Iron Ore (WA) completed numerous erosion studies, including field-based studies at Tom Price, Paraburdoo, West Angelas, and Nammuldi, and laboratory-based studies for materials from Tom Price, Channar, and Marandoo. Between 2010 and 2021 they have continued to undertake a program of works to generate erodibility data for a range of mineral waste materials from their iron ore mine sites in the Pilbara. Most recently for Brockman 2 & Nammuldi, data for materials were collected in 2021.

These erodibility data have been used to establish a way for a material's erosion characteristics to directly inform rehabilitation planning. Erodibility is defined differently depending on the erosion prediction tool being used. Erodibility has been considered in two ways.

First, material erodibility from the Revised Universal Soil Loss Equation (RUSLE) [3] has been used to rank each mineral waste type into groups that help to broadly consider erosion risk. Erodibility from the RUSLE is linked to a material's particle size distribution (PSD), and when linked with a measure of surface rock cover level, can be used to rank materials into one of three levels of erodibility – low, medium, or high. Second, erodibility has been considered within the WEPP[4] runoff/erosion model to define material-specific landform designs for each mineral waste type. WEPP erodibility parameters are directly related to material erodibility and provide a more robust means of assessing erosion risk.

1.3 Erodibility ranking system using the RUSLE

The erodibility ranking system developed using the RUSLE seeks to broadly rank mineral wastes into one of three levels of erodibility – low, medium, or high. The RUSLE is an empirical equation that calculates long-term annual erosion using five factors that are multiplied together[5]. Two of these factors, erodibility (K-factor) and cover (C-factor), are specifically related to the material. The remaining three factors describe rainfall, batter geometry, and slope conditions.

The K-factor is calculated from a material's fine fraction PSD (<2mm diameter), excluding the coarse fraction (>2mm). The standard procedure for its calculation is detailed by Rosewell and Loch (2002)[6]. The C-factor describes the impact of different cover elements on erosion. For this ranking system, surface rock cover is important in reducing erosion potential. Rock cover is the percentage of the rain-armoured surface that is covered by rock particles. Other cover elements such as litter and vegetation surface cover were not considered as they are typically low in the Pilbara (vegetation surface cover levels are typically <5%).

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[3] Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., and Yoder, D.C., *Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE)*, Agricultural Handbook Number 703, US Department of Agriculture.

[4] Water Erosion Prediction Project

[5] $A = R \times K \times LS \times P \times C$ where A is average annual erosion (t/ha/y), R is rainfall erosivity (MJ.mm/ha.h.y), K is soil erodibility (t.ha.h/ha.MJ.mm), LS is the slope length and steepness factor (ratio), P is the support practice factor (ratio), and C in the cover management factor (ratio).

[6] Rosewell, C.J. and Loch, R.J. (2002) *Estimation of the RUSLE soil erodibility factor*, in N. McKenzie, K. Coughlan, and H. Cresswell (eds), Soil Physical Measurement and Interpretation for Land Evaluation, CSIRO Publishing, Collingwood.

Simanton *et al.* (1984)[7], reporting results from their study and two others (Meyer *et al.* (1972)[8]; Box (1981)[9]), found that the RUSLE C-factor can be used to account for changes in rock cover and offer a conservative means of estimating its ability to reduce erosion potential (Figure 1). It was calculated using the RUSLE software (version 1.06) supplied by the US Department of Agriculture.

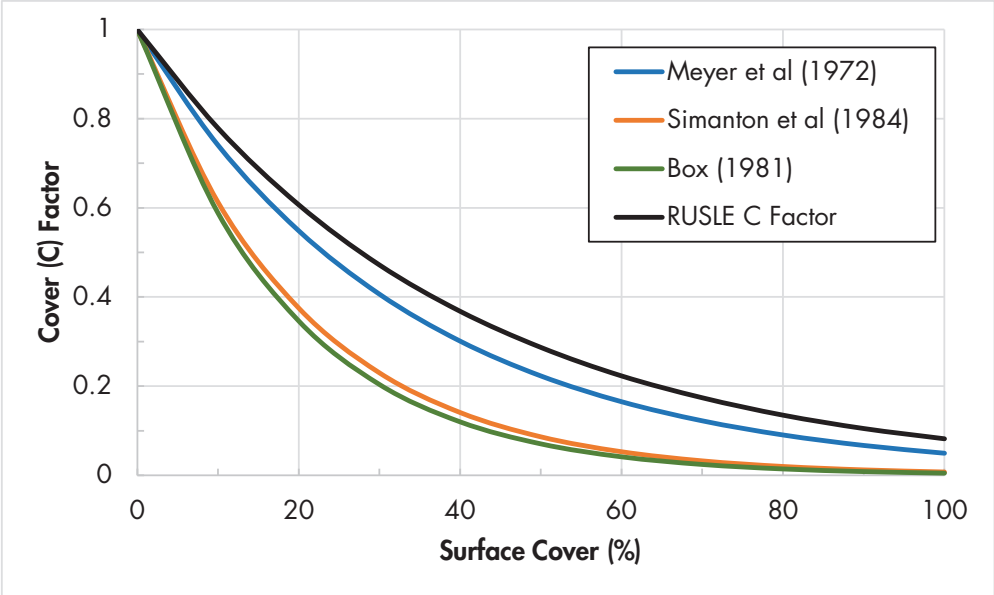


Figure 1: Rock cover and C-factors reported for three studies compared to the RUSLE C-factor relationship (Source: Simanton *et al.* (1984)).

The ranking system was developed using PSD and rain-armoured rock cover levels measured for 36 different mineral wastes sourced from across Rio Tinto's Pilbara iron ore mine sites, including Brockman 4, Hope Downs 1, Mesa A, Mesa J, Nammuldi, Paraburdoo, Tom Price, West Angelas, Western Turner Syncline, and Yandicoogina. The samples had a wide range of PSD and rock cover levels (10-90%). Analysis of the data showed that all K-factors were consistent with highly and very highly erodible materials. By themselves, the K-factors did not explain the observed differences in erosion potential of the wastes. However, when the impact of rock cover was included using the C-factor, it was shown that rock cover strongly influenced erodibility and could explain the observed differences in erosion potential between materials. Mineral wastes that had rock cover levels >70% were ranked as low erodibility and had an erodibility factor (K-factor X C-factor) of <0.001. Materials with rock cover levels of 30-70% were ranked as medium erodibility and had an erodibility factor of 0.02-0.001. Materials with rock cover levels <30% were ranked as high erodibility and had an erodibility factor >0.02.

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[7] Simanton, J.R., Rawitz, E. and Shirley, E.D. (1984) *Effects of rock fragments on erosion of semiarid rangeland soils*, in 'Erosion and productivity of soils containing rock fragments', Special Publication 13, pp. 65–72, Soil Science Society of America, Madison, WI.

[8] Meyer, L.D., Johnson, C.B., Foster, G.R. (1972) *Stone and woodchip mulches for erosion control on construction sites*, J. Soil Water Conserv., 27(6): 264-269.

[9] Box, J.E. Jr (1981) *The effects of surface slaty fragments on soil erosion by water*, Soil Sci. Am. J., 45:111-116.

The erosion that occurs for a material is dependent not only on the material's erodibility, but also on the climate and how the materials are placed (batter geometry). A material that has a low erodibility ranking can be made to erode at high rates if the batter gradients used are too steep or the slope lengths are too long. Vice versa, a material that has a high erodibility ranking can be used to produce stable batter profiles if an appropriate slope geometry is adopted. Therefore, the actual erosion potential of a material is not defined by this erodibility ranking, but by the results of the WEPP erosion modelling, as it considers all the relevant factors (material erodibility, climate, and batter geometry).

1.4 Landform design database

An outcome of the erodibility studies has been the generation of erodibility parameters for a wide range of Rio Tinto's mineral wastes. These erodibility parameters have been used to parameterise the WEPP runoff/erosion model with material-specific parameters. The WEPP model has in turn been used to generate a database of erosionally stable landform batter geometries (combinations of lift height, gradient and profile shape) for Rio Tinto's key mineral wastes. This database is also called the Batter Selector Tool, or BST. Rio Tinto use these batter geometries to develop 3D landform designs that will satisfy long-term erosional stability requirements.

The key mineral wastes were identified by assessment of Rio Tinto's waste drilling records for active mining operations across the Pilbara. Erodibility parameters for these key waste types were then gathered using simulated rainfall and overland flow testing techniques. Site-specific climate sequences were developed using site data and data from nearby Bureau of Meteorology climate stations. WEPP was run using the site-specific climate sequence and material erodibility parameters to develop the database of erosionally stable batter geometries. This process is described in more detail below.

2. WEPP erosion modelling

2.1 The WEPP runoff and erosion model

The WEPP model was used to simulate annual runoff and erosion. It was developed by the United States Department of Agriculture (USDA) and can predict runoff, erosion, and deposition for hillslopes. WEPP has a daily input time step, although sub-daily storm parameters are used to describe the intensity and duration of daily storm events, enabling more accurate estimation of runoff and erosion potential than is generally achievable with daily time step models. When rainfall occurs, soil characteristics are considered to determine the likelihood of runoff. If runoff is predicted to occur, WEPP computes sediment detachment, transport, and deposition along the inputted slope geometry. In this way, WEPP is able to give average erosion over an entire slope length, and erosion rates at any point along the slope (peak erosion rates are calculated using this information).

The model's erosion component uses a steady-state sediment continuity equation as the basis for the erosion computations. Soil detachment in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate. Soil detachment in rills is predicted to occur if the runoff hydraulic shear stress is greater than the critical shear stress at which rilling is initiated, and when the sediment load of the runoff is below its capacity to transport sediment. Deposition in rills is computed when the sediment load of the runoff is greater than the capacity of the runoff to transport it.

Climate data

All WEPP simulations use a 100-year stochastic climate sequence derived from data observed at Rio Tinto's sites and from nearby Bureau of Meteorology climate stations. A total of 9 climate sequences were created to represent 15 mine sites:

- Brockman 4, Brockman 2, and Nammuldi;
- Tom Price and Western Turner Syncline;
- West Angelas;
- Channar, Eastern Range, and Paraburdoo;
- Marandoo;
- Hope Downs 1/2;
- Hope Downs 4;
- Mesa J and Mesa A; and
- Yandicoogina.

Each of the 9 climate sequences contain 36,525 daily climate data sets that describe rainfall, storm duration and intensity, temperature, solar radiation, and wind. The sequences contain a wide range of rainfall events, including several extreme events. Each climate sequence was assessed against the Bureau of Meteorology's Design Rainfall Data System[10] to consider the Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI) of the larger rainfall events within the sequence. The findings for the Brockman 2 & Nammuldi climate sequence are given in Table 1. The rarest event within the Brockman 2 & Nammuldi climate sequence has an AEP of <0.05%, equivalent to a storm with an ARI of >2,000 years. This storm is defined within the Australian Rainfall and Runoff Guideline (AR&R) as 'extreme'. For Brockman 2 & Nammuldi, the second rarest rainfall event also has an AEP of 0.07% (1,500 year ARI) and the third rarest event has an AEP of 0.1% (1,000 year ARI). These are both defined as 'very rare' events.

The Brockman 2 & Nammuldi climate sequence is consistent with long-term averages and includes multiple very rare and rare rainfall events. Therefore, the resultant erosion modelling is also consistent with long-term averages, including the erosion that would occur from multiple very rare events.

Table 1: The Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI) values of the three rarest rainfall events within the Brockman 2 & Nammuldi climate sequence.

Rainfall Event Details					
Rarest		2nd Rarest		3rd Rarest	
Total & Duration	AEP (%) & ARI (years	Total & Duration	AEP (%) & ARI (years	Total & Duration	AEP (%) & ARI (years
268mm 5 hours	<0.05% >2,000 years	175mm 5 hours	0.07% 1,500 years	171mm 4 hours	0.1% 1,000 years

[10] http://www.bom.gov.au/water/designRainfalls/revised-ifd/

Validation of WEPP modelling

WEPP model validation data are provided to demonstrate that the model is able to adequately predict erosion in a mining context. WEPP has been extensively validated by Landloch for mine site batters (Figure 2).

The data presented were sourced from 27 locations on 12 waste landforms on mine sites in Western Australia. Several sites were located at Rio Tinto's Pilbara iron ore sites. The observed erosion data were collected using 30-50 m wide cross-slope erosion transects located on upper and lower sections of waste dump batters. Batter geometries include both linear and concave cross-sectional profiles. Gradients assessed are consistent with the slopes commonly used for mining landforms (12-20°). Surfaces assessed include loamy soils, clay soils, and rocky soils. The ages of the batters range from 3-8 years. Slope conditions range from minimally eroded to heavily eroded.

The observed cumulative erosion rates show good agreement with rates predicted by WEPP. Given that these data include predictions from both the upper and lower sections of landform batters, WEPP is shown to be able to suitably predict changes in erosion rates with changing slope lengths and gradients. The model can adequately represent both runoff accumulation down the slope and flow concentration across the slope. The accuracy of the predictions shown in Figure 2 also indicates that the methods used to derive the model parameters produce accurate model results. This gives confidence that accurate calibration of the WEPP model can be achieved, provided suitable testing methods are used.

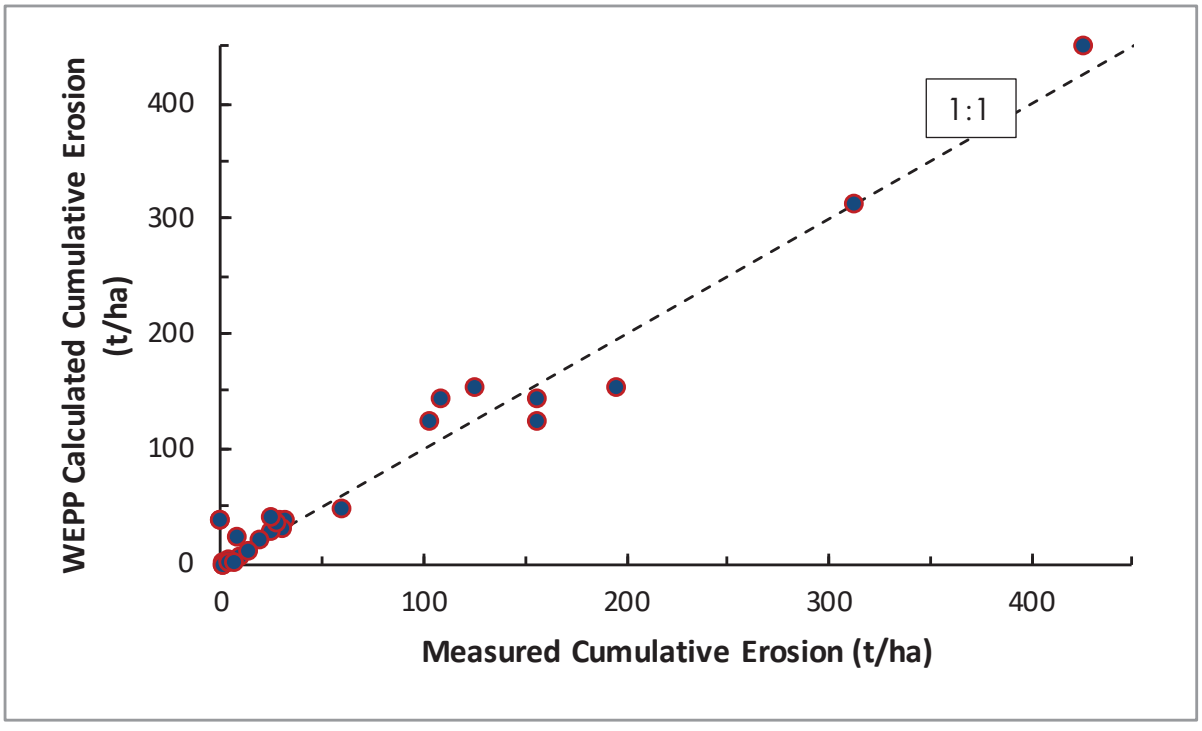


Figure 2: WEPP-predicted cumulative erosion and observed cumulative erosion for 27 locations from Western Australian mine sites.

Establishing acceptable long-term erosion rates

The suitability of the batter geometries found within the Rio Tinto Iron Ore Batter Selector Tool is determined by comparison of the modelled long-term average erosion rates with rates that have been demonstrated to be acceptable. Historically, the acceptable long-term erosion rate has been set based on a desire to limit the initiation of rill erosion. A value of 5t/ha/y was used. More recently, a review of acceptable erosion rate values for the Pilbara region[11] considered acceptability using six different concepts:

- Rates of soil renewal (soil formation and deposition by dust);
- Maintenance of surface soil/growth media quality;
- Rates of naturally occurring erosion in the Pilbara;
- Rates that increase the potential for gully development;
- Water quality and off site impacts; and
- Impacts on vegetation.

The review found that the acceptable rates of long-term erosion were similar regardless of the concept considered. A value of 6t/ha/y for long term average slope erosion was found to be consistent with rates of soil renewal and naturally occurring erosion, and consistent with a surface with a low tendency for rill and gully erosion. Given that the erosionally stable batter geometries adopted by Rio Tinto prior to the more recent review are modelled to erode at rates less than 5t/ha/y, it is concluded by Landloch that the slopes currently within the Batter Selector Tool are suitable, provided surface water control from the dump top and berms, and around the landform are also suitably managed.

2.2 Landform evolution modelling

Other erosion models exist that can be usefully deployed as part of the landform design process at different phases of mining operations. WEPP is used to define erosionally stable two-dimensional landform batter designs. Landform evolution models (LEMs) can be used to consider landforms in three dimensions.

SIBERIA is the most widely adopted LEM for use in mining, particularly in Australia. It is a model tailored to the consideration of the impacts of the 3D shape on the long-term stability of a landform. SIBERIA modifies the 3D shape of a landform in response to erosion and deposition. It is different to a surface water model in that it does not predict or route runoff over the surface. Rather it uses relationships between surface hydrology (contributing areas and discharge rates) and erosion to predict changes in 3D landform shape.

Within the context of mining landforms, SIBERIA has been used to consider the:

- likelihood of the development of rill or gully erosion over time;
- breaching of surface layers designed to encapsulate underlying problematic wastes;
- erosion risk at the interface between a waste dump and adjacent undisturbed land; and
- erosional impact of placement of different materials over the land surface.

[11] Howard, E.J. and Loch, R.J. (2019) *Acceptable erosion rates for mine waste landform rehabilitation modelling in the Pilbara, Western Australia*, in AB Fourie & M Tibbett (eds), Proceedings of the 13th International Conference on Mine Closure, Australian Centre for Geomechanics, Perth, pp. 1545-1560.

SIBERIA is more complex to parametrise than WEPP. It requires parameterisation with time series data of runoff and erosion for a specific combination of material and landform shape. Because it is fitted to time series data for runoff and erosion (not rainfall), SIBERIA cannot easily be used to predict erosion for a single rainfall event. For example, it is not able to be used to predict land changes in response to a single extreme event. The most appropriate use of SIBERIA is to assess long-term changes in landform shape (over decades or hundreds of years).

Given that final 3D landform shapes are not exactly known during the early phases of mining (i.e. feasibility or approvals stage), the usefulness of SIBERIA in these early stages is limited. Two dimensional batter erosion models such as WEPP provide sufficient information in order for the broad shape of a rehabilitation landform to be defined. For example, the erosionally stable slope lengths, heights, and gradients, the batter profile shape (linear, concave etc.), and the required capacity of cross-slope berms and crest bunding, can all be derived from WEPP modelling without the need for SIBERIA modelling. If the broad shape of the landform batter is set based on stable batter geometries defined by WEPP, the resultant 3D landform is likely stable, provided it is coupled with an investigation of surface water flows to account for risks such as flood flows (which SIBERIA is not equipped to do) and intentional flow concentrations (as can occur in more complex 3D shapes).

SIBERIA modelling becomes increasingly useful closer to the point of rehabilitation when more detailed designs are available and where it can address risks associated with how the landform ultimately meshes into the surrounding landscape.

3. Material abundance

Table 2 provides a summary of the percentage of each waste type for Brockman 2 & Nammuldi. The proportions are for the 2018 life of mine data (approved excluding proposed) as provided by Rio Tinto (pers. comm. C. Dodge, 17 August 2020).

Table 2: Waste material summary for Brockman 2 & Nammuldi (2018 LOM data)

Waste	Erodibility Ranking	Total waste (kt)	Total waste (%)*
Detritals	High	805,044,137	59
Wittenoom Dolomite	Medium	125,556,082	9
Dales Gorge	Low	108,995,409	8
Whaleback Shale	Medium	61,313,627	5
Mt Newman Member	Low	50,325,072	4
Hydrated Zone	Low	35,486,983	3
Wittenoom Formation	High	15,313,694	1
Joffre	Low	10,780,297	<1
Footwall Zone	Low	8,855,930	<1
MacLeod Member	Low	7,446,641	<1
McRae Shale	Medium	7,048,468	<1
Dolerite	High	4,974,795	<1
Nammuldi	Medium	4,099,639	<1
Mount Sylvia	Medium	857,458	<1
Other	Medium	117,451,851	9

* The proportion of waste present in individual dumps will vary, but aggregated data is provided for the site to show the broad material types present.

Detritals are the dominant waste at Brockman 2 & Nammuldi. Wittenoom Dolomite, Dales Gorge, and Whaleback Shale are also present in appreciable proportions. Many other waste types are present but in small proportions (<5%); several of them have a low erodibility ranking.

Erodibility studies have been carried out on 90 waste samples from Rio Tinto's Pilbara iron ore mines. Of these 90 samples, 5 were sourced specifically from Brockman 2 & Nammuldi, namely:

- Detritals (1 sample),
- Calcrete (1 sample),
- West Angelas Shale (1 sample), and
- McRae Shale (2 samples).

These samples cover the main wastes from Brockman 2 & Nammuldi and account for 59% of the waste at Brockman 2 & Nammuldi. More widely, there exists data for 1 Detritals sample[12], 1 Dales Gorge sample[13], 1 Whaleback Shale sample[14], and 2 Hydrated Zone samples[15]. These materials are sourced from Brockman 4 (25km south-west of Brockman 2) and Western Turner Syncline (35km south-east of Brockman 2). Including these, 75% of the Brockman 2 & Nammuldi waste types have been broadly characterised for erodibility. No data exists for the Wittenoom Dolomite waste material.

Plant growth data for 69 samples of similar materials are available for Brockman 2 & Nammuldi and other Pilbara iron ore sites:

- Brockman 2/Nammuldi (4 Detritals, 2 Dales Gorge samples);
- Brockman 4 (3 Detritals, 3 Whaleback Shale, 1 Hydrated Zone samples);
- Gudai-Darri (1 Detritals sample);
- Hope Downs 1/2 (6 Detritals, 3 Mt Newman, 1 Hydrated Zone samples);
- Hope Downs 4 (3 Detritals samples);
- Marandoo (6 Detritals, 2 Mt Newman samples);
- Greater Paraburdoo (3 Detritals, 7 Dales Gorge, 1 Whaleback Shale, 6 Hydrated Zone samples);
- Tom Price (1 Detritals, 5 Dales Gorge, 2 Whaleback Shale, 1 Mt Newman Member, 1 Hydrated Zone samples); and
- Western Turner Syncline (3 Detritals, 4 Dales Gorge, 1 Whaleback Shale, 1 Hydrated Zone samples).

Data for these materials will be used to discuss plant growth and erosion potential below.

[12] Western Turner Syncline
[13] Western Turner Syncline
[14] Brockman 4
[15] Brockman 4, Western Turner Syncline

4. Material testing methods

4.1 Plant growth potential

Samples of the fine component (<2mm) of some of these materials were analysed for soil $pH_{1:5}$ (water), $EC_{1:5}$ as a measure of salinity, Exchangeable Sodium Percentage (ESP), and particle size distribution (coarse sand, fine sand, silt, and clay). These properties were used to define risks to vegetation growth inherent in the wastes (e.g. salinity and poor structure). The coarse components (>16mm) were also assessed for properties that indicate their likely durability, tendency to weather, and usefulness as an armour material. Properties assessed include coarse fraction content, rock particle density, and rock water absorption.

4.2 Material erodibility

Assessment of long-term erosion potential for each of the materials was assessed using the WEPP model. WEPP describes erodibility using a number of specific parameters:

- Interrill Erodibility (K_i);
- Rill Erodibility (K_R);
- Critical Shear for Rill Initiation (τ_c); and
- Effective Hydraulic Conductivity (K_e).

These erodibility parameters were derived from data collected using application of:

- Simulated rain to test surfaces and measurement of runoff and sediment in runoff to obtain estimates of K_i and K_e; and
- Simulated overland water flows and measurement of runoff, sediment, and rill characteristics, to obtain estimates of K_R and τ_c.

Simulated rainfall and overland flows

Rainfall and overland flow simulations have been widely used to define the erodibility of mine wastes. The process is briefly described below.

For rainfall simulation, flat fan nozzles mounted on an oscillating manifold positioned ~2m above a test surface produce the simulated rain (Figure 3). The kinetic energy generated by the nozzles is consistent with the energy of natural rainfall at intensities >40mm/hr. The nozzles sweep back and forth across the test surfaces, achieving high spatial distribution uniformity (<10% coefficient of variation). For each material tested, triplicate plots (0.75m square) are subjected to a rainfall event sufficiently intense to ensure runoff occurs (usually 80-100mm/hr). This allows measurement of K_i and K_e.

For overland flow simulations, rill erodibility parameters are derived by applying overland flows at various rates to flumes 0.4m wide and 2.0m long set at gradients ranging from 10-30% (Figure 4). K_R and τ_c are derived based on relationships between flow shear stress and sediment detachment rates measured from these flumes.

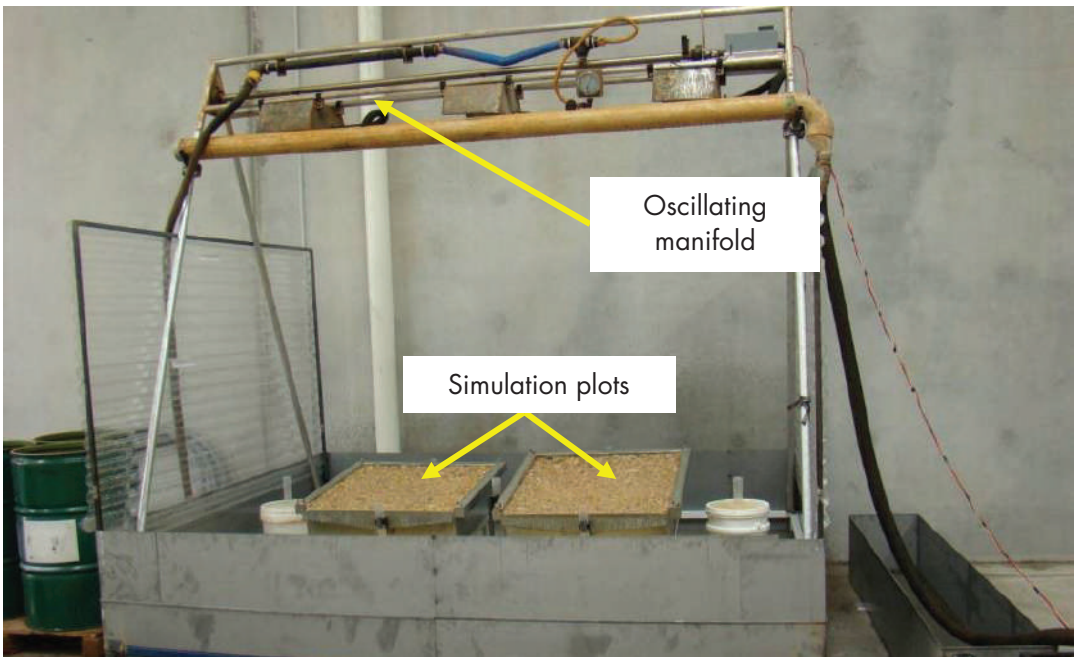


Figure 3: Typical laboratory-based rainfall simulator installation.



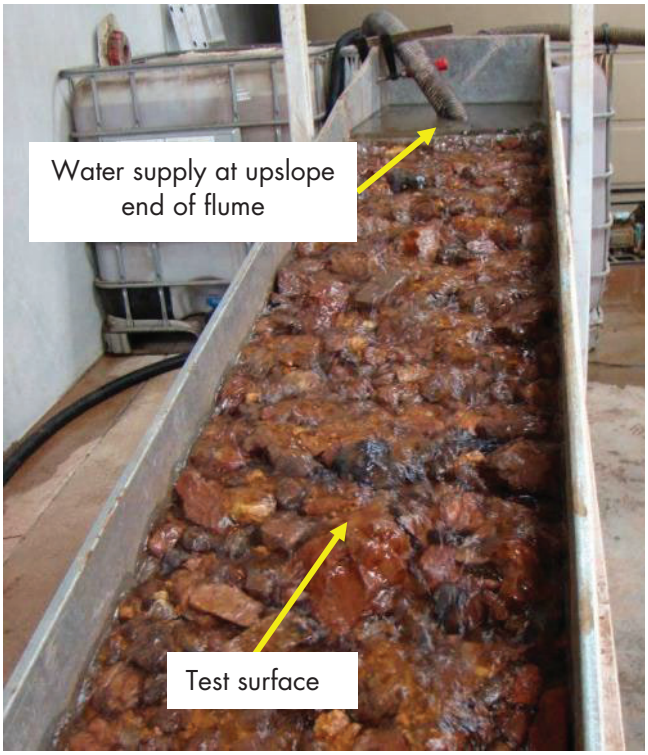


Figure 4: Example of flume setup used to simulate overland flows.

5. Materials of Brockman 2 & Nammuldi

5.1 Plant growth potential

A summary of waste characterisation data relevant to plant growth are given in Tables 3 (fines fraction) and 4 (coarse fraction). Data are provided for materials from both Brockman 2 & Nammuldi and other sites that have the same materials. The results would be broadly consistent with those from Brockman 2 & Nammuldi.

Table 3: Characteristics of the soil fraction (<2mm) of Brockman 2 & Nammuldi materials, and similar materials from other sites.

Geology	Particle Size Distribution (Fine Fraction)				Soil Texture	$pH_{1:5}$ (Water)	$EC_{1:5}$	ESP
	Coarse Sand	Fine Sand	Silt	Clay				
	%	%	%	%		pH Units	dS/m	%
Brockman 2 & Nammuldi								
Detritals	35.9	34.7	11.3	18.2	L	8.7	0.16	1.5
	39.2	31.9	9.4	19.5	L	6.0	0.07	-
	41.0	35.1	9.2	14.7	SL	8.0	0.12	-
	-	-	-	-	-	6.5	0.06	3.4
Dales Gorge	53.9	33.0	4.6	8.5	LS	8.0	0.34	-
	46.2	34.6	10.6	8.5	LS	7.5	0.27	-
Brockman 4								
Detritals	50.2	31.6	11.2	7.0	LS	8.0	0.25	-
	47.6	30.6	4.0	17.8	SL	7.0	0.05	-
	48.8	25.7	6.0	19.5	SL	7.8	0.23	-
Whaleback Shale	46.3	30.7	14.9	8.1	LS	8.5	0.10	-
	50.5	24.4	5.9	19.2	SL	7.5	0.12	-
	44.3	32.7	2.2	20.5	SCL	7.0	0.59	11
Hydrated Zone	54.0	28.0	9.0	9.0	LS	7.5	0.16	5.7
Gudai-Darri								
Detritals	51.6	33.2	5.9	9.3	LS	7.5	0.08	-
Hope Downs 1/2								
Detritals	39.5	32.8	6.6	21.0	SL	7.0	0.06	-
	30.2	19.6	11.8	38.4	C	8.0	0.29	-
	59.0	24.0	0.0	16.0	SL	7.4	1.06	8.6
	61.4	7.4	7.6	23.6	CL	6.1	0.07	5.1
	56.2	18.9	9.9	14.9	L	7.6	0.07	1.6
Mt Newman	50.1	31.2	9.6	9.2	LS	6.7	0.03	20
	41.8	31.0	16.0	11.2	LS	7.4	0.07	7.0
	58.2	21.5	10.6	9.5	LS	7.6	0.06	5.1
Hydrated Zone	55.0	25.0	5.0	15.0	SL	8.0	-	-
Hope Downs 4								
Detritals	5.8	62.9	5.9	25.4	CL	7.4	0.02	4.9
	34.3	34.1	6.5	25.2	CL	8.0	0.08	-
	63.2	24.4	2.2	10.1	SL	7.5	0.04	-
Marandoo								
Detritals	51.7	29.1	6.4	12.9	SL	8.3	0.40	6.3
	57.7	25.9	3.0	13.4	SL	8.1	0.11	4.3
	59.6	23.4	2.9	14.1	SL	8.5	0.36	7.8
	24.3		27.9	47.8	ZC	6.6	0.07	<0.1
	19.1		24.3	56.6	C	8.2	0.18	<0.1
Mt Newman	51.6	27.1	8.2	13.0	SL	7.7	0.16	1.3
	45.0	32.3	13.0	9.8	LS	8.2	0.02	1.5

Geology	Particle Size Distribution (Fine Fraction)				Soil Texture	$pH_{1:5}$ (Water)	$EC_{1:5}$	ESP
	Coarse Sand	Fine Sand	Silt	Clay				
	%	%	%	%		pH Units	dS/m	%
Greater Paraburdoo								
Detritals	49.4	31.5	6.6	12.5	SL	7.9	0.02	6.8
	59.0	27.0	7.0	7.0	L	8.0	0.05	16
	70.0	18.0	6.0	6.0	LC	8.0	0.04	16
Dales Gorge	63.9	15.8	6.7	13.5	SL	7.0	0.04	-
	45.8	26.7	15.3	12.2	LS	6.5	0.04	-
	42.5	38.5	10.0	9.0	LS	8.0	0.04	-
	34.8	42.8	16.8	5.6	LS	8.0	0.06	-
	37.3	40.0	15.3	7.4	LS	8.0	0.20	-
	44.0	27.0	6.0	23.0	SCL	8.1	0.14	1.2
	46.7	30.3	12.9	10.2	LS	6.7	0.14	14
Whaleback Shale	46.0	23.0	6.0	25.0	SCL	5.6	0.10	20
Hydrated Zone	45.0	23.0	3.0	29.0	SCL	5.6	0.10	31
	58.8	19.0	9.7	12.5	SL	7.6	1.04	13
	38.9	32.7	18.3	10.2	LS	6.6	0.12	22
	49.9	28.7	5.6	15.9	SL	6.6	0.18	6.5
	42.2	28.7	11.2	17.8	L	6.6	0.10	14
Tom Price								
Detritals	64.9	23.3	5.7	6.0	LS	6.5	0.03	-
Dales Gorge	42.7	37.2	10.8	9.3	LS	7.0	0.04	-
	41.2	38.8	14.3	5.7	LS	6.5	0.06	-
	54.3	28.8	9.3	7.7	LS	7.5	0.11	-
	22.0	24.0	25.0	29.0	CL	-	-	-
	23.0	20.0	35.0	22.0	ZL	-	-	-
Whaleback Shale	37.0	35.4	21.9	5.7	LS	7.0	0.06	-
	39.0	25.0	8.0	28.0	CL	4.8	0.06	14
Mt Newman	42.2	36.6	16.7	4.5	LS	8.0	0.80	-
Hydrated Zone	59.0	27.0	1.0	12.0	SL	8.1	0.55	6.3
Western Turner Syncline								
Detritals	33.7	38.0	9.6	18.7	L	8.0	0.08	-
	59.2	28.5	6.8	5.5	LS	8.5	0.06	-
	47.0	25.0	1.0	27.0	SCL	6.1	0.20	8.5
Dales Gorge	54.3	31.3	11.1	3.3	LS	7.0	0.08	-
	47.7	30.4	15.1	6.8	LS	7.5	0.11	-
	64.9	23.4	4.5	7.1	LS	8.0	0.06	-
	24.0	2.0	38.0	34.0	ZCL	8.5	0.08	1.6
Whaleback Shale	30.1	36.3	18.9	14.7	L	7.3	0.38	-
Hydrated Zone	59.0	25.0	1.0	15.0	SL	6.9	0.29	26

Notes: Coarse sand: 2.0-0.2mm; Fine sand: 0.2-0.02mm; Silt: 0.02-0.002mm; Clay <0.002mm. Texture: SL: Sandy Loam; LS: Loamy Sand; CL: Clay Loam; L: Loam; C: Clay; ZCL: Silty Clay Loam. '-' indicates that no data are available for this parameters. Those samples with no baseline data shown here are included for completeness as they are present in the erodibility testing results.

Table 4: Characteristics of the coarse fraction (>2mm) of Brockman 2 & Nammuldi materials, and similar materials from other sites.

Geology	Full Particle Size Distribution				Coarse Fraction Content	Rock Particle Density	Rock Water Absorption
	Rock	Pebble	Gravel	Fines			
	%	%	%	%	%	%	g/cm³
Brockman 2 & Nammuldi							
Detritals	38	13	35	14	86	2.5	4.0
	0	36	38	26	74	-	-
	2	47	17	34	66	-	-
	0	0	43	57	43	-	-
Dales Gorge	45	42	5	9	91	-	-
	18	56	8	18	82	-	-
Brockman 4							
Detritals	8	10	57	25	75	-	-
	6	3	76	15	85	-	-
	1	13	59	27	73	-	-
Whaleback Shale	0	1	48	51	49	-	-
	7	7	43	43	57	-	-
	48	17	27	8	92	3.6	4.5
Hydrated Zone	2	0	26	72	28	3.4	3.3
Gudai-Darri							
Detritals	0	5	56	39	61	-	-
Hope Downs 1/2							
Detritals	4	6	55	34	66	-	-
	5	5	33	57	43	-	-
	7	6	42	45	55	2.9	5.3
	29	15	35	21	79	-	-
	12	32	32	24	76	3.2	1.4
	20	25	25	31	69	2.3	12.5
Mt Newman	20	18	44	18	82	3.4	1.6
	24	30	30	15	85	3.0	3.5
	14	31	31	25	75	3.4	1.1
Hydrated Zone	60	22	17	1	99	4.6	3.5
Hope Downs 4							
Detritals	2	2	49	47	53	2.6	8.1
	0	20	20	59	41	-	-
	0	14	36	50	50	-	-
Marandoo							
Detritals	6	45	17	32	68	3.5	4.8
	17	34	16	33	67	2.4	11.4
	7	46	18	29	71	2.9	10.5
	8	11	56	26	74	-	-
	-	-	-	55	45	-	-
	-	-	-	45	55	-	-
Mt Newman	16	41	14	29	71	3.1	11.4
	31	39	8	22	78	3.2	3.1

Geology	Full Particle Size Distribution				Coarse Fraction Content	Rock Particle Density	Rock Water Absorption
	Rock	Pebble	Gravel	Fines			
	%	%	g/cm³	%	%	%	g/cm³
Greater Paraburdoo							
Detritals	8	18	56	18	82	2.7	4.3
Dales Gorge	4	16	65	14	86	-	-
	8	15	54	23	77	-	-
	9	16	47	28	72	-	-
	10	5	39	46	54	-	-
	1	3	46	50	50	-	-
	35	26	32	7	93	2.9	1.0
	19	40	13	28	72	3	8.9
Whaleback Shale	37	27	32	4	96	3	6
Hydrated Zone	7	22	57	14	86	3.4	4.6
	-	-	-	52	48	-	-
	28	37	11	24	76	-	-
	28	36	11	24	76	2.9	3.5
	14	50	12	24	77	3.1	6.1
	0	58	14	28	72	3.3	2.4
Tom Price							
Detritals	11	13	52	24	76	-	-
Dales Gorge	5	16	62	18	82	-	-
	17	11	53	19	81	-	-
	9	17	56	18	82	-	-
	0	19	38	43	57	-	-
	0	32	18	50	50	-	-
Whaleback Shale	6	14	58	22	78	-	-
	0	7	45	48	52	-	-
Mt Newman	12	14	43	32	68	-	-
Hydrated Zone	20	14	42	24	76	2.5	10.5
Western Turner Syncline							
Detritals	6	6	52	35	65	-	-
	0	5	54	41	59	-	-
	0	4	72	24	76	-	-
Dales Gorge	5	17	50	28	72	-	-
	14	16	43	27	73	-	-
	14	18	47	21	79	-	-
	32	22	33	13	87	2.3	13.2
Whaleback Shale	4	11	45	41	59	-	-
Hydrated Zone	0	0	72	28	72	-	-

Notes: Rock: >45mm; Pebble: 15-45mm; Gravel: 2-15mm; Fines: <2mm.

The materials have the following properties:

- Commonly low salinity (mean 0.17dS/m), with values unlikely to adversely affect plant germination or growth.
- Acidic to alkaline pH values are measured for the materials, though this variation is not likely to significantly limit plant growth.
- High coarse fraction content (mean 70%), ranging from 43% to 92% for the Brockman 2 & Nammuldi materials.
- The rock fraction of the samples tested tends to be dense (rock particle density >2.3g/cm^3) and the water absorption rates are low to moderate. These materials are likely to be reasonable for use as armouring in terms of the durability.
- The fine fraction (< 2 mm diameter) of the samples tested tends to have a loam to sandy clay loam texture.

Wastes can have elevated (>6%) Exchangeable Sodium Percentage (ESP). Elevated ESP can indicate a clay fraction with a tendency to disperse and become prone to structural decline. However, these materials would still have a low tendency for structural decline because the clay fraction makes up a very small proportion (median 4%) of the entire material mass, with the majority comprised of non-dispersive sands, gravels, pebbles, and rock.

5.2 Erodibility

Table 5 shows the site-specific erodibility parameters for Brockman 2 & Nammuldi and nearby sites. Also shown are the aggregated parameter values adopted and used to develop stable batter geometries within the Batter Selector Tool.

The impact of this difference in erodibility parameters was assessed by conducting additional runoff/erosion modelling with the WEPP model. The results of the erosion modelling are given in Table 6.

Table 5: Site specific erodibility parameters and those generally adopted for erosion modelling.

Material	K_e (mm/h)	K_i (kg.s/m^4)	K_R (s/m)	τ_c (Pa)
Detritals				
Aggregated Value	26	236,317	0.0116	28
Brockman 2 & Nammuldi	12	472,428	0.0122	14
Western Turner Syncline	135	40,605	0.0366	34
Dales Gorge				
Aggregated Value	33	203,540	0.0033	28
Western Turner Syncline	18	128,962	0.0010	45
Whaleback Shale				
Aggregated Value	46	100,207	0.0042	26
Brockman 4	60	97,572	0.0056	25
Hydrated Zone				
Aggregated Value	103	63,860	0.0030	28
Brockman 4	200	50,000	0.00216	23.7
Tom Price	97	90,228	0.00237	35.5

Table 6: Erosionally stable batter heights for the Brockman 2 & Nammuldi materials within the BST and calculated using site specific erodibility data. In some cases, data for Brockman 2 & Nammuldi are not available. In these instances, data from nearby sites are shown and indicated in brackets.

Material	Erosionally Stable Batter Geometries in the BST	Erosionally Stable Batter Geometries using Site Samples
Detritals	5m, 20°	5m, 20°
Dales Gorge	15m, 20°	20m, 20° (Western Turner)
Whaleback Shale	5m, 20°	10m, 20° (Brockman 4)
Hydrated Zone	20m, 20°	20m, 20° (Tom Price, Western Turner)

Predicted erosion for the Detritals using the aggregated parameters indicates that a stable geometry of a batter with a uniform gradient of 20 degrees would be 7m. When compared to the Detritals from Brockman 2 & Nammuldi, the same height limitation exists. When compared against the Western Turner Syncline Detritals the stable height indicated by the modelling increases to 20m at 20 degrees. This indicates that the erodibility of the Detritals can be variable.

Predicted erosion for the Dales Gorge materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 15m. When compared with the Dales Gorge materials from Western Turner Syncline, heights of 20m are predicted to be acceptably stable.

Predicted erosion for the Whaleback Shale materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 5m. When compared with the Whaleback Shale materials from Brockman 4, heights of 10m are predicted to be acceptably stable.

Predicted erosion for the Hydrated Zone materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 20m. When compared with the Hydrated Zone materials from Brockman 4 and Tom Price, heights of 20m are predicted to be acceptably stable.

No erodibility data exists for Wittenoom Dolomite materials. Assuming they are similar to Whaleback Shale (they have the same erodibility ranking of medium), the stable geometry for these materials (based on the aggregated parameter values) would be 5m at 20 degrees.

No site-specific information exists for the Dales Gorge, Whaleback Shale, Hydrated Zone, and Wittenoom Dolomite materials from Brockman 2 & Nammuldi. In these cases, results for similar materials from nearby sites have been listed. These stable batter geometries will need to be verified using site-specific samples of Dales Gorge materials. This should be addressed as part of the continuous sampling and testing of wastes at Brockman 2 & Nammuldi.

The slope gradients for uniform batters within the Batter Selector Tool range from 14-20°. This range was selected as being the maximum gradient (20°) at which machinery could safely operate on a slope, and the lowest gradient (14°) that is typically considered for rehabilitation by Rio Tinto. Results for the 20° gradient slope have been shown in order to demonstrate whether use of the site specific erodibility data yield significantly different results to those of the aggregated erodibility data used in the Batter Selector Tool. It should not be construed as a

recommendation that a 20° slope is preferred to a lower gradient slope. Slopes lower than 14° could also be considered if required.

6. Closing

Erosion modelling has used data collected from 90 samples of key wastes across Rio Tinto's Pilbara operations. These samples have been subjected to testing to measure their erodibility, with these erodibility parameters used to model long-term erosion using the WEPP model. The climate sequences used in the modelling contain a wide range of rainfall events including several extreme and rare events.

The model results have been compared against acceptable erosion rate values consistent with measured erosion for undisturbed land in the Pilbara, soil renewal rates, and rates at which the risk of rill and gully erosion is low. The model output has been validated at 27 locations on mine sites in Western Australia and shown to agree with observed erosion.

An assessment of the samples specific to Brockman 2 & Nammuldi (and for other sites with similar waste types) show that the batter geometries generated using the aggregated erodibility parameters will be suitable (and possibly conservative in some cases) for use at Brockman 2 & Nammuldi.

Continued sampling and erodibility testing of materials is required as mining continues at Brockman 2 & Nammuldi in order to continue to build Rio Tinto's knowledge of wastes on site. Further, when coupled with erosion monitoring of waste dumps that includes a measure of an erosion rate, the erodibility data should be used to undertake periodic verification of the rehabilitation profiles includes within the Batter Selector Tool.

Regards





Mr EVAN HOWARD
PRINCIPAL CONSULTANT

Disclaimer

All care and diligence have been exercised in testing, interpreting data and the development of recommendations presented in this document. The monitoring and testing have been undertaken in a skilled, professional manner, according to accepted practices. Specific circumstances and research findings after the date of publication may influence the accuracy of the data and recommendations within this document.

The landscape is not uniform. Because of this non-uniformity, no monitoring, testing or sampling technique can produce completely precise results for any site. Any conclusions based on the monitoring and/or testing presented in this document can therefore only serve as a 'best' indication of the environmental condition of the site at the time of preparing this document. It should be noted that site conditions can change with time.

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Appendix 10: Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, Silvergrass

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2079.20e (Rev 1)

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Memorandum: Characterisation of erosion potential of mineral wastes for use in developing rehabilitated landform designs, Silvergrass

1. Introduction

1.1 Regulatory expectations

Across Australia, mining regulatory bodies provide guidance on the required state of rehabilitated landforms. In Western Australia the Department of Mines, Industry Regulation and Safety (DMIRS) define land rehabilitation as the, "return of disturbed land to a safe, stable, non-polluting/non-contaminating landform in an ecologically sustainable manner that is productive and/or self-sustaining and is consistent with the agreed post-mining land use"[1]. In their technical guidance note on waste rock dumps, DMIRS also state that the geometry of waste dump batter slopes should be designed such that they are not prone to significant erosion[2].

Therefore, fundamental to creating safe, stable, and non-polluting landforms is the development of land surfaces that:

- do not erode at rates likely to be unstable in the long-term;
- are sufficiently stable such that vegetation can establish;
- erode such that the agreed post-mining land use can be achieved; and
- generate sediment levels consistent with those of the surrounding landscape.

[1] Department of Mines, Industry Regulation and Safety (2020) *Mine Closure Plan Guidance - How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans*, Version 3.0, Government of Western Australia, https://www.dmp.wa.gov.au/Documents/Environment/REC-EC-112D.pdf, accessed 2 September 2020.

[2] Department of Mines and Petroleum (2009) *Waste Rock Dumps, Environmental Notes on Mining*, Government of Western Australia, https://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-223.pdf, accessed 2 September 2020.

1.2 Rio Tinto's historical involvement in erodibility testing and erosion modelling

Rio Tinto has been involved in the development of erosion assessment methods for mining waste landforms for a long time, with the first application of material erodibility testing and erosion models to mining landforms occurring in 1998.

Since that time, testing methods and the use of erosion models have improved and been refined to the point where rehabilitation landform shapes can be usefully informed by models that are calibrated using site-specific material erodibility and climate data.

Between 1998 and 2006, Rio Tinto completed numerous erosion studies, including field-based studies at Tom Price, Paraburdoo, and Nammuldi, and laboratory-based studies for materials from Tom Price, Channar, and Marandoo. Rio Tinto has then undertaken an extensive and ongoing program of works between 2010 and 2018 to generate erodibility data for a range of mineral waste materials from their iron ore mine sites in the Pilbara. Data has been collected from Channar, Eastern Range, Paraburdoo, Tom Price, Western Turner Syncline, Yandi, West Angelas, Marandoo, Brockman 2, Brockman 4, Nammuldi, Mesa J, Mesa A, Warramboo, Mesa H, and Hope Downs 1. These erodibility data have been used to establish a way for a material's erosion characteristics to directly inform rehabilitation planning.

Erodibility is defined differently depending on the erosion prediction tool being used. Erodibility has been considered by Rio Tinto in two ways. First, material erodibility from the Revised Universal Soil Loss Equation (RUSLE) has been used to rank each mineral waste type into groups that help to broadly consider erosion risk. Erodibility from the RUSLE is linked to a material's particle size distribution (PSD), and when combined with a measure of surface rock cover, can be used to rank materials into one of three levels of erodibility – low, medium, or high. Second, erodibility has been considered within the WEPP[3] runoff/erosion model to define material-specific landform designs for each mineral waste type. WEPP erodibility parameters are directly related to material erodibility and provide a more robust means of assessing erosion potential.

1.3 Erodibility ranking system using the RUSLE

The erodibility ranking system developed using the RUSLE seeks to broadly rank mineral wastes into one of three levels of erodibility risk – low, medium, and high. The RUSLE is an empirical equation that calculates long-term annual erosion rates using five multiplicative factors[4]. Two factors, erodibility (K-factor) and cover (C-factor) are specifically related to the material. The remaining three factors describe the rainfall and batter geometry and surface conditions.

The K-factor is calculated from a material's fine fraction PSD (<2mm diameter), excluding the coarse fraction (>2mm). The standard procedure for its calculation is detailed by Rosewell and Loch (2002)[5]. The C-factor describes the impact of different cover elements on erosion. For this ranking system, surface rock cover is important in reducing erosion potential. Rock cover is the percentage of the rain-armoured surface that is covered by rock particles. Other cover elements

[3] Water Erosion Prediction Project

[4] $A = R \times K \times LS \times P \times C$ where A is average annual erosion (t/ha/y), R is rainfall erosivity (MJ.mm/ha.h.y), K is soil erodibility (t.ha.h/ha.MJ.mm), LS is the slope length and steepness factor (ratio), P is the support practice factor (ratio), and C in the cover management factor (ratio).

[5] Rosewell, C.J. and Loch, R.J (2002), *Estimation of the RUSLE soil erodibility factor*, in N. McKenzie, K. Coughlan, and H. Cresswell (eds), 'Soil Physical Measurement and Interpretation for Land Evaluation', CSIRO Publishing, Collingwood.

such as vegetation litter and vegetation surface cover were discounted as vegetation levels are typically low in the Pilbara (vegetation surface cover levels are typically <5%).

The ranking system was developed using PSD and rain-armoured rock cover levels measured for 36 different mineral wastes sourced from across Rio Tinto's Pilbara iron ore mine sites, including Brockman 4, Hope Downs 1, Mesa A, Mesa J, Nammuldi, Paraburdoo, Tom Price, West Angelas, Western Turner Syncline, and Yandicoogina. The samples had a wide range of PSD and rock cover levels (10-90%). Analysis of the data showed that K-factors for the materials were consistent with highly and very highly erodible materials. By themselves, the K-factors did not explain the observed differences in erosion potential of the wastes. However, when the impact of rock cover was included using the C-factor, it was shown that rock cover strongly influenced material erodibility and could explain the observed differences in erosion potential between materials. Mineral wastes that had rock cover levels >70% were ranked as low erodibility and had an erodibility factor (K-factor multiplied by C-factor) of <0.001. Materials with rock cover levels of 30-70% were ranked as medium erodibility and had an erodibility factor ranging from 0.02-0.001. Materials with rock cover levels <30% were ranked as high erodibility and had an erodibility factor >0.02.

The erosion that occurs for a material is dependent not only on the material erodibility, but also on the climate and how the materials are placed. A material that has a low erodibility ranking can be made to erode are high rates if the batter gradients used are too steep or the slope lengths are too long. Vice versa, a material that has a high erodibility ranking can be used to produce stable batter profiles if an appropriate slope geometry is adopted. Therefore, the actual erosion potential of a material is not defined by this erodibility ranking, but by the results of the WEPP erosion modelling, as it considers all the relevant factors (material erodibility, climate, and batter geometry).

1.4 The landform design database

An outcome of the erodibility studies has been the generation of erodibility parameters for a wide range of Rio Tinto's mineral wastes. These erodibility parameters have been used to parameterise the WEPP runoff/erosion model with material-specific parameters. The WEPP model has in turn been used to generate a database of erosionally stable landform batter geometries[6] for Rio Tinto's key mineral wastes. This database is also called the Batter Selector Tool, or BST. Rio Tinto uses these batter geometries to develop landform designs that will satisfy long-term erosional stability requirements.

The key mineral wastes were identified by assessment of Rio Tinto's waste drilling records for a selection of sites across the Pilbara. Erodibility parameters for these key waste types were then gathered using simulated rainfall and overland flow testing techniques. Site-specific climate sequences were developed using site data and data from nearby Bureau of Meteorology climate stations. WEPP was run using the site-specific climate sequence and material erodibility parameters to develop the database of erosionally stable batter geometries. This process is described in more details below.

[6] Combinations of batter height, gradient, and profile shape.

2. WEPP erosion modelling

2.1 The WEPP runoff and erosion model

The WEPP model was used for simulations of annual runoff and erosion. It was developed by the United States Department of Agriculture (USDA) and can predict runoff, erosion, and deposition for hillslopes. WEPP has a daily input time step, although sub-daily storm parameters are used to describe the intensity and duration of daily storm events, enabling more accurate estimation of runoff and erosion potential than is generally achievable with daily time step models. When rainfall occurs, soil characteristics are considered to determine the likelihood of runoff. If runoff is predicted to occur, WEPP computes sediment detachment, transport, and deposition at 100 points along the inputted slope geometry. In this way, WEPP is able to give average erosion over an entire slope length and erosion rates at any point along the slope (peak erosion rates are calculated using this information).

The model's erosion component uses a steady-state sediment continuity equation as the basis for the erosion computations. Soil detachment in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate. Soil detachment in rills is predicted to occur if the runoff hydraulic shear stress is greater than the critical shear stress at which rilling is initiated, and when the sediment load of the runoff is below its capacity to transport sediment. Deposition in rills is computed when the sediment load of the runoff is greater than the capacity of the runoff to transport it.

Climate data

All WEPP simulations use a 100-year stochastic climate sequence derived from data observed at Rio Tinto's sites and from nearby Bureau of Meteorology climate stations. A total of 9 climate sequences were created to represent 15 mine sites:

- Brockman 4, Brockman 2, Nammuldi, and Silvergrass;
- Tom Price and Western Turner Syncline;
- West Angelas;
- Channar, Eastern Range, and Paraburdoo;
- Marandoo;
- Hope Downs 1;
- Hope Downs 4;
- Mesa J and Mesa A; and
- Yandicoogina.

Each of the 9 climate sequences contain 36,525 daily climate data sets that describe rainfall, storm duration and intensities, temperature, solar radiation, and wind. The sequences contain a wide range of rainfall events, including several extreme events. Each climate sequence was assessed against the Bureau of Meteorology's Design Rainfall Data System[7] to consider the Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI) of the larger rainfall events within the sequence. The findings for the Silvergrass climate sequence are given in Table 1.

[7] http://www.bom.gov.au/water/designRainfalls/revised-ifd/

Table 1: The Annual Exceedance Probability (AEP) and Average Recurrence Interval (ARI) values of the three rarest rainfall events within the Silvergrass climate sequence.

Location	Rainfall Event Details					
	Rarest		2nd Rarest		3rd Rarest	
	Total & Duration	AEP (%) & ARI (Years)	Total & Duration	AEP (%) & ARI (Years)	Total & Duration	AEP (%) & ARI (Years)
Silvergrass	268mm 5 hours	<0.05% >2,000 years	175mm 5 hours	0.07% 1,500 years	171mm 4 hours	0.1% 1,000 years

The rarest event within the Silvergrass climate sequence has an AEP of 0.05%, equivalent to a storm with an ARI of >2,500 years. This storm is defined within the Australian Rainfall and Runoff Guideline (AR&R) as 'extreme'. For Silvergrass, the second rarest rainfall event has an AEP of 0.07% (1,500 year ARI) and the third rarest event has an AEP of 0.1% (1,000 year ARI). These are defined as 'very rare' events.

The Silvergrass climate sequence is consistent with long-term averages and includes multiple very rare and extreme rainfall events. Therefore, the resultant erosion modelling is also consistent with long-term averages, including the erosion that would occur from multiple very rare events.

Validation of WEPP modelling

WEPP model validation data is provided to demonstrate that the model is able to adequately predict erosion in a mining context. WEPP has been extensively validated by Landloch for mine site batters (Figure 1).

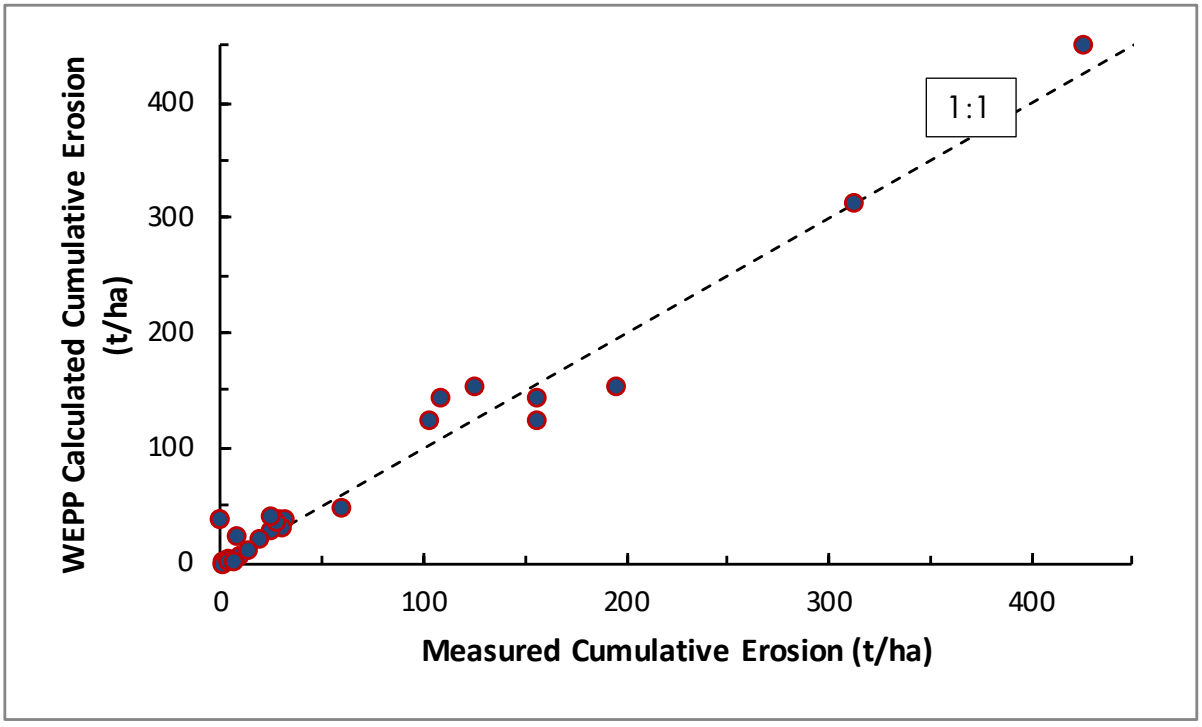


Figure 1: WEPP-predicted cumulative erosion and observed cumulative erosion for 27 locations from Western Australian mine sites.

The data presented were sourced from 27 locations on 12 waste landforms on mine sites in Western Australia. Several sites were located at Rio Tinto's Pilbara iron ore sites. The observed erosion data were collected using 30-50 m wide cross-slope erosion transects located on upper and lower sections of waste dump batters. Batter geometries include both linear and concave cross-sectional profiles. Gradients assessed are consistent with the slopes commonly used for mining landforms (12-20°). Surfaces assessed include loamy soils, clay soils, and rocky soils. The ages of the batters range from 3-8 years. Slope conditions range from minimally eroded to heavily eroded.

The observed cumulative erosion rates show good agreement with rates predicted by WEPP. Given that these data include predictions from both the upper and lower sections of landform batters, WEPP is shown to be able to suitably predict changes in erosion rates with changing slope lengths and gradients. The model can adequately represent both runoff accumulation down the slope and flow concentration across the slope. The accuracy of the predictions shown in Figure 1 also indicates that the methods used to derive the model parameters produce accurate model results. This gives confidence that accurate calibration of the WEPP model can be achieved, provided suitable testing methods are used.

Establishing acceptable long-term erosion rates

The suitability of the batter geometries found within the landform design database (i.e. Batter Selector Tool) is determined by comparison of the modelled long-term average erosion rates with rates that have been found to be acceptable. Historically, the acceptable long-term erosion rate has been set based on a desire to limit the initiation of rill erosion. A value of 5t/ha/y was used. More recently, a review of acceptable erosion rate values for the Pilbara region[8] considered acceptability using six different concepts:

- Rates of soil renewal (soil formation and deposition by dust);
- Maintenance of surface soil/growth media quality;
- Rates of naturally occurring erosion in the Pilbara;
- Rates that increase the potential for gully development;
- Water quality and off site impacts; and
- Impacts on vegetation.

The review found that the acceptable rates of long-term erosion were similar regardless of the concept considered. A value of 6t/ha/y for long term average slope erosion was found to be consistent with rates of soil renewal and naturally occurring erosion, and consistent with a surface with a low tendency for rill and gully erosion. Given that the erosionally stable batter geometries adopted by Rio Tinto prior to the more recent review are modelled to erode at rates less than 5t/ha/y, it is concluded that the slopes within the landform design database (Batter Selector Tool) are suitable, provided surface water control from the dump top and berms, and around the landform are also suitably managed.

[8] Howard, E.J. and Loch, R.J. (2019) *Acceptable erosion rates for mine waste landform rehabilitation modelling in the Pilbara, Western Australia*, in AB Fourie & M Tibbett (eds), Proceedings of the 13th International Conference on Mine Closure, Australian Centre for Geomechanics, Perth, pp. 1545-1560, https://doi.org/10.36487/ACG_rep/1915_121_Howard

2.2 Landform evolution modelling

Other erosion models exist that can be usefully deployed as part of the landform design process at different phases of mining operations. WEPP is used to define erosionally stable two-dimensional landform batter designs. Landform evolution models (LEM) can be used to consider the landforms in three dimensions.

SIBERIA is the most widely adopted LEM for use in mining, particularly in Australia. It is a model tailored to the consideration of the impacts of the 3D shape on the long-term stability of a landform. SIBERIA modifies the 3D shape of a landform in response to erosion and deposition. It is different to a surface water model in that it does not predict runoff or route runoff over the surface. Rather it uses relationships between surface hydrology (contributing areas and discharge rates) and erosion to predict changes in 3D landform shape.

Within the context of mining landforms, SIBERIA has been used to consider the:

- likelihood of the development of rill or gully erosion over time;
- breaching of surface layers designed to encapsulate underlying problematic wastes;
- erosion risk at the interface between a waste dump and adjacent undisturbed land; and
- erosional impact of placement of different materials over the land surface.

SIBERIA is more complex to parametrise than WEPP. It requires parameterisation with time series data of runoff and erosion for a specific combination of material and landform shape. Because it is fitted to time series data for runoff and erosion (not rainfall), SIBERIA cannot easily be used to predict erosion for a single rainfall event. For example, it is not able to be used to predict land changes in response to a single extreme event. The intent of SIBERIA is to assess long-term changes in landform shape (over decades or hundreds of years).

Given that the final 3D landform shape is not exactly known during the early phases of mining (i.e. feasibility or approvals stage), the usefulness of SIBERIA in these early stages is limited. Two dimensional batter erosion models such as WEPP provide sufficient information in order for the broad shape of a rehabilitation landform to be defined. For example, the erosionally stable slope length, height, and gradient, the batter profile shape (linear, concave etc.), and the required capacity of cross-slope berms and crest bunding, can all be derived from WEPP modelling without the need for SIBERIA modelling. If the broad shape of the landform batter is set based on stable batter geometries defined by WEPP, the resultant 3D landform is likely stable, provided it is coupled with an investigation of surface water flows to account for risks such as flood flows (which SIBERIA is not equipped to do).

SIBERIA modelling becomes increasingly useful closer to the point of rehabilitation when more detailed engineering designs are completed and where it can be address risks associated with how the landform ultimately meshes into the surrounding landscape.

3. Material abundance

Table 2 provides a summary of the percentage of each waste type for Silvergrass. The proportions are from the 2018 life of mine data (approved tonnes excluding proposed tonnes) as provided by Rio Tinto (pers. comm. C. Dodge, 17 August 2020).

Table 2: Waste material summary for Silvergrass (2018 LOM data)

Waste material type	Erodibility Ranking	Total waste (kt)	Total waste (%)
Detritals	High	252,512,461	58
Mt Newman Member	Low	70,337,095	16
Wittenoom Formation	Medium	53,849,862	12
Hydrated Zone	Low	37,642,696	9
MacLeod Member	Low	10,413,346	2
Others	Medium	12,220,890	3

Detritals are the dominant waste at Silvergrass. Mt Newman Member, Wittenoom Formation, and Hydrated Zone are also present in appreciable proportions. MacLeod Member and other waste types are present but in small proportions (<5%).

Erodibility studies have been carried out on 48 mineral waste samples from Rio Tinto's Pilbara iron ore mining operations. No sampling has specifically been completed for Silvergrass. However, sampling of relevant wastes has been completed nearby Nammuldi, Brockman 4, and Western Turner Syncline. At these nearby sites, the following relevant samples have been tested:

- 1 Detritals sample from both Western Turner Syncline and Nammuldi; and
- 1 Hydrated Waste sample from both Brockman 4 and Western Turner Syncline.

Using these materials, 67% of the Silvergrass materials have been assessed from nearby sites. Sampling of the Mt Newman Member (2 samples) was been conducted at Hope Downs 1. Including these samples, 83% of the Silvergrass waste has been broadly characterised for erodibility.

No data exists for the Wittenoom Formation materials.

4. Material testing methods

4.1 Plant growth potential

Samples of the fine component (<2 mm) of some of these materials were analysed for soil $pH_{1:5}$, $EC_{1:5}$ as a measure of salinity, Exchangeable Sodium Percentage (ESP), and particle size distribution (coarse sand, fine sand, silt, and clay). These properties were used to define risks to vegetation growth inherent in the wastes (e.g. salinity and poor structure). The coarse component (>16 mm) were also assessed for properties that indicate their likely durability, tendency to weather, and usefulness as an armour material. Properties assessed include rock particle size, rock particle density, and rock water absorption.

4.2 Material erodibility

Assessment of long-term erosion potential for each of the materials was assessed using the WEPP model. WEPP describes erodibility using a number of specific parameters: Interrill Erodibility (K_i); Rill Erodibility (K_R); Critical Shear for Rill Initiation (τ_c); and Effective Hydraulic Conductivity (K_e). These erodibility parameters were derived from data collected using application of:

- Simulated rain to test surfaces and measurement of runoff and sediment in runoff to obtain estimates of K_i and K_e; and
- Simulated overland water flows and measurement of runoff, sediment, and rill characteristics, to obtain estimates of K_R and τ_c.

Simulated rainfall and overland flows

Rainfall and overland flow simulations have been widely used to define the erodibility of mine wastes. The process is briefly described below.

For rainfall simulation, flat fan nozzles mounted on an oscillating manifold positioned ~2m above a test surface produce the simulated rain (Figure 2). The kinetic energy generated by the nozzles is consistent with the energy of natural rainfall at intensities >40mm/hr. The nozzles sweep back and forth across the test surfaces, achieving high spatial distribution uniformity (<10% coefficient of variation). For each material tested, triplicate plots (0.75m square) are subjected to a rainfall event sufficiently intense to ensure runoff occurs (usually 80-100mm/hr). This allows measurement of K_i and K_e.

For overland flow simulations, rill erodibility parameters are derived by applying overland flows at various rates to flumes 0.4m wide and 2.0m long set at gradients ranging from 10-30% (Figure 3). K_R and τ_c are derived based on relationships between flow shear stress and sediment detachment rates measured from these flumes.

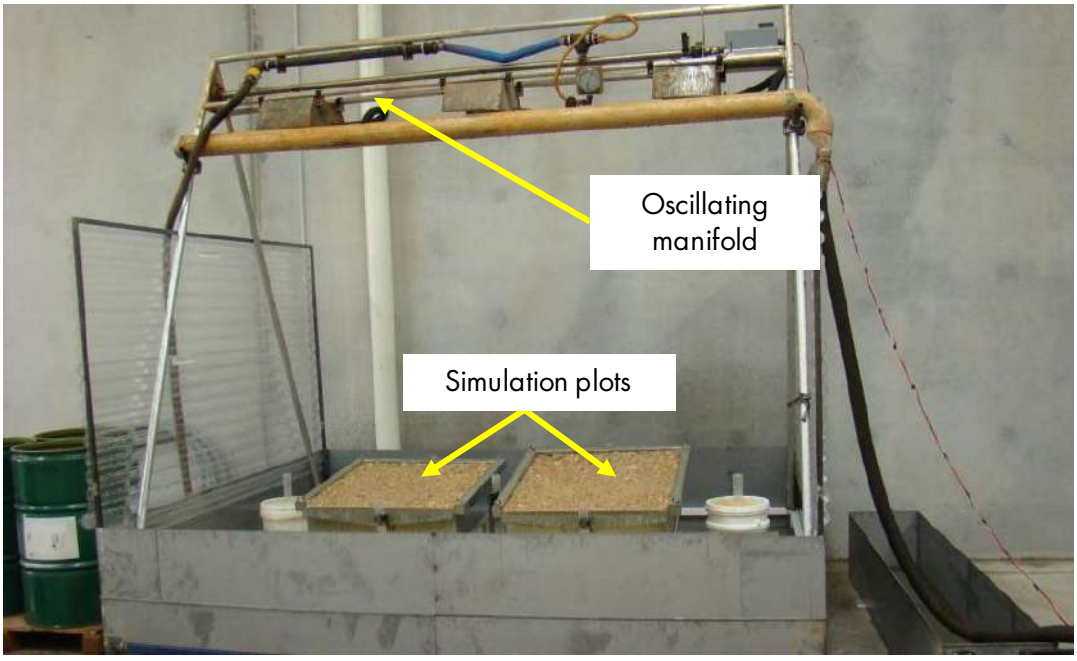


Figure 2: Typical laboratory-based rainfall simulator installation.

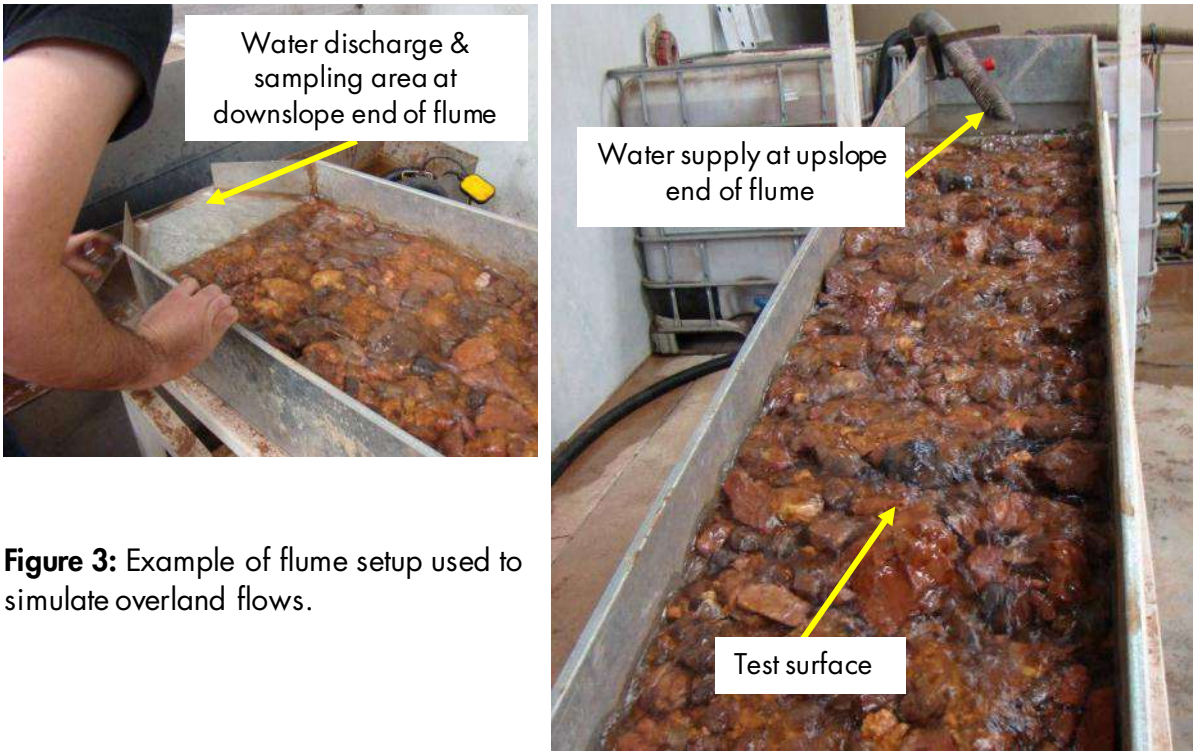


Figure 3: Example of flume setup used to simulate overland flows.

5. Materials of Silvergrass

5.1 Plant growth potential

A summary of waste characterisation data relevant to plant growth are given in Tables 3 (fines fraction) and 4 (coarse fraction). Data are provided for materials from sites near to Silvergrass that have the same materials. The results from the nearby sites would be broadly consistent with those from Silvergrass. Data for the Mt Newman Member material from Hope Downs 1 has also been included as it is the only example of Mt Newman Member currently available.

Table 3: Characteristics of the soil fraction (<2mm) of wastes from nearby sites. Data for dominant wastes only is shown.

Location	Waste Type	Particle Size Distribution of Fines				Soil Texture	$pH_{1:5}$ (H_2O)	$EC_{1:5}$	ESP
		Coarse Sand	Fine Sand	Silt	Clay				
		%	%	%	%		-	dS/m	%
Brockman 4	Hydrated Zone	54	28	9	9	LS	7.5	0.16	5.7
Nammuldi	Detritals	70		15	15	L	6.5	0.06	3.4
Western Turner Syncline	Hydrated Zone	59	25	1	15	SL	6.9	0.29	26
	Detritals	47	25	1	27	SCL	6.1	0.20	8.5
Hope Downs 1	Mt Newman Member 1	42	31	16	11	LS	7.4	0.07	7.0
	Mt Newman Member 2	58	22	11	10	LS	7.6	0.06	5.1

Notes: Coarse sand: 2.0-0.2mm; Fine sand: 0.2-0.02mm; Silt: 0.02-0.002mm; Clay <0.002mm. Texture: LS: Loamy Sand; SCL: Sandy Clay Loam; L: Loam; ZCL: Silty Clay Loam; SL: Sandy Loam.

Table 4: Characteristics of the coarse fraction (>2mm) of wastes from nearby sites. Data for dominant wastes only is shown.

Source Location	Geology	Full Particle Size Distribution				Coarse Fraction Content	Rock Particle Density	Rock Water Absorption
		Rock	Pebble	Gravel	Fines			
		%	%	%	%	%	g/cm³	%
Brockman 4	Hydrated Zone	2	0	26	72	28	3.4	3.3
Nammuldi	Detritals	0	0	43	57	43	-	-
Western Turner Syncline	Hydrated Zone	0	0	72	28	72	-	-
	Detritals	0	4	72	24	76	-	-
Hope Downs 1	Mt Newman Member 1	24	30	30	15	85	3.0	3.4
	Mt Newman Member 2	14	31	31	25	75	3.4	1.1

Notes: Rock: >45mm; Pebble: 15-45mm; Gravel: 2-15mm; Fines: <2mm. '-' indicates that no data are available for these parameters.

The materials have low salinity with values unlikely to adversely affect plant growth. The materials have circum-neutral pH values; this is not likely to limit plant growth. The fine fractions (< 2mm diameter) of the samples tested have a loamy sand to loam texture. These materials are likely to have reasonable plant available water content values.

Coarse fraction content is variable. Most materials have high coarse fraction content (43-85%, mean 74%). However, the Hydrated Zone material at Brockman 4 has a lower coarse fraction content (28%. This could lead to increased erosion potential. However, a mitigating factor is the high rock particle density and low water absorption values measured for the Brockman 4 material. These materials are likely to be reasonable for use as armouring in terms of their durability.

The Exchangeable Sodium Percentage (ESP) of the wastes is low (<6%) for three samples, and elevated for the other samples (7.0-26%). Low ESP values indicate a clay fraction with a low tendency to disperse and a low risk of structural decline. For those materials with elevated ESP, they still have a low tendency for structural decline because of the high proportion of non-dispersive sands, gravels, pebbles, and rock (96% for the Western Turner Syncline Hydrated Zone sample, 94% for the Western Turner Syncline Detritals sample, and 97% for the Hope Downs 1 Mt Newman Member sample). The potentially dispersive clays account for only ~3-6% of the total volume of material. Therefore, if the clay were to disperse, it is not likely to mobilise through the void spaces within the material and will not likely result in tunnel erosion. That said, the dispersion of the clay may cause hardsetting surfaces that will impact runoff and erosion rates. This impact is incorporated in the erodibility testing and the erosionally stable batter geometries adopted for these materials.

5.2 Erodibility

Table 5 shows the erodibility parameters for the sites nearby to Silvergrass and the Mt Newman Member materials from Hope Downs 1. Also shown are the aggregated parameter values adopted and used to develop stable batter geometries within the landform design database (i.e. Batter Selector Tool).

The impact of this difference in erodibility parameters was assessed by conducting additional runoff/erosion modelling with the WEPP model.

Table 5: Site specific erodibility parameters and aggregate parameters adopted for the development of batter geometries in the Batter Selector Tool.

Material	Erosion Class	K_e (mm/h)	K_i (kg.s/m^4)	K_R (s/m)	τ_c (Pa)
Detritals					
Aggregated (all samples)	High	26	236,317	0.0116	28
Nammuldi	High	12	472,428	0.0122	14
Western Turner Syncline	High	135	40,605	0.0366	34
Mt Newman					
Aggregated (all samples)	Low	25	311,045	0.0034	44
Hope Downs 1 Sample 1	Low	10	347,648	0.0014	41
Hope Downs 1 Sample 2	Low	40	274,442	0.0054	46
Hydrated Zone					
Aggregated (all samples)	Low	103	63,860	0.0030	28
Brockman 4	Low	140	50,000	0.0022	17
Western Turner Syncline	Low	83	22,145	0.0101	23

Predicted erosion for the Detritals using the aggregated parameters indicates that a stable geometry of a batter with a uniform gradient of 20 degrees would be <5m. When compared to the Detritals from Nammuldi, the same height limitation exists. When compared against the Western Turner Syncline Detritals, the stable height indicated by the modelling increases to 20m at 20 degrees. This indicates that the erodibility of the Detritals can be variable.

Predicted erosion for the Mt Newman Member waste using the aggregated parameters indicates that a stable geometry of a batter with a uniform gradient of 20 degrees would be 20m. When compared to the Mt Newman Member wastes from Hope Downs 1, the same stable height (20m) is predicted to be acceptably stable.

Predicted erosion for the Hydrated Zone materials using the aggregated parameters indicates that a stable geometry would be a uniform gradient of 20 degrees and height of 20m. When compared with the Hydrated Zone materials from Brockman 4 and Western Turner Syncline, the same stable height (20m) is predicted to be acceptably stable.

No erodibility data exists for Wittenoom Formation. Assuming they are similar to Whaleback Shale (they have the same erodibility ranking of medium), the stable geometry for these materials (based on the aggregated parameter values) would be 5m at 20 degrees.

6. Closing

Erosion modelling has used data collected from 48 samples of key wastes across Rio Tinto's Pilbara operations. These samples have been subjected to testing to measure their erodibility, with these erodibility parameters used to model long-term erosion using the WEPP model. The climate sequences used in the modelling contain a wide range of rainfall events including several extreme and very rare events.

The model results have been compared against acceptable erosion rate values consistent with measured erosion for undisturbed land in the Pilbara, soil renewal rates, and rates at which the risk of rill and gully erosion is low. The model output has been validated at 27 locations on mine sites in Western Australia and shown to agree with observed erosion.

An assessment of the samples relevant to Silvergrass (Brockman 4, Western Turner Syncline, and Hope Downs 1) show that the batter geometries generated using the aggregated erodibility parameters will be suitable (and possibly conservative in some cases) for use at Silvergrass.

Regards

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Disclaimer

All care and diligence have been exercised in testing, interpreting data and the development of recommendations presented in this document. The monitoring and testing have been undertaken in a skilled, professional manner, according to accepted practices. Specific circumstances and research findings after the date of publication may influence the accuracy of the data and recommendations within this document.

The landscape is not uniform. Because of this non-uniformity, no monitoring, testing, or sampling technique can produce completely precise results for any site. Any conclusions based on the monitoring and/or testing presented in this document can therefore only serve as a 'best' indication of the environmental condition of the site at the time of preparing this document. It should be noted that site conditions can change with time.

The information that comprises this document should only be used within the limitations stipulated herein. Landloch does not accept any risks and responsibilities for losses, damages, costs, and other consequences resulting from using any information, material, and recommendations in this document.

Appendix 11: Spontaneous Combustion and Acid Rock Drainage (SCARD) management plan

Iron Ore (WA)

Spontaneous Combustion and ARD (SCARD) Management Plan

for Operations

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1 Purpose

The Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan for operations outline the activities and groups accountable for the management of the environmental, safety, health, reputational and business risks associated with:

- Black shale
- Sulfidic material within detritals
- Sulfidic material within Banded Iron Formation (BIF)
- Elevated-sulfur material within shale, waste and ore.

Due to differing risks, the management of sulfides within black shale has been delineated from that associated with sulfides within detritals and BIF, and material containing sulfates.

This plan enables the development and implementation of appropriate risk reduction measures to lower risk. It sets and implements the appropriate monitoring plans that quantify the actual impacts and compares them with that predicted, to determine if risk reduction methods have been effective.

2 Definitions

2.1 Abbreviations

ABA	Acid Base Accounting
AMD	Acid and Metalliferous Drainage
ANC	Acid Neutralising Potential
ARD	Acid Rock Drainage
BIF	Banded Iron Formation
BS	Black Shale
DG	Dales Gorge Member
FWZ	Footwall Zone
MCS	Mount McRae Shale
NAF	Non-Acid Forming
PAF	Potentially Acid Forming (including black shale and sulfides in BIF and detritals)
SWP	Safe Work Practice
WS	Whaleback Shale Member

2.2 Hazards Definitions

The risks associated with black shale, BIF and detritals are triggered by the presence of sulfides, in particular pyrite (FeS_2) within these material types. Pyrite will remain stable if constantly water-saturated with no exposure to oxygen or ferric iron. Alunite ($KAl_3(SO_4)_2(OH)_6$) and jarosite ($KFe_3(SO_4)_2(OH)_6$) have been identified in AWT waste and ore. When excavated during mining, pyrite can oxidise and sulfate minerals dissolve and generate the following risks to the operation:

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ARD (also known as Acid and Metalliferous Drainage (AMD))

The process of pyrite oxidation results in the release of dissolved acidity, sulfate, iron and other metal ions into drainage waters. The acidic conditions can often induce weathering of clay minerals in the host material and also release dissolved metals such as aluminium, manganese, zinc and/or copper into the drainage. The Acid Neutralising Capacity (ANC) of many of the other waste materials in the Hamersley Group is low and insufficient to neutralise the acidity released from most pyritic waste rocks.

Alunite weathers to an aluminium oxyhydroxide phase (e.g. gibbsite or boehmite, etc.) via dissolution; it can produce acid and buffer the pH in the region of 4.0 to 4.5. The rate of acid release is low and the acidity can be neutralised by any minerals that have the capacity to consume acid.

Risk Areas: Contamination of surface and/or ground water and soil, and potential disturbance to surrounding ecosystems from ARD generated within waste rock dumps and pits or voids. Potential health risks from direct handling or accidental consumption of ARD products.

Premature Blast Detonation

Spontaneous combustion is a major safety concern to RTIO (WA) due to the risk of reaction with explosives in loaded blast holes potentially leading to premature detonation. Ammonium nitrate (NH_4NO_3) based explosives, commonly known as ANFO, are typically used however due to the risk of spontaneous combustion, explosives based on inhibited emulsion blended with ANFO are used if spontaneous combustion may occur.

Risk areas: Potential safety risk from the premature and unexpected detonation of explosives.

Spontaneous Combustion within Dumps

In waste dumps where self-heating occurs, heat may be transferred from hot to cold regions of the dump through the evaporation of moisture (water vapour) in hot areas and subsequent condensation in colder areas. This heat transfer is in addition to the transport of heat by natural convection. Water vapour transport is an important heat transfer mechanism within waste dumps and therefore it is not recommended that water is added to a hot spot. The added water may shift the heat from one region to another. This may be the reason that self-heating is observed in black shale after increases in humidity and rain. If the rate of energy generated by oxidation is greater than the rate at which energy can be dissipated to the environment via conduction, convection and evaporation then the dump will self-heat.

Risk areas: Gas venting from waste dumps, geotechnical instability and increased rates of ARD generation due to the elevated temperatures and oxygen exposures.

Gas Exposures

The major gases produced from the spontaneous combustion of the black shale (and possibly lignite in detritals) are likely to be sulfur dioxide (SO_2), carbon dioxide (CO_2), hydrogen sulfide (H_2S), carbon monoxide (CO) and methane (CH_4). In the open air, the rate of reaction is slow and the heat of reaction is quickly dissipated to the environment. Within waste dumps, the heat cannot dissipate as readily and there can be localised hot spots that promote SO_2 generation. The SO_2 generated can then vent from the waste, potentially causing problems with the establishment of vegetation.

Risk areas: Human exposure to toxic gases and safety risks.

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Dust Exposure

Black shale can be fine and powdery with elevated concentrations of alumina and silica.

Risk areas: Human exposure to dust and safety risks.

2.3 Waste Definition

Waste containing sulfur can have the potential to generate ARD and some materials can also spontaneous combust. The potential for wastes to generate ARD or spontaneously combust is defined at Rio Tinto Iron Ore (WA) operations as:

ARD/AMD potential: The propensity for a material to generate ARD/AMD is determined using a series of tests referred to as Acid Base Accounting (ABA). Without site-specific ABA data, a total sulfur concentration of 0.1% is used as the approximate boundary between non-acid forming and potentially acid forming material. Marra Mamba Iron Formation BIF and detritals are the only material that can use a 0.3% sulfur cut-off value and this is due to the presence of some acid neutralising materials.

Spontaneous Combustion potential: The spontaneous combustion mechanisms of pyritic black shale are poorly understood. However, it is likely to be associated with the following properties of the shale: high surface area, high porosity, small particle size distribution, moisture content, carbon content and sulfur content. All black shale and lignite material is deemed by RTIO (WA) to pose a spontaneous combustion risk (although significant tonnages of lignite are yet to be mined so spontaneously combust has not been observed).

Depending on the potential for ARD generation and/or spontaneous combustion (risk), waste should be classified into one of three categories and it should be dumped in accordance with the specifications for that category (Appendix 1).

Inert waste: Material is currently classified as inert by RTIO (WA) if it does not contain sulfur or carbonaceous material (i.e., S < 0.3% for BIF and detritals located below the water table (BWT); S < 0.1% for elevated-sulfur material located above the water table (AWT); and not including any black shale or lignites). Black shale within the Whaleback Shale Member may be classified as inert waste when it represents a small fraction of a mine block and the average sulfur content of the block is < 0.1%.

Cold black shale/sulfidic BIF/sulfidic siderite: This material is not likely to spontaneously combust within the dump and is managed only to control the ARD risk. Typical material within this category includes:

- Cold black shale (MCS): Represents black shale with low sulfur concentrations. Due to possible variability within the unit, this material requires special management. Whilst the sulfur content is low (i.e., < 0.1%), there is still the potential for metalliferous drainage as a result of oxidation of the organic carbon material within the black shale.
- Dales Gorge Member (DG) black shale: Represents black shale with sulfur concentrations up to 2% and containing some acid neutralising capacity (e.g.,15 kgH_2SO_4/t). Samples are mostly non-acid forming but may be potentially acid forming with low capacity.
- Sulfides within BIF and detritals (siderite): The sulfur concentration in these materials is generally in the range of 0.1% to 0.3% but can reach 15%. The risk of spontaneous combustion in the dump is considered low due to the lack of organic carbon associated with this material.
- Whaleback Shale Member (WS) black shale: If the average sulfur content is > 0.1% or black shale accounts for the majority of the block material, then this material should be placed in a cold black shale dump as there is very low potential for acid generation.

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Hot black shale/Lignite: This material may spontaneously combust in the dump and is managed to control combustion within the dump. Typical material within this category is:

- Hot black shale (MCS): Black shale which generally has significantly higher sulfur concentrations and high organic carbon concentrations typically > 2%.
- Sulfides in lignite: The risk of spontaneous combustion of sulfidic lignite material is currently unknown. Until proven otherwise, sulfidic lignites should be managed to minimise the risk of spontaneous combustion.

Elevated sulfur: The sulfate minerals alunite and jarosite can be found AWT, predominantly in the Dales Gorge Member, Whaleback Shale Member and oxidised MCS. These are found particularly in close proximity to those units containing sulfide minerals, and/or a source of potassium such as dolerite dykes. When alunite or jarosite occur in significant quantities (termed elevated-sulfur material) it will need to be specially managed due to its propensity to release acid and associated metals. Without site specific test work for sulfates, a total sulfur concentration of 0.1% is used as the approximate boundary between non-acid and potentially acid forming material due to the low solubility of these minerals and presence of some acid neutralising materials.

3 Assessing if a Site needs to implement this Management Plan

The RTIO (WA) Mineral Waste Management Plan describes the ARD, spontaneous combustion and mineral waste characterisation work that must be undertaken during Resource Evaluation, Studies and Mine Operations. A detailed ARD Risk Assessment should be undertaken for any new deposits or significant expansions of current operations to identify whether excavated sulfides will represent a risk to health, safety and environment (including the impacts on-site, off-site and to the receiving environment). If risks are deemed to be minimal then a management plan will not be required. If a risk assessment has already been undertaken at a site then for any additional significant resource drilling or expansions of the operation the risk assessment should be updated. For any mine site that exposes or could potentially expose sulfidic or elevated-sulfur material, then this SCARD Management Plan will need to be implemented.

The accountability for the identification and subsequent management of spontaneous combustion and ARD risks associated with black shale and sulfidic BIF and detritals are listed in Section 4 and Section 5. It provides an overview of management at RTIO (WA) operations from initial characterisation and modelling, through project development, mine planning, production and closure. The RTIO (WA) SCARD management strategy is broadly based upon the following principles:

1) Identification of PAF material distribution and character;
2) Minimising the exposure and mining of PAF material to the extent possible;
3) Identification and special handling of PAF material that must be mined;
4) Encapsulation of PAF material inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated, or placement of PAF material below the water table in backfilled open pits to limit oxygen contact; and
5) Monitoring impacts and taking corrective actions (when necessary).

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4 Requirements, Accountabilities and References for Black Shale

Black shale management during mining operations is conducted in accordance with Figure 1 and Figure 2. The mining protocols are designed to:

1) Minimise the risk of unplanned detonations in charged blast holes;
2) Ensure that hot and cold black shale truck loads are transported and placed in designated black shale dumps according to design requirements;
3) Ensure that the location and geometry of all black shale repositories is recorded;
4) Minimise environmental impacts of AMD products; and
5) Refine geological block models and block-out procedures.

Requirements	
4.1	**Mine Planning and Closure**
4.1.1	Mine plans must include estimates for hot and cold BS production and compare to inert waste production to ensure that sufficient material will be available for dump construction.
4.1.2	Ensure that BS dumps are sited to minimise long term environmental impacts and financial liabilities. Obtain signoff from Environment, Hydrogeology and Hydrology.
4.1.3	Ensure that final pit and dump designs are consistent with Appendix 1, Appendix 3, Appendix 4 and the RTIO Landform Design Guidelines. Waste dump designs must be coupled with a rehabilitation design showing how the dump is proposed to be rehabilitated upon closure. The rehabilitation design should be provided to the Rehabilitation team for review. Obtain signoff from Environment, Hydrogeology and Hydrology.
4.1.4	During the mine planning process identify areas that are available for rehabilitation and inform the rehabilitation and closure team.
4.2	**Mine Technical Services - Planning**
4.2.1	Ensure that Medium Term plans predict hot and cold BS production from each pit and delivery to each dump. Ensure that sufficient inert waste will be produced for encapsulation in accordance with the specifications in Appendix 1 and that sequencing will allow dump construction to occur as required.
4.2.2	Major changes to waste dump designs must be reflected in changes to the associated rehabilitation design. Receive sign-off from Environment, Rehabilitation Team, Hydrogeology and Hydrology before major modifications to BS dump designs are implemented.
4.2.3	Plan and design works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 4, Appendix 7 and the RTIO Landform Design Guidelines. Waste dump designs must be coupled with a rehabilitation design showing how the dump is proposed to be rehabilitated for closure. The design should be provided to the Rehabilitation Team for review. Obtain sign-off from Environment, Hydrogeology and Hydrology.
4.2.4	During the mine planning process identify areas that are available for rehabilitation and inform the rehabilitation and closure team.
4.2.5	When planning open pits that will intersect BS, the possibility of dewatering discharge/groundwater becoming acidic must be considered so that appropriate mitigation infrastructure can be installed.
4.2.6	Black shale exposed on the waste rock dumps must be minimised during the wet season (November to April).

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Requirements

4.3 Mine Geology

Blasting

4.3.1 Identify BS in blast hole cones and demarcate using agreed methods.

4.3.2 Alert key personnel in Mine Technical Services Planning and Pit Operations of the location of BS blast holes via e-mail.

Dumping

4.3.3 Based on visual inspection, total S values and stratigraphy, designate holes as cold BS, hot BS or inert waste. Create Block-outs that show contacts between waste types within blast patterns.

4.3.4 Perform periodic reconciliations between the Block-outs and the geological block model.

4.3.5 Collect (as required) representative samples of hot and cold black shale for full ABA and NAG analysis.

4.3.6 Regularly review the boundary between cold BS and hot BS to ensure it is still valid and has not changed as mining progresses deeper. Advise the relevant teams of the results and undertake change management if necessary.

4.4 Survey

4.4.1 Maintain as-built dump designs that include a 3D plan showing approximate locations and volumes of BS.

4.4.2 Ensure that monthly face pick-up surveys are conducted on all active BS waste dumps.

4.5 Operational Planning

4.5.1 Create a “Waste Dump Progression Plan” at least every three months to implement the detailed dump designs in the field.

4.5.2 Create “PLOD” sheets to aid dig operators in waste assignment and check that CAES is working.

4.5.3 Monitor and adjust to reconcile rehabilitation plans with original designs as appropriate.

4.5.4 Perform field inspections to ensure that BS is transported to the proper dump locations and placed as required. Register non-conformances in SAP.

4.5.5 Ensure reports contain hot and cold BS volumes delivered to every dump.

4.5.6 In consultation with Mine Geology perform regular reconciliations between Block-outs, survey and ORDW data for hot and cold BS volumes.

4.5.7 Black shale exposures on the waste rock dumps must be minimised during the wet season.

4.6 Drill, Blast and Development

4.6.1 Ensure all safety procedures related to BS management are followed during the charging and firing of blast holes i.e., temperature logging, timing.

4.6.2 Maintain site specific Drill and Blast SWPs and ensure it is consistent with this management plan and other SWPs and guidance notes.

4.6.3 Submit samples for isothermal reactivity testing for compatibility with ANFO explosives.

4.7 Load and Haul

4.7.1 Ensure that BS is properly identified and placed in the correct dump location consistent with PLOD sheets, CAES mining assignments and the Waste Dump Progression Plan from Operations Planning.

4.7.2 Perform field inspections to ensure that BS is transported to the proper dump locations and placed as required. Register non-conformances in SAP.

4.7.3 Ensure that “Exclusions” in CAES are reviewed and corrected in the field as required.

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Requirements	
4.7.4	The time between blasting and hauling of BS should be minimised and generally should occur within three weeks or less during the wet season (November to April) and within 12 weeks during the dry season (May to October). This will limit the amount of time the material has to oxidise in an uncontrolled manner.
4.7.5	Whenever possible the outer inert waste rock "skin" of a BS lift should be constructed first. This will ensure that BS lifts are not extended beyond the design footprint of the BS dump, will limit convective oxygen transport through the uncompacted sides of the dump lift, and will help contain contaminated contact water on the dump.
4.7.6	Hot BS lifts should be covered as rapidly as possible with the overlying inert waste rock layer, particularly during the wet season. Ideally, hot BS should be covered within two weeks of placement in the waste rock dump. If rapid covering is not possible the paddock-dumped hot BS piles should at least be dozed into a planar surface as soon as possible. This will help minimise infiltration and oxygen transport into the material.
4.7.7	The locations, volumes and sulfur concentrations (if available) of all BS repositories should be recorded so that a three dimensional plan of BS distribution within each dump is maintained by the survey group.

4.8 Hydrogeology/Technical Services

4.8.1	Maintain and implement a site specific "Acid Water Management Plan" and SWPs to deal with poor quality water that has contacted BS exposures or waste dumps. This should include information regarding bunding requirements, water quality monitoring (including the action response and relevant corrective actions including treatment) and disposal or use.
4.8.2	Ensure that water management and storage practices do not cause offsite surface water impacts or groundwater quality degradation in down gradient aquifers.
4.8.3	Provide technical overview and support during planning for above-ground and in-pit BS waste disposal.
4.8.4	Ensure that routine sampling, visual inspection, and analysis is performed for in-pit locations, including: • groundwater monitoring wells (surrounding BS dumps and pits; • dewatering water; and • surface water bodies (including temporary or permanent pit lakes within inactive open pits that contain BS exposures). This should be consistent with the master monitoring schedule for the site.

4.9 WRE Mineral Waste Management Team

4.9.1	Provide site support for the management of mineral waste, as necessary. Facilitate the transfer of knowledge between RTIO sites and studies.
4.9.2	Undertake or update AMD Risk Assessments for significant changes to the pit shell or geochemical risks. Advise the site leadership and environment group for significant changes to risk.
4.9.3	Ensure the SCARD management plan is updated at least every 2 years. More frequent updates may be required for significant changes to risk or the knowledge base.
4.9.4	For pits that intersect the water table, ensure the following information is available which would contribute to a conceptual understanding: • Catchment size; • Depth to pre-mining water table; • Current and ultimate pit depth; • Available water storage within the entire ultimate pit and above the pre-mining water table in the pit; • Predicted runoff volume for a 100 year storm event; • Distance to closest down-gradient permanent surface water body; and • Down-gradient water use. Determine the geochemical risk of the pit. Update this report for any significant changes.

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Requirements

4.9.5 Geochemical, hydrogeology and hydrology modelling to determine contaminant release from the pit should be undertaken if the report (in Item 4.9.4) finds a significant geochemical risk (i.e., a significant amount of PAF material exposed on the pit wall, a significant amount of dewatering occurring over many years, a likely saline and flow through water body, etc.).

4.9.6 For PAF material waste dumps, compile a 'Conceptual Model' report for each site. This report should contain the following information for each waste dump on the site:

- Footprint;
- Up-gradient catchment area;
- Likely material types in the waste dump i.e., oxidised MCS, DG1 BIF;
- Quantify the PAF tonnes and the total tonnes of material within each waste dump;
- Dumping methodology;
- Underlying and down-gradient geology;
- Distance to the closest regionally significant aquifer;
- Distance to closest down-gradient permanent surface water body;
- Down-gradient water use; and
- Closure/rehabilitation plans for the dump (or reference to the appropriate document).

4.9.7 Geochemical modelling to determine long-term contaminant release from the waste dump should be undertaken if the 'Conceptual Model' finds a significant geochemical risk (i.e., a significant amount of PAF material within the waste dump or significant receptors nearby).

4.10 Environment

4.10.1 Perform field inspections to ensure BS management, dump construction, rehabilitation and store and release cover performance is consistent with the requirements of the SCARD Management Plan.

4.10.2 Undertake relevant ecological assessment (appropriate for the scale of the SCARD generation and predicted level of pollution/ecological impacts), develop and implementation appropriate risk reduction measures and monitoring programmes.

4.10.3 Ensure that routine sampling, visual inspection, and analysis is performed for out of pit locations that could potentially be impacted by AMD. This may include

- groundwater monitoring wells surrounding BS dumps and pits (if they can be accessed outside the pit)
- surface water bodies (including abandoned pit lakes, permanent or seasonal natural water bodies, dewatering discharge to creeks).

This should be consistent with the master monitoring schedule for the site.

4.10.4 Record the environment risks related to BS in a site risk register and annually review/verify/validate these risks; verify that the ministerial conditions, legal and other requirements and obligations are met.

4.11 Rehabilitation and Closure

4.11.1 In consultation with relevant stakeholders identify monitoring requirements (e.g. lysimeters) for BS waste dumps following rehabilitation.

4.11.2 Coordinate the review and approval of the BS waste dump design by relevant stakeholders, including the Mineral Waste Management Team to ensure compliance with this document.

4.11.3 Assess the risks that need to be managed as part of the rehabilitation process for BS dump designs, focussing on the SCARD risks and ensure that all key stakeholders are consulted.

4.12 Health and Safety

4.12.1 Monitor the occupational gas and dust exposures surrounding BS. Ensure data is captured in a user friendly database. Ensure problems are brought to the attention of the site Mineral Waste Management Team.

4.12.2 Train occupational exposure groups on the correct use of respiratory equipment and monitors. Competency should be assessed and recorded in SAP.

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Requirements

4.12.3 Ensure the site specific guidance notes on acceptable gas levels, monitoring and demarcation are periodically refined and updated so it is consistent with current best practice.

4.12.4 Record health and safety risks associated with BS in a site risk register and annually review these risks.

4.13 Site Mineral Waste Management Team

4.13.1 A site based Mineral Waste Management Team should be formed and meet on a regular basis (e.g., monthly). It should include representatives of every department that has accountabilities related to SCARD management.

4.13.2 The primary function of the Site Mineral Waste Management Team is to ensure on-going improvement and implementation of the SCARD Management Plan.

4.13.3 Agenda items and meeting minutes should be produced for every meeting.

4.13.4 An overview of issues relating to BS must be included in any introductory training provided to new employees and contractors. The level of training should be commensurate to the level of risk BS poses to the site.

4.13.5 Develop emergency and contingency plans related to spontaneous combustion, ARD and BS management on an as need basis.

4.13.6 Coordinate a technical review of BS management by an external expert every four years. Track progress against outstanding actions at each meeting.

4.13.7 Coordinate all research related to BS characterisation, BS management, spontaneous combustion and ARD.

4.13.8 Ensure that SCARD related SWPs and guidance notes represent current practise and are up to date.

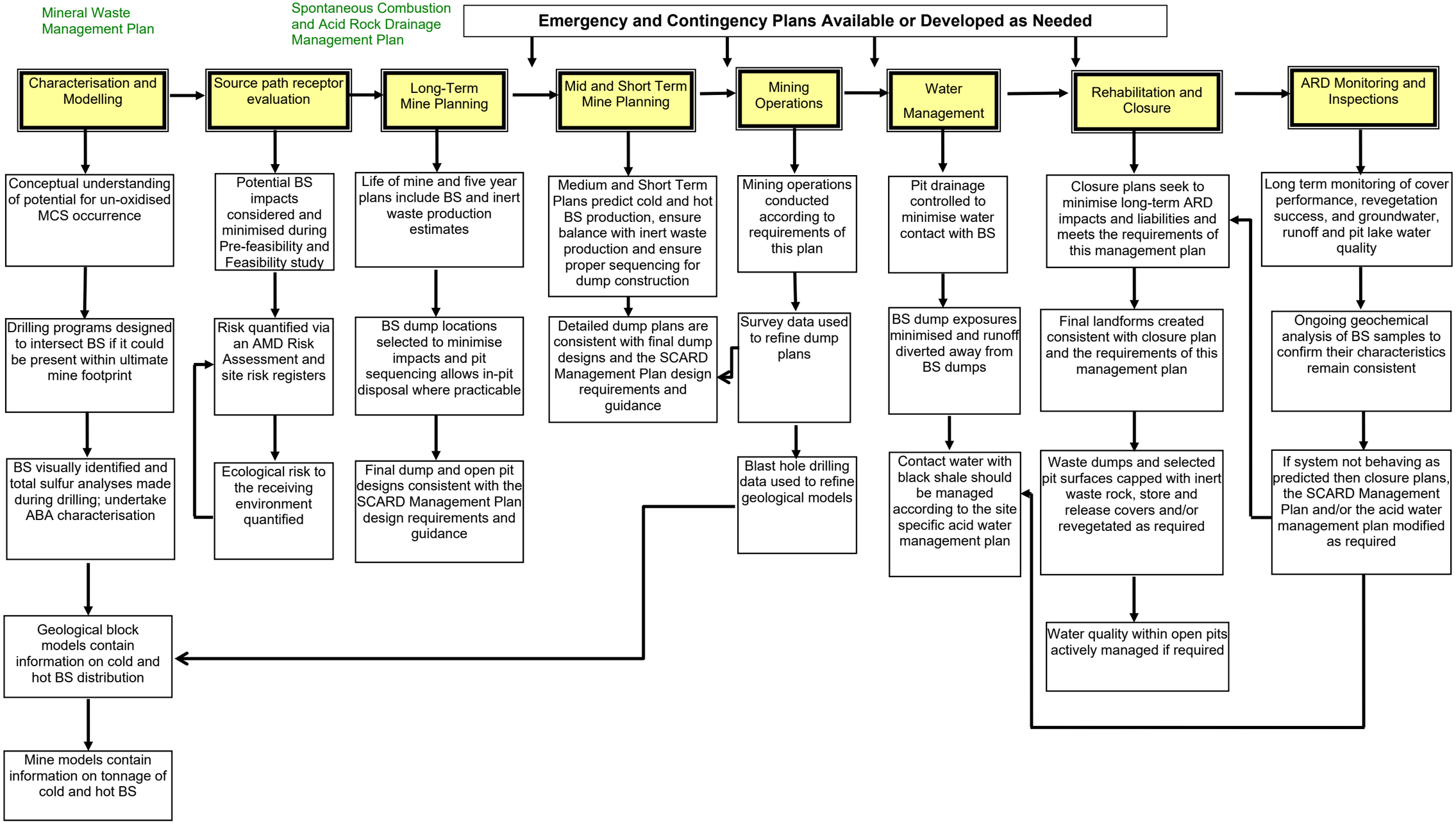
4.13.9 Changes to the SCARD management plan need to be provided to the Water Resource Evaluation Mineral Waste team to be included in future updates.

4.14 Management

4.14.1 Ensure progress is made against outstanding spontaneous combustion and AMD audit actions.

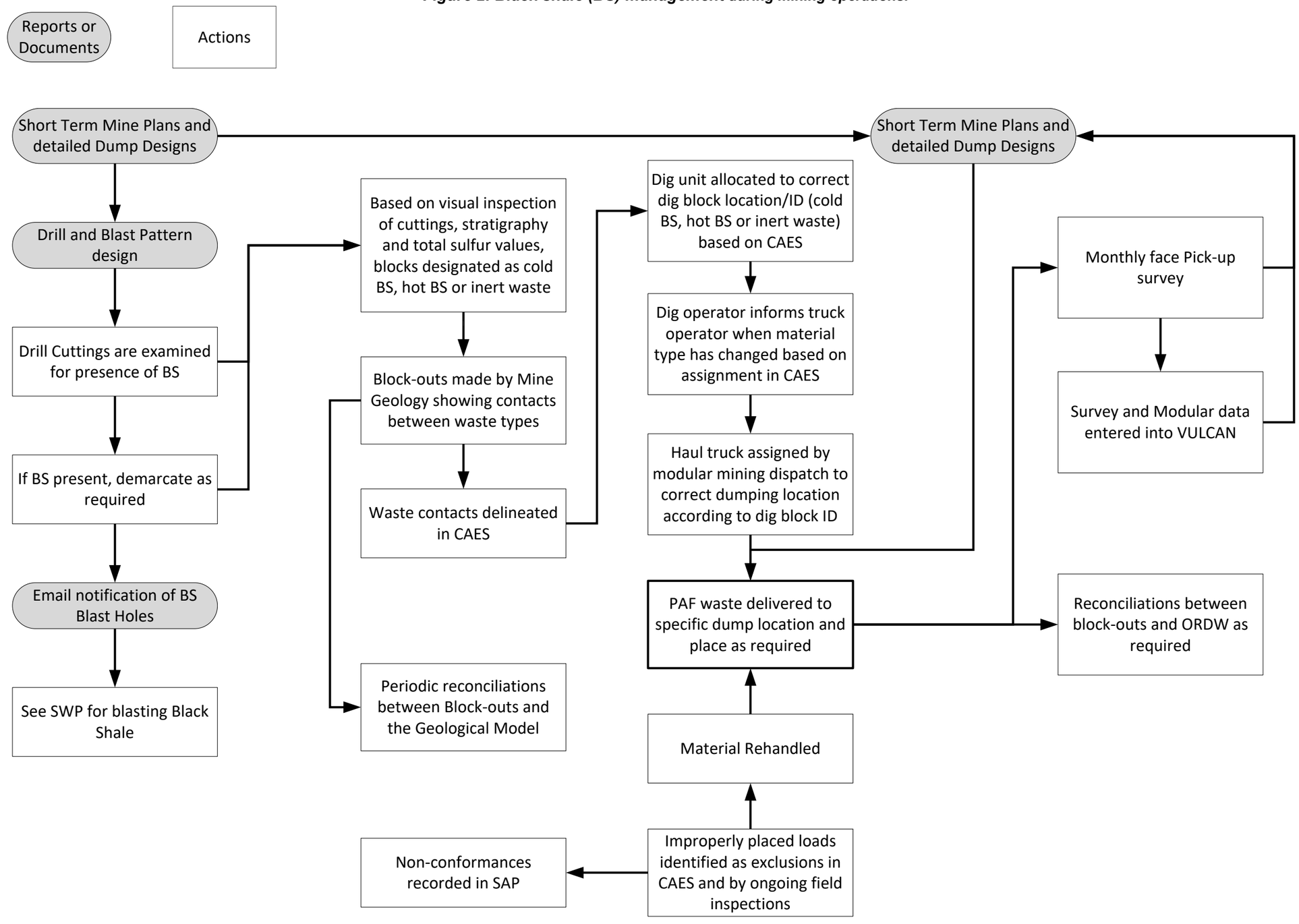
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Figure 1: Black shale (BS) management overview.



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Figure 2: Black shale (BS) management during mining operations.



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5 Requirements, Accountabilities and References for Sulfides within BIF and Detritals

Management of sulfidic BIF and detritals during mining operations is conducted in accordance with Figure 3 and Figure 4. The mining protocols are designed to:

1) Minimise the risk of unplanned detonations in charged blast holes;
2) Ensure that sulfidic BIF and detrital truck loads are transported and placed in PAF dumps according to design requirements;
3) Ensure that the location and geometry of all PAF repositories is recorded;
4) Minimise environmental impacts of ARD products; and
5) Refine geological block models and block-out procedures.

Requirements	
5.1	**Mine Planning and Closure**
5.1.1	Mine Plans must include estimates for production of PAF, neutralising and inert waste material.
5.1.2	Ensure that PAF dumps are sited to minimise long-term environmental impacts and financial liabilities. Obtain signoff from Environment, Hydrogeology and Hydrology.
5.1.3	Ensure that final pit and dump designs are consistent with Appendix 4, Appendix 5, Appendix 6, Appendix 7 and the RTIO Landform Design Guidelines. Waste dump designs must be coupled with a rehabilitation design showing how the dump is proposed to be rehabilitated upon closure. The rehabilitation design should be provided to the Rehabilitation Team for review. Obtain signoff from Environment and Hydrogeology and Hydrology.
5.1.4	During the mine planning process identify areas that are available for rehabilitation and inform the rehabilitation specialist.
5.2	**Mine Technical Services - Planning**
5.2.1	Ensure that Medium term plans predict PAF material and net neutralising material production from each pit and delivery to each dump. Ensure that sufficient inert and net neutralising waste will be produced for encapsulation in accordance to the specifications in Appendix 1 and that sequencing will allow dump construction to occur as required. The tonnes of material with neutralising potential should be quantified and used with PAF dump designs in accordance with Appendix 2.
5.2.2	Major changes to waste dump designs must be reflected in changes to the associated rehabilitation design. Receive sign-off from Environment, Rehabilitation Team, Hydrogeology and Hydrology before major modifications to BS dump designs are implemented.
5.2.3	When planning open pits that will intersect sulfidic material, the possibility of dewatering discharge/groundwater becoming acidic must be considered so that appropriate mitigation infrastructure can be installed.
5.2.4	Lignite exposed on the waste rock dumps must be minimised during the wet season (November to April).
5.3	**Geology**
5.3.1	Identify lignite in blast hole cones and demarcate using agreed method.
5.3.2	Alert key personnel in Mine Technical Services and Pit Operations of the location of lignite blast holes via e-mail.
5.3.3	If the geological block model indicates that sulfur grades may be > 0.3%, then samples from drill hole cuttings should be collected for total sulfur concentration analysis.

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Requirements

5.3.4 Review total S results and demarcate holes that contain > 0.3% S (for drill and blast identification).

5.3.5 Based on visual inspections, total S values and stratigraphy, designate holes as PAF, net neutralising or inert waste. Create Block-outs that show contacts between waste, net neutralising material and the PAF material within blast pattern.

Material blocked out for the PAF dump include:

- BIF: S > 0.3%
- Detrital Siderite: S > 0.3%
- Detrital Lignite: All (to manage neutral mine drainage risks in additional to PAF risks)

5.3.6 Perform periodic reconciliations between the Block-outs and the geological block model.

5.3.7 Collect (as required) representative samples of sulfidic material associated with BIF and detritals for full ABA and NAG analysis. Ensure results are communicated to the relevant teams.

5.4 Survey

5.4.1 Maintain as-built dump designs in Vulcan that include a 3D plan showing approximate locations and volumes of sulfidic material.

5.4.2 Ensure that monthly face pick-up surveys are conducted on all active sulfidic material waste dumps.

5.5 Operational Planning

5.5.1 Create a “Waste Dump Progression Plan” at least every three months to implement the detailed dump designs in the field.

5.5.2 Create “PLOD” sheets to aid dig operators in waste assignment and check modular mining system is working.

5.5.3 Monitor and adjust to reconcile rehabilitation plans with original designs as appropriate.

5.5.4 Ensure that operational reports contain sulfidic material volumes delivered to every dump. Confirm that sulfidic material has been transported to the correct dump and register non-conformances in SAP.

5.5.5 In consultation with Mine Geology perform six-monthly reconciliations between Block-outs, survey and operational data for sulfidic material volumes.

5.5.6 Sulfidic material exposures on the waste rock dumps must be minimised during the wet season. Lignites should be covered rapidly during the wet season to reduce the spontaneous combustion risk (i.e. 1 month)

5.5.7 The location, volume and sulfur concentration (if available) of all PAF (sulfidic material) repositories should be recorded so that a three dimensional plan of the distribution within each dump is maintained.

5.6 Drill and Blast

5.6.1 Ensure all safety procedures related to pyritic material and in particular lignite are followed during the charging and firing of blast holes.

5.6.2 Annually submit samples for isothermal reactivity testing for compatibility with ANFO explosives.

5.7 Load and Haul

5.7.1 Ensure that sulfidic material is properly identified and placed in the correct dump location consistent with PLOD sheets, CAES mining assignments and the Waste Dump Progression Plan from Operations Planning.

5.7.2 Ensure that “Exclusions” in CAES Mining are reviewed and corrected in the field as required.

5.7.3 The outer inert waste rock “skin” of a sulfidic material lift should be constructed first. This will ensure that sulfidic material lifts are not extended beyond the design footprint of the sulfidic material dump, will limit convective oxygen transport through the uncompacted sides of the dump lift, and will help contain contaminated contact water on the dump.

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Requirements	
5.7.4	Lignite material should be covered rapidly (i.e. 1 month) with net neutralising material during the wet season to reduce the risk of spontaneous combustion.

5.8 Hydrogeology/Technical Services

5.8.1 Maintain and implement the site specific "Acid Water Management Plan" and SWPs to deal with poor quality water that has contacted sulfidic material exposures or waste dumps. This should include information regarding bunding requirements, water quality monitoring (including the action response and relevant corrective actions including treatment) and disposal or use.

5.8.2 Ensure that water management and storage practices do not cause offsite surface water impacts or groundwater quality degradation in down gradient aquifers.

5.8.3 Provide technical overview and support during planning for above-ground and in-pit sulfidic material waste disposal.

5.8.4 Ensure that routine sampling, visual inspection, and analysis is performed for in-pit locations, including:

- groundwater monitoring wells (surrounding BS dumps and pits;
- dewatering water; and
- surface water bodies (including temporary or permanent pit lakes within inactive open pits that contain BS exposures).

This should be consistent with the master monitoring schedule for the site.

5.9 WRE Mineral Waste Management Team

5.9.1 Provide site support for the management of mineral waste, as necessary. Facilitate the transfer of knowledge between RTIO sites and studies.

5.9.2 Undertake or update AMD Risk Assessments for significant changes to the pit shell or geochemical risks. Advice the site leadership and environment group for significant changes to risk.

5.9.3 Ensure the SCARD management plan is updated at least every 2 years. More frequent updates may be required for significant changes to risk or the knowledge base.

5.9.4 For pits that intersect the water table, ensure the following information is available which would contribute to a conceptual understanding:

- Catchment size;
- Depth to pre-mining water table;
- Current and ultimate pit depth;
- Available water storage within the entire ultimate pit and above the pre-mining water table in the pit;
- Predicted runoff volume for a 100 year storm event;
- Distance to closest down-gradient permanent surface water body; and
- Down-gradient water use.

Determine the geochemical risk of the pit. Update this report for any significant changes.

5.9.5 Geochemical, hydrogeology and hydrology modelling to determine contaminant release from the pit should be undertaken if the report (in Item 5.9.4) finds a significant geochemical risk (i.e. a significant amount of PAF material exposed on the pit wall, a significant amount of dewatering occurring over many years, a likely saline and flow through water body etc).

5.9.6 For PAF material waste dumps, compile a 'Conceptual Model' report for each site. This report should contain the following information for each waste dump on the site:

- Footprint;
- Up-gradient catchment area;
- Likely material types in the waste dump i.e., LIG, SID, CAL.
- Quantify the PAF tonnes and the total tonnes of material within each waste dump;
- Dumping methodology;
- Underlying and down-gradient geology;
- Distance to the closest regionally significant aquifer;
- Distance to closest down-gradient permanent surface water body;

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Requirements

- Down-gradient water use; and
- Closure/rehabilitation plans for the dump (or reference to the appropriate document).

5.9.7 Geochemical modelling to determine long term contaminant release from the waste dump should be undertaken if the 'Conceptual Model' finds a significant geochemical risk (i.e. a significant amount of PAF material within the waste dump or significant receptors nearby).

5.10 Environment

5.10.1 Perform field inspections to ensure sulfidic material management, dump construction, rehabilitation and store and release cover performance is consistent with the requirements of the SCARD Management Plan.

5.10.2 Undertake relevant ecological assessment (appropriate for the scale of the SCARD generation and predicted level of pollution/ecological impacts), develop and implementation appropriate risk reduction measures and monitoring programmes.

5.10.3 Ensure that routine sampling, visual inspection, and analysis is performed for out of pit locations that could potentially be impacted by AMD. This may include

- groundwater monitoring wells surrounding BS dumps and pits (if they can be accessed outside the pit)
- surface water bodies (including abandoned pit lakes, permanent or seasonal natural water bodies, dewatering discharge to creeks).

This should be consistent with the master monitoring schedule for the site.

5.10.4 Record sulfidic material environment risks in a site risk register and annually review/verify/validate these risks; verify that the ministerial conditions, legal and other requirements and obligations are met.

5.11 Rehabilitation and Closure

5.11.1 Ensure that the rehabilitation process is completed as outlined within the Progressive rehabilitation – process and responsibilities and Rehabilitation design and approval process documents.

5.11.2 In consultation with relevant stakeholders identify monitoring requirements (e.g. lysimeters) for waste dumps following rehabilitation.

5.11.3 Coordinate the review and approval of the design by relevant stakeholders including the mineral waste team to ensure compliance with this document.

5.11.4 Assess the risks that need to be managed as part of the rehabilitation process for BS dump designs, focussing on the SCARD risks and ensure that all key stakeholders are consulted.

5.12 Health and Safety

5.12.1 Monitor the occupational gas and dust exposures surrounding sulfidic material (and gas generation if appropriate for lignite material). Ensure problems are brought to the attention of the site Mineral Waste Management Team.

5.12.2 If spontaneous combustion is likely to occur, train occupational exposure groups on the correct use of respiratory equipment and monitors. Competency should be assessed and recorded in SAP.

5.12.3 Ensure health and safety guidance notes relating to spontaneous combustion gas generation and dust are developed, periodically refined and updated so it is consistent with the current best practice.

5.12.4 Record sulfidic material health and safety risks in a site risk register and annually review these risks.

5.13 Site Mineral Waste Management Team

5.13.1 A site based Mineral Waste Management Team should be formed and meet on a regular basis. It must include representatives of every Department that has responsibilities related to ARD management.

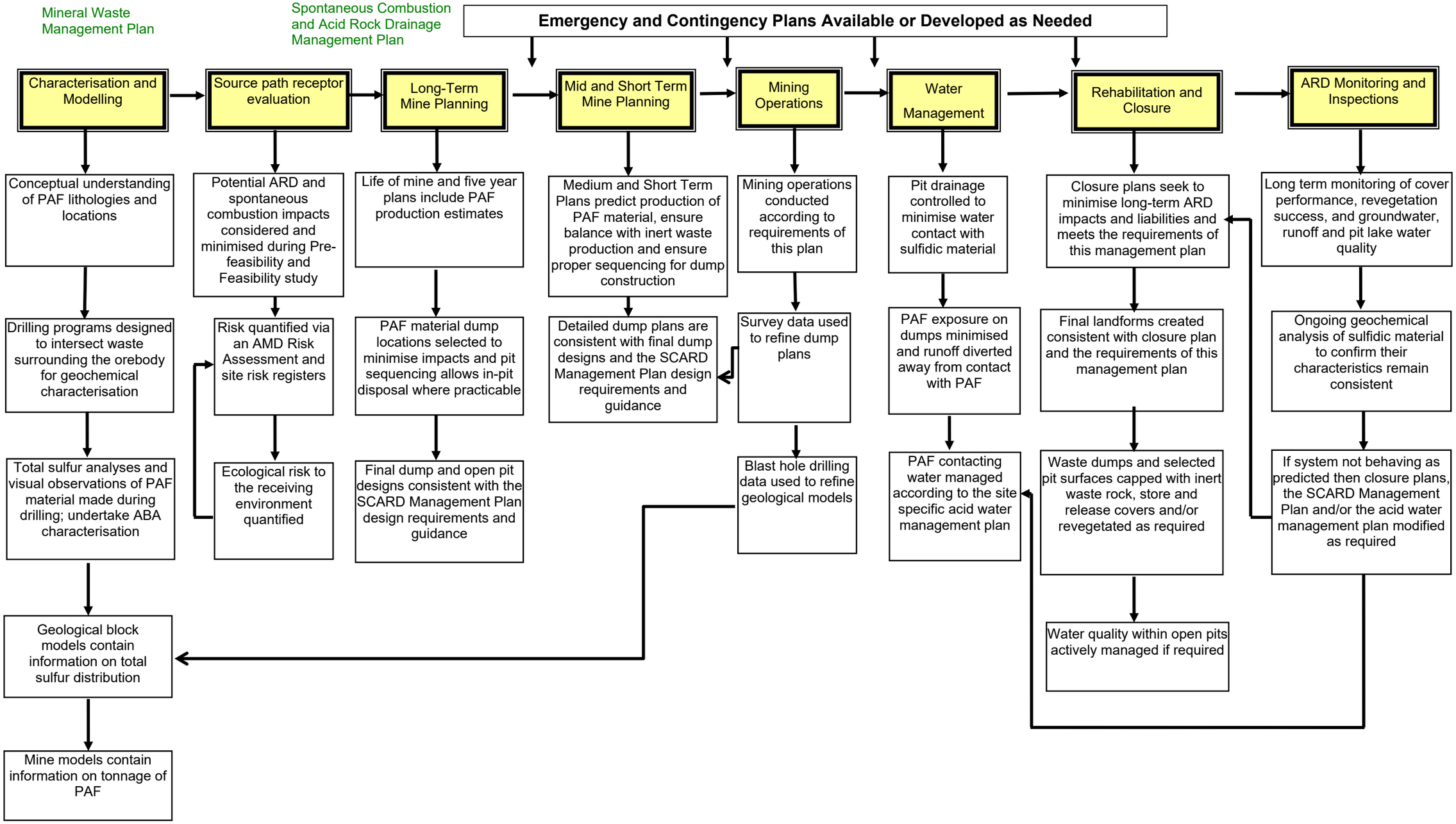
5.13.2 The primary function of the Mineral Waste Management Team is to ensure on-going improvement and implementation of the SCARD Management Plan.

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Requirements
5.13.3 Agenda items and meeting minutes should be produced for every meeting.
5.13.4 An overview of PAF issues must be included in any introductory training provided to new employees and contractors. Further training of those groups involved in the mining of PAF should be commensurate to the level of risk PAF material poses to the operation.
5.13.5 Develop site specific emergency and contingency plans related to spontaneous combustion, ARD and sulfidic material management on an as needs basis.
5.13.6 Coordinate a technical review of ARD management by an external expert every four years. Track progress against outstanding actions at each meeting.
5.13.7 Coordinate all research related to sulfidic material characterisation, management, spontaneous combustion and ARD.
5.13.8 Ensure that related SWPs and guidance notes represent current practise and are up to date.
5.13.9 Changes to the SCARD management plan need to be provided to the Water Resource Evaluation Mineral Waste Team to be included in future updates.
5.14 Management
5.14.1 Ensure progress is made against outstanding spontaneous combustion and AMD audit actions.

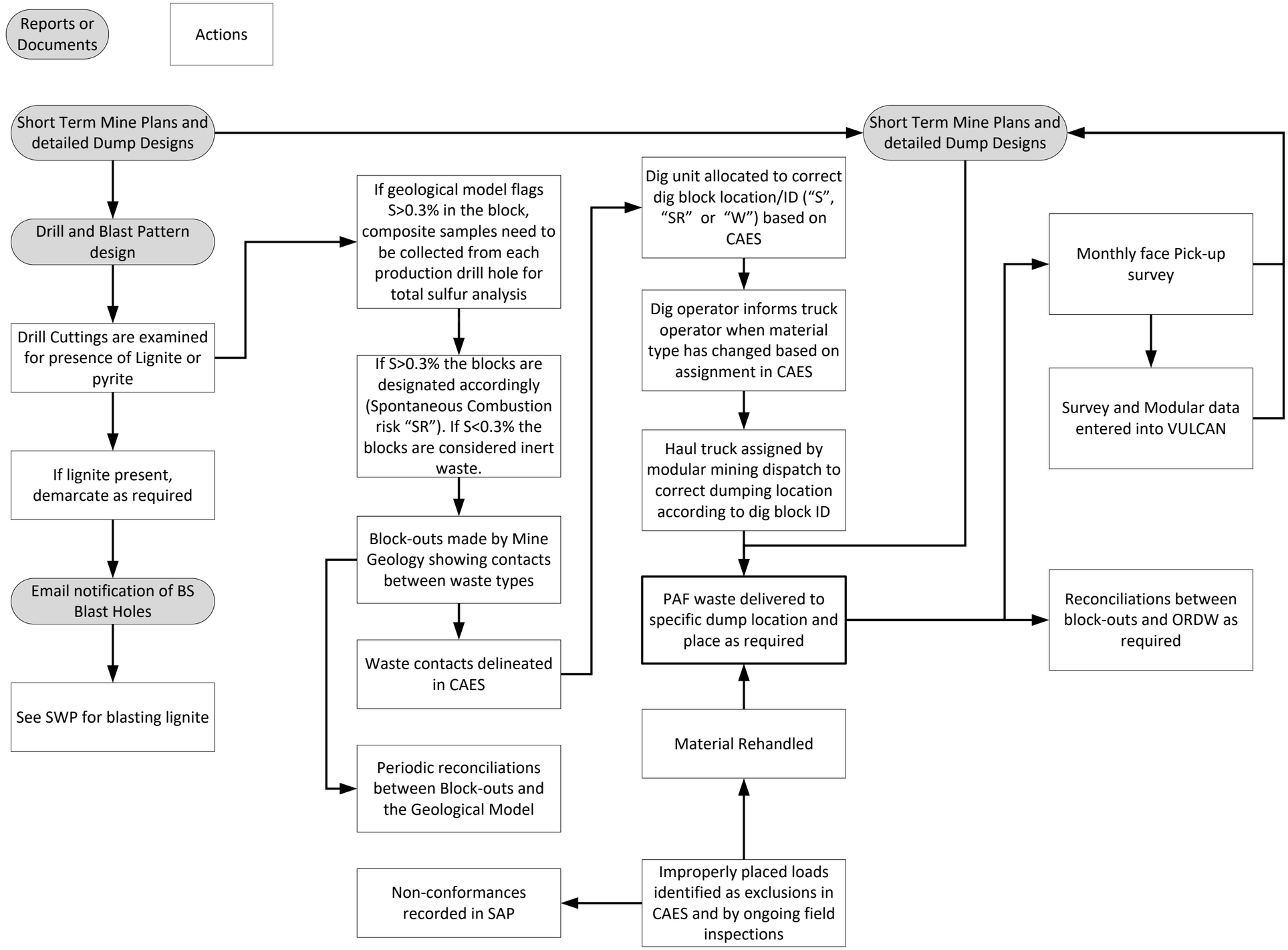
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Figure 3: Sulfidic material in BIF and detritals management during mining operations



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Figure 4: Sulfidic material in BIF and detritals management during mining operations



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6 Requirements, Accountabilities and References for Elevated Sulfur Material (including alunite)

It is expected that elevated sulfur presents an ARD risk but not a spontaneous combustion risk. This is based on the fact that the sulfur bearing mineral is sulfates rather than sulfides (AEISG, 2017).

Requirements	
6.1	**Mine Geology**
6.1.1	Identify from the geological model waste and low grade blocks estimated to contain elevated sulfur. Use these to create block-outs to show the contacts between elevated sulfur material and waste and low grade types within the blast patterns.
6.1.2	Collect (at least every five years) representative samples of elevated sulfur material for full ABA and NAG analysis. Ensure results are communicated to the relevant teams.
6.2	**Mine Technical Services - Planning**
6.2.1	Design elevated sulfur waste dump and low grade stockpiles such that the elevated sulfur material is not located within one metre of the outer surface at closure.
6.3	**Survey**
6.3.1	Monitor the construction of the dump such that elevated sulfur will not be located on the outer surface.
6.4	**Operational Planning**
6.4.1	Ensure material flagged as elevated sulfur is scheduled in CAES such that material is sent to the correct dump/stockpile.
6.5	**Load and Haul**
6.5.1	Ensure that elevated sulfur material is delivered to the correct location as assigned by mine geology.
6.5.2	Ensure that elevated sulfur material is dumped (where possible) from a tip head to ensure blending with inert material. If this is not achievable then paddock dumping will be satisfactory.
6.6	**Hydrogeology**
6.6.1	Ensure background water quality is established from water bores surrounding dumps and stockpiles where elevated sulfur material is stored. Undertake analysis of monitoring bores as required during dump construction and at closure.

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Appendices

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Appendix 1 Dump Specifications for Black Shale and Elevated Sulfur Material

Management of sulfates or sulfides within black shale, BIF or detritals needs to be considered during all phases of waste rock dump design, from initial selection of dump locations during the long-term planning process (five year and longer time horizon) to the detailed dump designs generated during short term planning (time horizon less than a year). The Waste Dump Design Checklist is to be filled in for all new waste dump designs to help ensure environmental issues are adequately considered.

A1.1 Selection of Dump Locations

When designing new PAF material dumps, the dump location and footprint should be selected to minimise potential long term environmental impacts and financial liabilities. Selection and design criteria that must be considered include:

- Under no circumstances should PAF material be used for works such as windrows, construction fill, ramps, fantails, roads or any other use that would disperse the material over a broad area in an uncontrolled manner.
- The PAF dump location should not receive runoff from surrounding areas. In particular waste dumps must not be sited in established drainages with significant upstream catchments.
- In pit disposal should be considered a priority instead of the construction of above ground waste rock dumps. However, hydrogeology investigations are required to evaluate water recovery levels and timeframes, and connection of the void to receptors.
- Placement of PAF material within pits that already contain PAF wall exposures is preferable to placement in pits that do not have these exposed on the pit walls.
- PAF dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom Formation.
- PAF dumps should not be placed over ore grade or near ore grade CID or BIF-derived deposits. These not only have potential economic value, but may act as significant local aquifers.
- PAF dumps should not be placed over, adjacent to, or where there is a connection to significant seeps or springs.
- Avoid siting new PAF dumps in catchment basins that do not already contain PAF material.
- The number of sites containing PAF material and the footprint of these dumps should be kept to a minimum.
- PAF dumps should be located near sources of clean waste rock for encapsulation.
- Background groundwater quality surrounding the dump location must be measured before any material is dumped. This will require the installation of groundwater monitoring bores. These bores will be used to provide a temporal record of groundwater quality in the vicinity of the dump.

A1.2 In-Pit Disposal Requirements

In pit disposal of PAF material is generally more secure than disposal in above ground waste rock dumps. Where practicable, in pit disposal should be considered the preferred disposal alternative because it:

- Reduces the risk of erosion exposing PAF material in the long term;
- Inhibits convective oxygen transport because the waste is surrounded by relatively impermeable rock walls;

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- Reduces the footprint of the waste disposal facilities;
- Reduces the volume of inert or net neutralising waste needed to encapsulate the PAF material; and
- May help to prevent the formation of acidic or hyper-saline pit lakes if the pit can be filled to above the post-mining water table.

Note that in some pits it may be possible to place PAF material both above and below the water table with a minimum 10 metre thick inert waste layer placed against the predicted mean post-mining water table. If PAF material is placed BWT, hydrogeology investigations are required to determine the water recovery level, rate of recovery and if there are any connections to receptors.

A4.2.1 In Pit Disposal Below the Water Table

If PAF material is placed below the post-mining water table, it will become permanently flooded which will control subsequent oxidation and acid release. In the long term, placement below the water table is the most secure and low risk disposal option. It is particularly beneficial for hot black shale because it removes the long-term risk of spontaneous combustion. If a pit can be backfilled so that the fill elevation is above the pre-mining water table level, it is possible that the water table will eventually rebound to or near the pre-mining elevation. If the pit is only partially backfilled to below the pre-mining water table, it is likely that a shallow intermittent, seasonal or permanent pit lake will form on top of the fill material.

Elevated sulfur material (i.e., containing sulfate minerals such as alunite or jarosite) should not be placed below the post-mining water table as the release of acid is controlled by the dissolution of the minerals and is not a kinetic controlled reaction as is the case for sulfidic PAF materials.

For sulfidic PAF material placed below the post-mining water table the following minimum design criteria apply:

- For pits backfilled above the predicted post-mining water table, the top of the PAF material backfill must be at least 5 metres below the mean predicted post-mining water table (Figure 19).

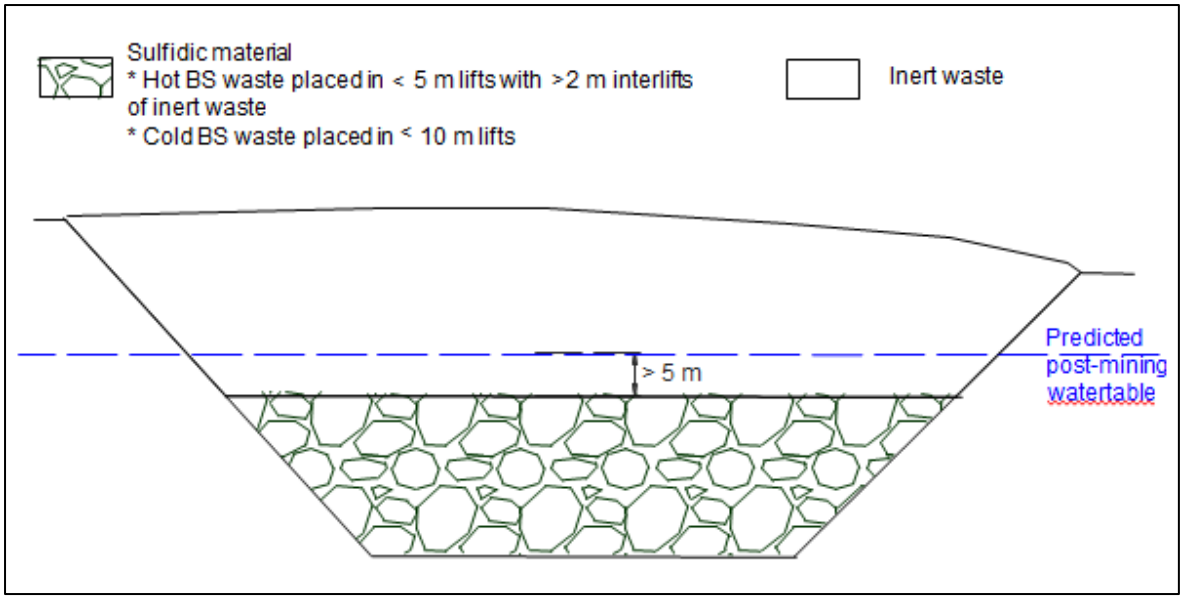


Figure 5: Example of PAF material placed BWT and with the pit completely backfilled.

- For pits that are only partially backfilled to below the pre-mining water table, the top of the PAF material backfill must be at least 5 metres below the estimated mean pre-mining water table and at least 5 metres below the predicted post-backfilling water table (Figure 20). In this situation it can generally be assumed that the mean post-mining water table will be at the top of the backfill. Thus, the PAF waste will be covered by at least 5 metres of inert waste.

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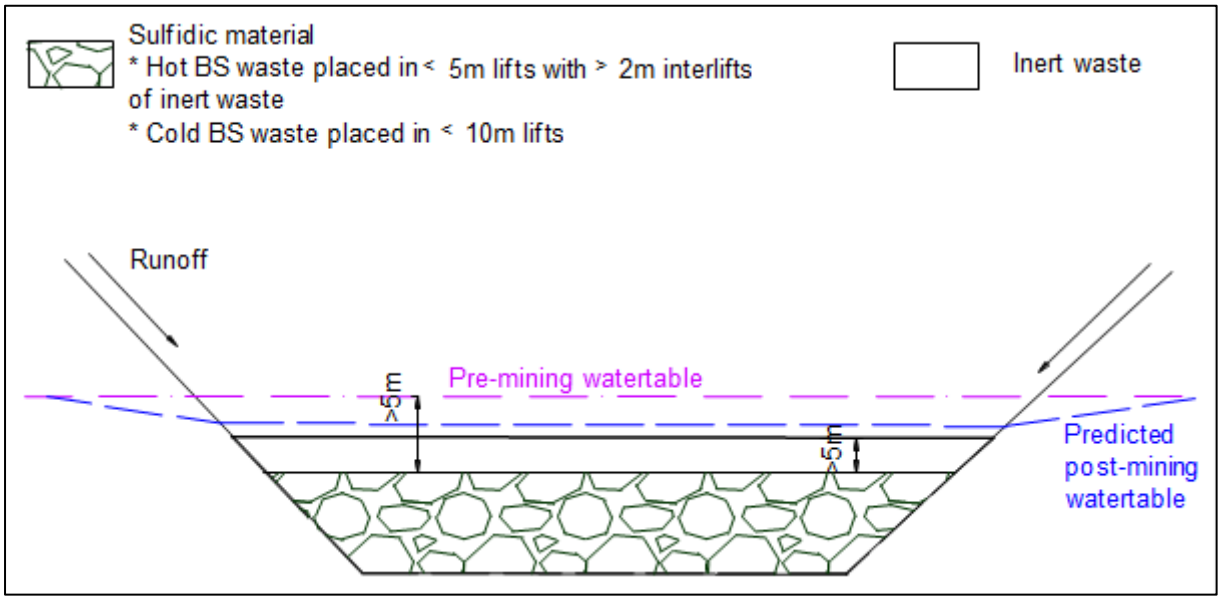


Figure 6: Example of PAF material placed below the water table and with the pit partially backfilled.

- The thickness of each hot black shale material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each hot black shale layer.
- The thickness of each cold black shale material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between cold black shale lifts.
- The uppermost lift of both cold and hot black shale material must be covered with a minimum 5 metre layer of inert or net neutralising waste rock.
- Each lift must be placed so that it ties into the pit walls on all sides to minimise the risk of convective oxygen transport until the waste is flooded.
- If backfilled to above the post-mining water table, the upper inert waste rock surface must be revegetated.
- A store and release cover is not needed if all PAF material in a pit is placed below the water table.

In addition to the minimum design requirements listed above, the optimum design for in-pit disposal below the water table also includes:

- Enough inert or net neutralising backfill should be placed on top of the PAF waste to raise the fill level to at least above the post-mining water table (preventing the formation of a pit lake) and preferably above the pit walls so that runoff is not directed into the pit fill (see Figure 19).
- If required, flooding of the backfilled pit should be enhanced by diverting surface water flows into the pit or directing dewatering water from active open pits into the backfilled pit. The more rapidly the waste can be inundated, the less pyrite will ultimately oxidise. Rapid flooding will minimise the build-up of soluble sulfide oxidation products in the material. As long as geotechnical safety requirements are met, construction of waste lifts into standing water on the pit floor is acceptable. Figure 21 demonstrates that less than 50% of the sulfidic material oxidises if the water table is recovered within 100 years and less than 15% oxidises if the water table is recovered in 30 years. This may differ from site to site, however this example clearly demonstrates the advantage of BWT PAF storage and rapid water recovery.

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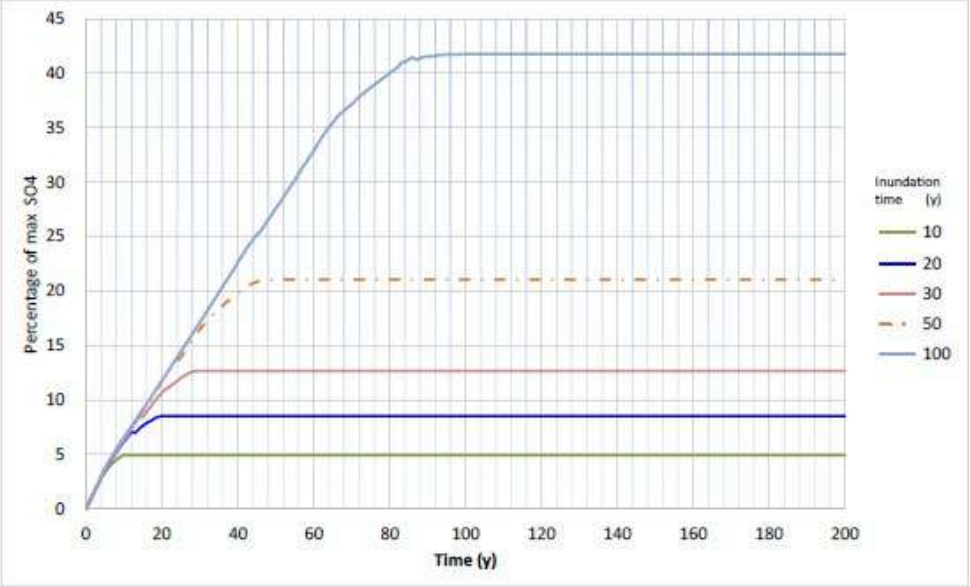


Figure 7: An example of modelling the effects of different inundation time on sulfate generation.

A4.2.2 In Pit Disposal Above the Water Table

If PAF material is placed above the post-mining water table, it must be ensured that long-term variations in the water table elevation do not allow water to rise into the overlying PAF material. Intermittent contact with infiltrating water from above must also be minimised. For PAF material placed above the post-mining water table the following minimum design criteria apply:

- The base of the PAF material backfill must be at least 5 metres above the predicted mean post-mining water table.
- At least 5 metres of inert or net neutralising waste rock must be placed at the base of the open pit before PAF backfill is placed. The most likely location for a perched water table to form is at the base of the backfilled pit because of the permeability contrast between the bedrock and the backfill.
- The thickness of each hot black shale material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each hot black shale layer.
- The thickness of each cold black shale material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between cold black shale material lifts.
- The uppermost lift of both cold and hot black shale material must be covered with a minimum 2 metre layer of inert or net neutralising waste rock. This will prevent runoff water from contacting the underlying PAF material until the store and release cover can be constructed.
- If the pit can be completely backfilled so that no high walls are exposed above the inert waste rock fill, then each inert, cold and hot black shale material layer should tie into the pit walls on all sides to minimise the risk of convective oxygen transport (see Figure 22 and Figure 23 for examples).

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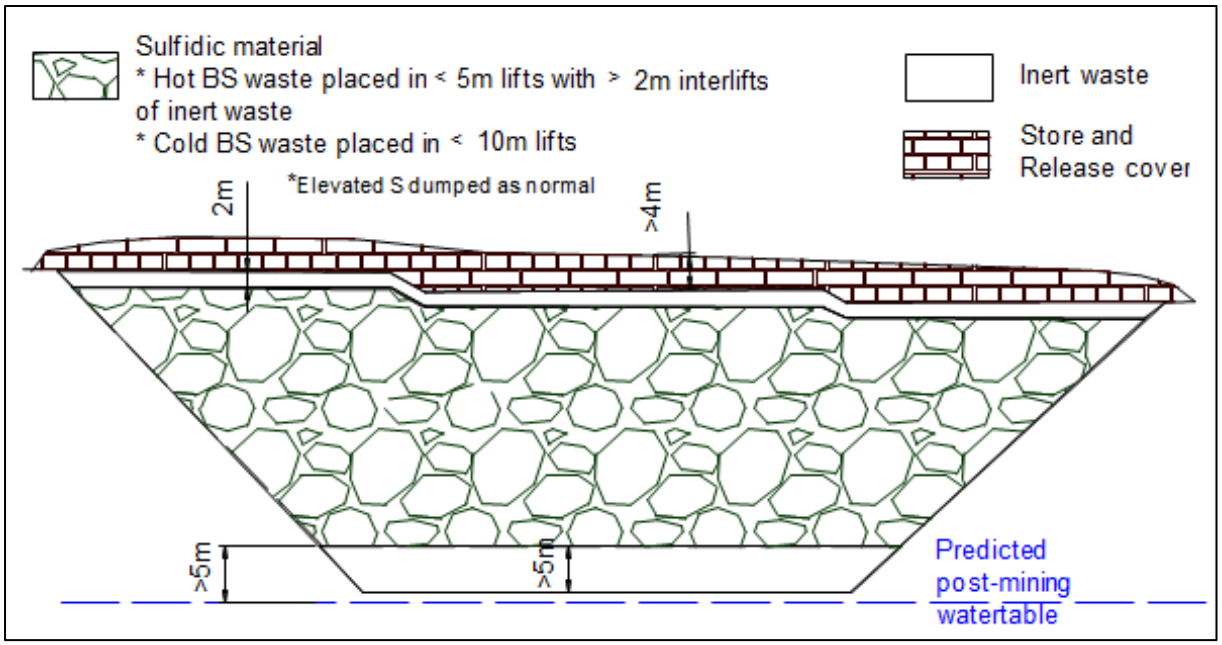


Figure 8: Example of PAF material placed in a dry pit that is completely backfilled.

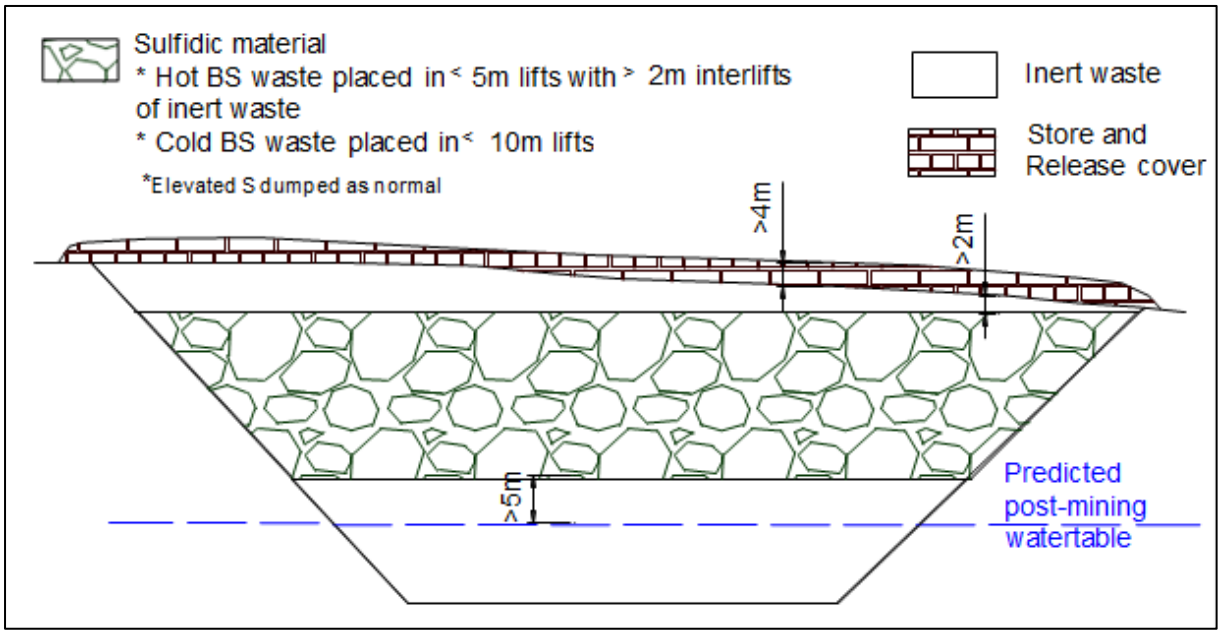


Figure 9: Example of PAF material placed above the water table and with the pit completely backfilled.

- If the pit will only be partially backfilled so that highwalls are exposed above the final backfill surface and that the runoff from the remaining highwalls will flow towards the backfill, a minimum five metre (measured both horizontally and vertically) buffer of inert waste rock must be placed between the pit walls and each PAF material lift where possible (see Figure 23 for an example). A 2 metre high by 5 metre wide abandonment bund will also need to be placed adjacent to the exposed high walls to prevent run on water from infiltrating into the cover over the PAF material.

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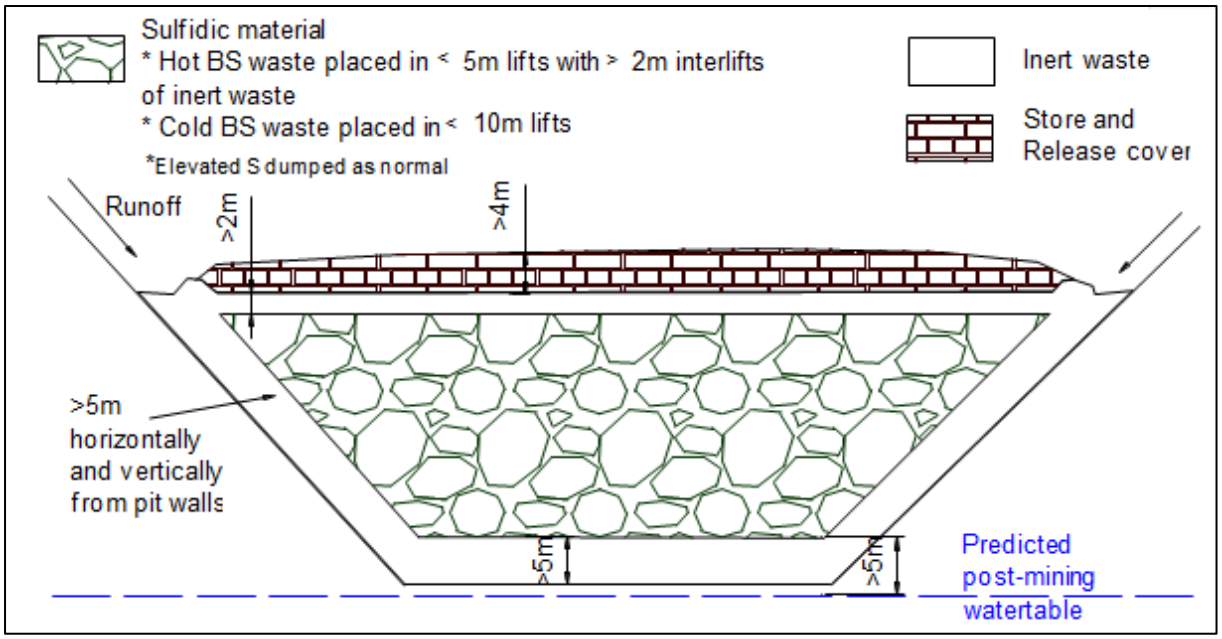


Figure 10: Example of PAF material placed above the water table and with the pit partially backfilled.

In addition to the minimum design requirements listed above, the optimum design for in-pit disposal above the water table also includes:

- If possible, the pit should be backfilled above the lowest point on the pits walls so that the final backfill surface can be sloped to allow runoff water to flow out of the pit footprint.
- The optimum design would be to backfill the pit so that there are no highwalls exposed that could direct runoff onto the store and release cover and underlying PAF material (see Figure 22 and Figure 23).

A1.3 Above Ground Disposal Requirements

If PAF material waste rock dumps are to be constructed on top of the original ground surface, more stringent design criteria are required than for in-pit disposal because of the risk of erosion exposing encapsulated PAF material and because of the likelihood of the convective transport of oxygen through the side slopes of the dump. Design criteria for hot black shale dumps are also more stringent than for cold black shale dumps and elevated-sulfur dumps.

A1.3.1 *Design of Outer Waste Rock Dump Slopes*

To the extent possible, cold and hot black shale material should be excluded from beneath final waste rock dump slopes. There are several issues associated with the placement of cold and hot black shale beneath waste rock dump slopes:

- There is an increased risk of slope erosion damaging vegetation and covers in the short term, or in the long term exposing the underlying material.
- The probability of convective oxygen transport to the sulfidic material is higher than for cold and hot black shale material only placed in the dump interior.
- Store and release covers cannot be built on slopes because they are constructed with more erodible fine-grained materials. It is likely that infiltration rates into the underlying cold and hot black shale material will be higher on slopes than on flat surfaces with a store and release cover, which could result in increased AMD.

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- Uncertainties with the requirements for final dump slopes may require the importation of additional inert material to achieve the final landform design to ensure the preservation of the minimum 5 metres of inert cover over the sulfidic material.
- The berm and batter design of final slopes would direct water through the slopes and into the underlying PAF material.

The minimum design criteria in the following section reduce but do not completely mitigate these risks. **For this reason, hot black shale should not be placed under final slopes, and the volume of cold black shale should be minimised wherever possible**[1]**.** The greatest benefit can be derived from excluding hot black shale material from beneath the slopes because it not only has the potential to spontaneously combust, but also has anywhere from 2 to 70 times more acid producing potential on average than the cold black shale material.

A1.3.2 *Hot Black Shale*

Figure 25 shows the optimum design for the waste rock dumps in which hot black shale is completely excluded from beneath the footprint of the final recontoured slope.

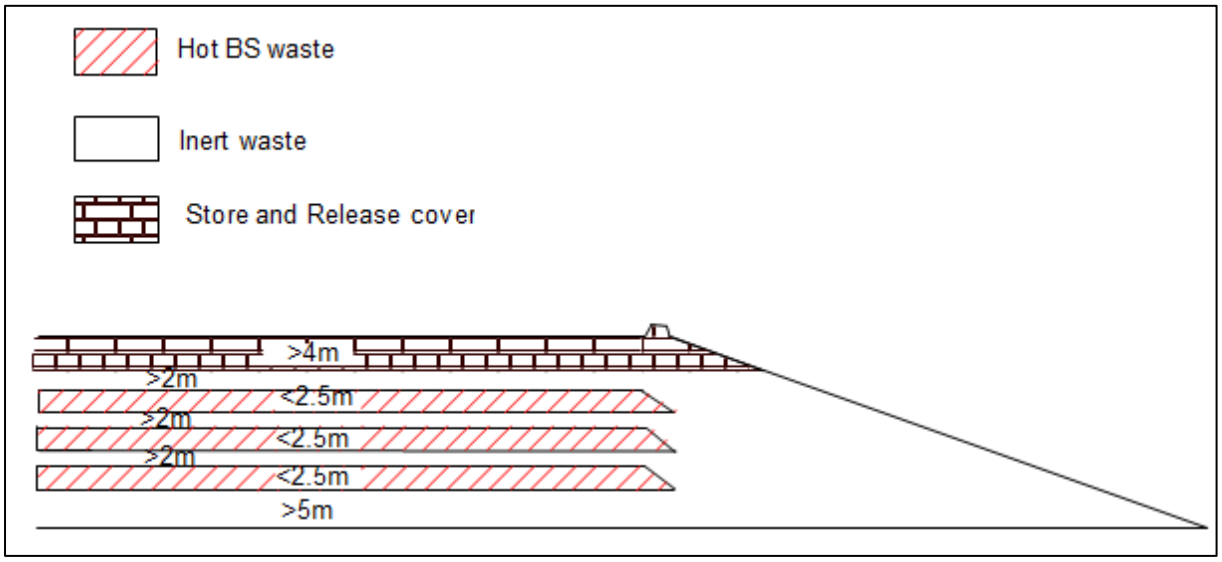


Figure 11: Example of the design for hot black shale dumps.

The minimum design criteria for hot black shale dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- Enough inert waste rock must be placed against hillsides so that PAF material is not located within 5 metres of the hillside as measured both vertically and horizontally.
- The thickness of each hot black shale material lift must not exceed 2.5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock. Lifts are to be constructed by paddock dumping (or reverse paddock dumping and pushing out) so that the hot black shale can cool and so that incident vehicle traffic helps create a compacted layer every 2 to 2.5 metres to inhibit water movement and convective oxygen transport.
- Enough inert or net neutralising waste rock must be placed on the outer skin of the hot black shale waste rock dump so that no hot black shale material is located under the final slopes.[2]

[1] Effective from the 2016 SCARD update. Earlier designs and dumps can still contain hot black shale under slopes.

[2] Effective from the 2016 SCARD update. Dumps designed and built prior to 2016 can continue to dump hot black shale under slopes, however it must be located > 5 metres (measured across the shortest distance) from the final dump slope.

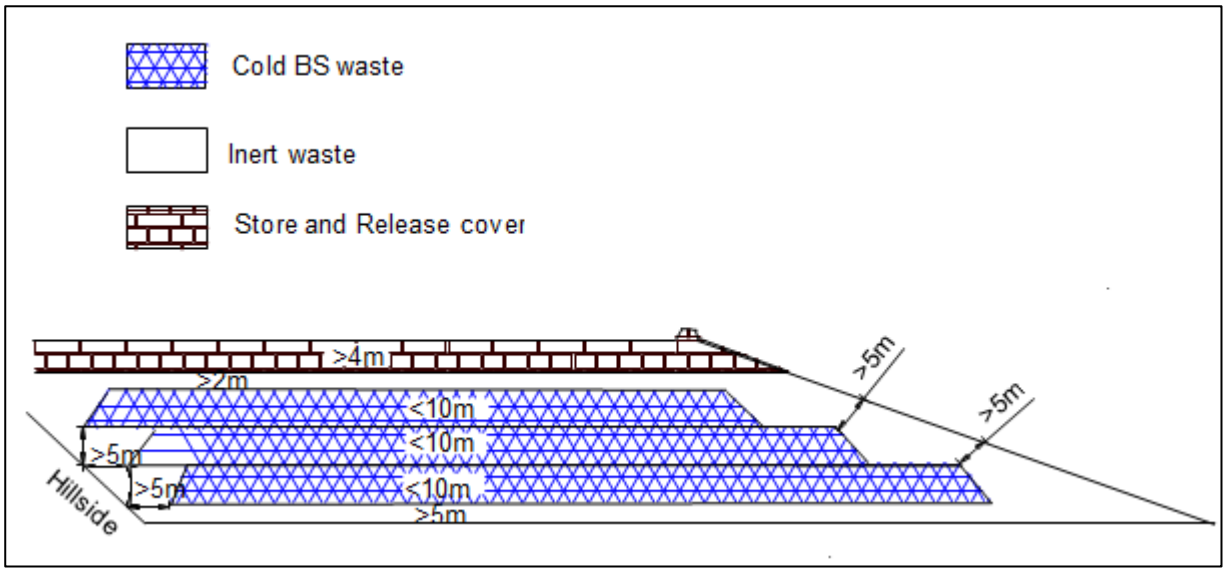
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- Hot black shale may be mixed with Elevated S material in dumps, however elevated sulfur material should not be used on the outer slopes.
- The final lift on a hot black shale waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying PAF material until the minimum 4 metre-thick store and release cover can be constructed.
- During construction and at closure, the upper dump surface of the hot black shale waste dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

A1.3.3 *Cold Black Shale*

An example of a cold black shale waste rock dump constructed according to the minimum dump design criteria is shown in Figure 26. The minimum design criteria for cold black shale dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- Enough inert waste rock must be placed against hillsides so that cold black shale is not located within 5 metres of the hillside as measured both vertically or horizontally.
- The thickness of each lift of cold black shale must not exceed 10 metres. This will create a vehicle compacted layer every 10 metres in the dump to inhibit water movement and convective oxygen transport[3].
- No inert or net neutralising waste rock layer is needed between cold black shale lifts.
- Enough inert or net neutralising waste rock must be placed on the outer skin of the cold black shale waste rock dump so that no material is located within 5 metres of the final dump surface after the slope has been re-contoured at closure.
- The final lift on a cold black shale waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying material until the minimum 4 metre-thick store and release cover can be constructed.
- During construction and at closure, the upper dump surface of the cold black shale dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.



[3] Note that this has been changed from 5 m lifts as the gas movement through waste dumps has been shown during ANSTO testing to be diffusive and it is likely that the difference in ARD generation between 10 and 5 m lifts will be negligible.

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Figure 12: Example of the minimum design criteria for cold black shale dumps.

A1.3.4 *Elevated S*

An example of an Elevated S waste rock dump constructed according to the minimum dump design criteria is shown in Figure 27. The minimum design criteria for elevated-sulfur dumps are:

- Inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- At least one (1) metre of inert material is located on the outer surface of the waste dump at closure.
- Elevated-sulfur material can be mixed with inert material and dumped accordingly.
- Co-disposal of elevated-sulfur waste with materials containing excess available neutralising capacity is recommended.
- During construction and at closure, the upper dump surface of the elevated-sulfur dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

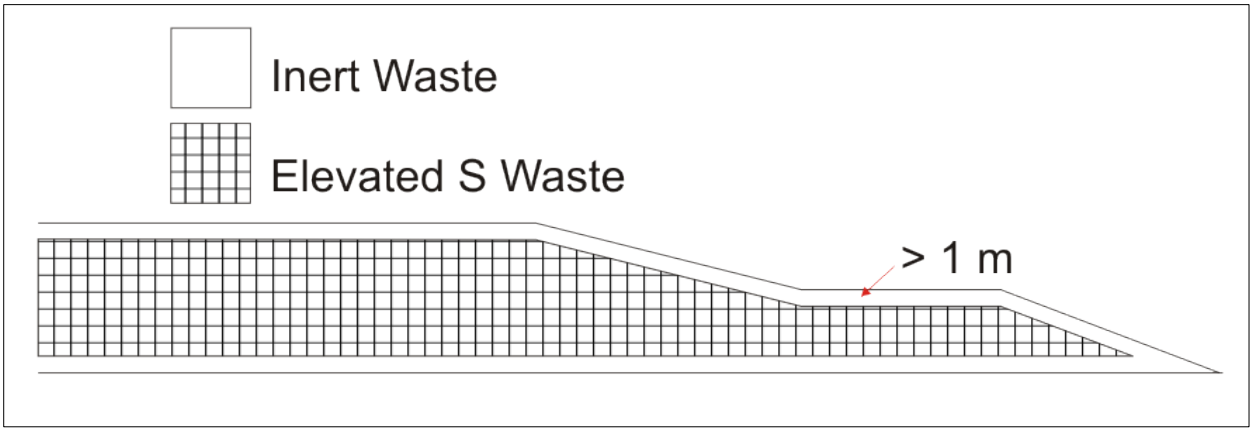


Figure 13: Example of the minimum design criteria for Elevated S dumps. No store and release cover is required and only 1 metre inert material cover at surface required.

A1.3.5 *Composite Designs*

Figure 28 shows an example of a composite hot and cold black shale dump in which hot black shale is excluded from the beneath the slope and cold black shale is placed below the slope. Composite dumps of this kind may significantly reduce the residual risk associated with the dump slopes without significantly reducing the total storage capacity for sulfidic material within the dump. There must be at least a one metre buffer (measured horizontally or vertically) between the hot and cold black shale material where they are in close contact on the outer slopes of the hot black shale repository.

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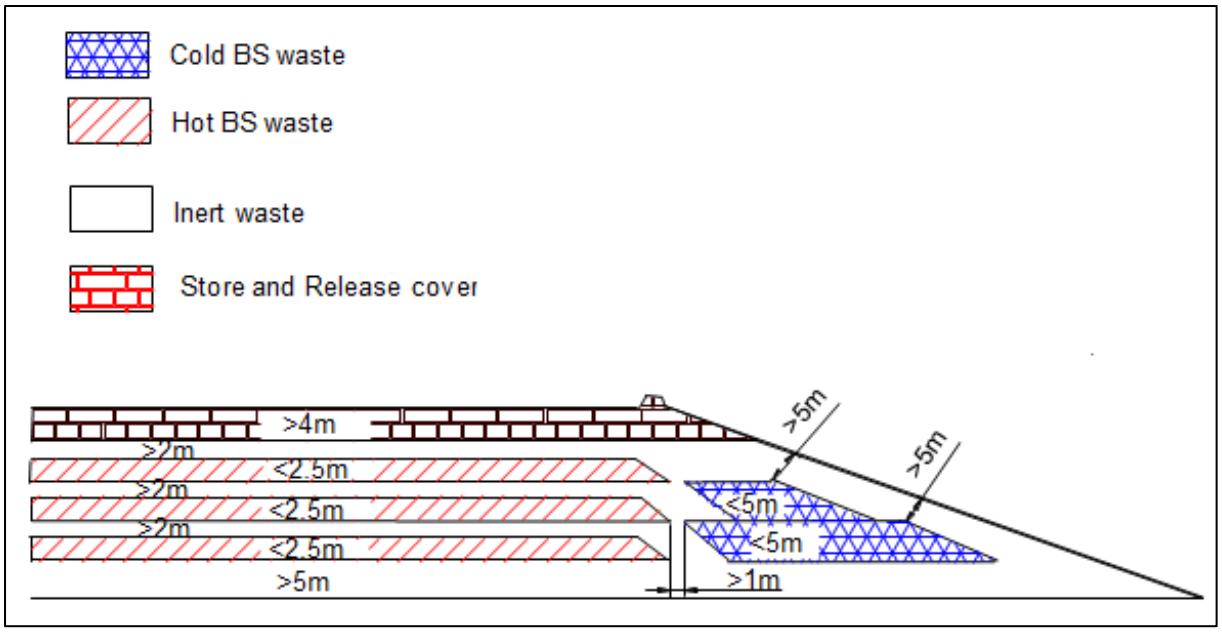


Figure 14: Example of optimum composite designs for cold and hot black shale dumps.

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Appendix 2 Dump Designs for Material with Neutralising Potential

A2.3 Dumping Scenarios

The following dump designs were developed specifically for cases where neutralising material is available. Calcrete is the preferred net neutralising material, however if calcrete is not available then dolomite from the Wittenoom Formation can be used as net neutralising waste. Please note that only the dolomite within the Wittenoom Formation has sufficient neutralising material and it is not mapped separately within geological models and could be difficult to source.

A2.3.1 *Above Ground Disposal Requirements*

An example of the minimum dump design criteria is shown in Figure 29.

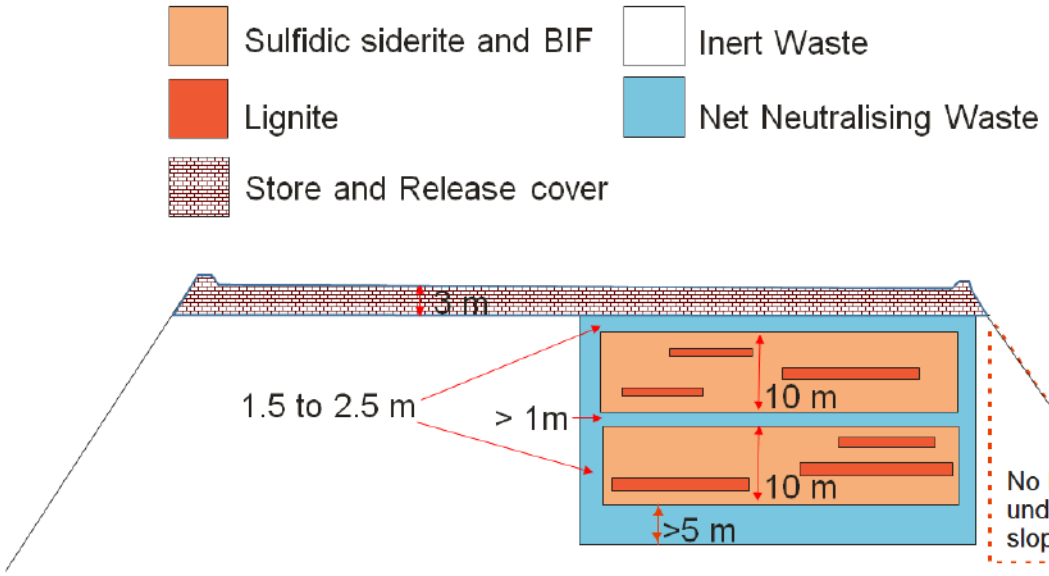


Figure 15: Example of minimum design for a combined sulfidic BIF and siderite with lignite dump – Permanent storage

The minimum design criteria for AWT PAF dumps are:

- No PAF material is to be placed under the final rehabilitation slopes of the waste dump.
- Minimum of 5 metre of net neutralising waste rock must be placed as a basal layer prior to PAF placement within the dump. This material can be end tipped. This basal layer can be reduced in thickness to 2.5m, if the PAF cell is located higher in the waste dump. The mineral waste team should assess this.
- A 1.5 – 2.5 metre layer of net neutralising waste should be placed at the top, sides and base of each PAF lift i.e. a net neutralising waste bund should be created prior to PAF placement. This will reduce the lateral flow of incident rainfall.
- If spontaneous combustion is a risk, the thickness of each lignite material lift must not exceed 2.5 metre followed by a 1.5 to 2.5 metre lift of net neutralising waste rock. Lifts are to be constructed by paddock dumping so that lignite material can cool and so that incident vehicle traffic helps create a compacted layer every 1.5 to 2.5 metres to inhibit water movement and convective oxygen transport.
- The thickness of each lift of sulfidic BIF and siderite material must not exceed 10 metre. A 1.5 – 2.5 metre paddock dumped layer of net neutralising waste should then be placed on top of the PAF lift.

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- The 10 metre PAF layer should be paddock dumped in a number of small lifts to limit the risk of material segregation and tightly compact the waste dump to prevent oxygen ingress i.e. 4 x 2.5 metre thick PAF layers. The dumping of PAF material during the wet season should be avoided, where possible.
- The final lift on the PAF waste rock dump must be composed of a minimum 1.5-2.5 metre thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 3 metre thick store and release cover can be constructed.
- Only incident rainfall and no run-on from adjacent areas should pass through the dump.
- If there is insufficient PAF to create the 10 metre lift, the >1 metre net neutralising waste layer can be constructed at <10 metre.
- If spontaneous combustion is a risk, lignite material should be covered with net neutralising material within 1 month during the wet season (due to the spontaneous combustion risk). Where possible, the sulfidic BIF and sulfidic siderite material should be covered with net neutralising waste during the wet season.
- If PAF is temporarily stored within a waste dump, the previous criteria still applies, however PAF can be stored underneath the final slopes, as long as there is a 10 metre offset (consisting of calcrete closest to the PAF and inert waste) (Figure 30). If PAF is placed on 30m of inert material, it would need to be rehandled within 20 years. If there is a delay in rehandling then the placement of a temporary cover on the dump should be considered.

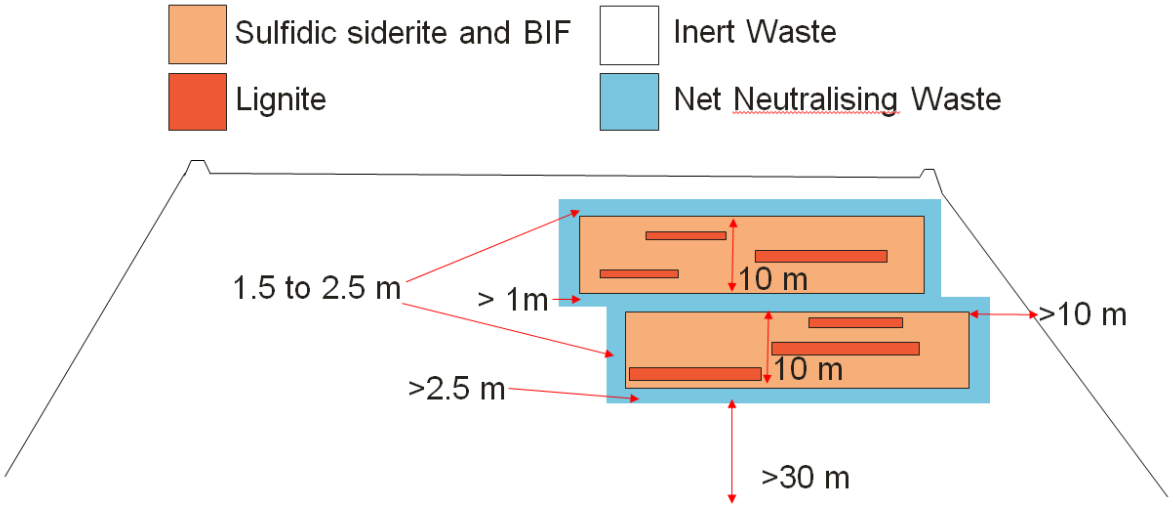


Figure 16: Example of minimum design for a combined sulfidic BIF and siderite with lignite – Temporary storage

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Appendix 3 Rehabilitation and Closure

A3.1 Final Landforms

To reduce the risk of erosion and to minimise infiltration, final landforms should be designed in accordance with the following criteria:

- Final landform design should be designed in accordance with the Rio Tinto Iron Ore (WA) Landform Design Guidelines.
- Final landforms must be designed so that runoff is not directed onto surfaces that are underlain by sulfidic material.
- A back-sloping crest bund must be placed around the top of each dump slope and berm. This will prevent runoff water flowing from the dump surface over the slopes and causing erosion.
- If PAF material is exposed during the re-contouring of waste rock dumps that were created before waste rock segregation was practiced, it must be covered with at least 2 metres of inert waste rock. This will help ensure that the entire final dump surface is able to support vegetation.
- Wrapping the PAF dump is preferred rather than dozing down the slope.

A3.2 Store and Release Covers

A3.2.1 *Design*

Store and release covers must be constructed on all flat surfaces over PAF waste dump repositories and over some sulfide/black shale exposures within open pits. Store and release covers are designed to limit infiltration into the underlying waste rock by maximising the evapo-transpiration of incident rain water. The cover is designed to store water near the surface during the wet season so that it can be removed from the cover material and returned to the atmosphere during the dry season by evaporation and plant transpiration.

Waste rock that is used to construct store and release covers must contain sufficient fine-grained material to have both a high moisture retention capacity and a relatively low permeability (i.e. large boulders should not be placed on the cover). Waste rock composed of well-graded clayey, silty, sandy gravel or clayey silty gravely sand makes the best store and release cover material. As a rough guide, waste rock containing more than 1/3 coarse sand size and finer particles (< 5 mm) will make a suitable cover material. **Blocky BIF composed of gravel with very little silt, sand or clay is not ideal** for use in cover construction and should be avoided if another more suitable waste type is available (Figure 31).

Where possible, 4 metres of oxidised shale should be used in preference to 4 metres of BIF on flat top covers. If detrital material is available, then a cover constructed out of 4 metres of detrital material overlying 2 metres of oxidised shale has been shown to reduce net percolation and salt uptake. Topsoil should be preferentially placed on covers as the vegetation can significantly reduce the amount of net percolation through the cover. If the cover will be less than 6 metres thick then advice should be sought from the mineral waste management team. For guidance on the covers on slopes please see the Rio Tinto Iron Ore (WA) Landform Design Guidelines.

A3.2.2 *Construction*

During construction there should be regular quality control checks to ensure large boulders have not been placed into the cover.

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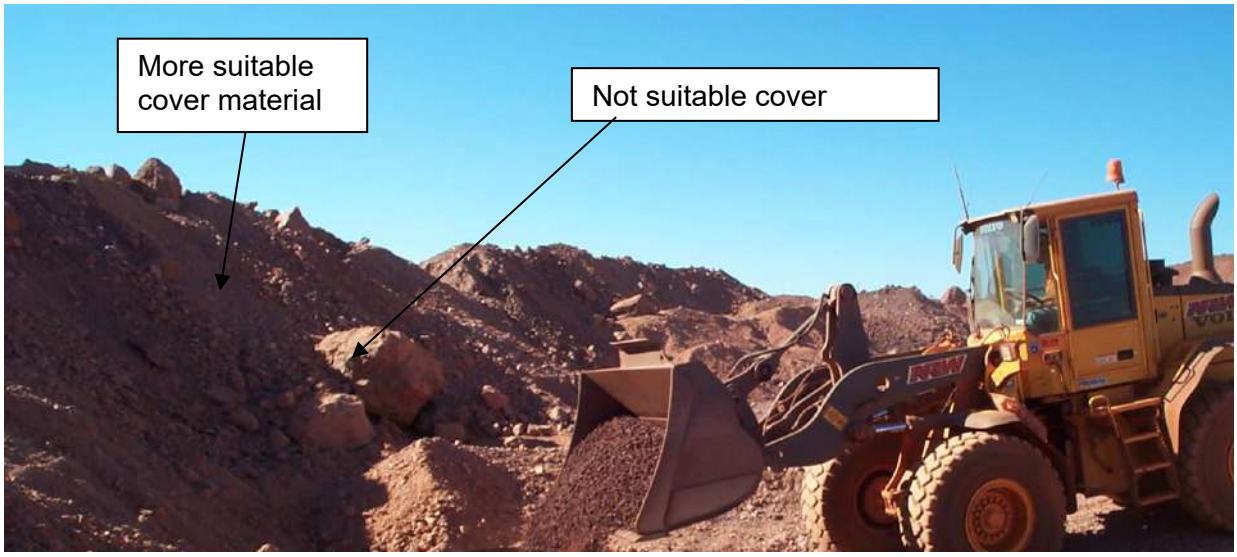


Figure 17: An example of suitable and not suitable material to be used in the construction of a store and release cover.

Waste rock that is used to construct store and release covers must also be able to support vegetation, so materials with high salinity, and acidic or very basic pH should be avoided. The waste rock should be placed in a manner that minimises segregation of the material into coarse and fine particles. For this reason covers should be paddock dumped, they should never be constructed by dumping in four metre lifts.

Store and release covers should be constructed as follows (Figure 32):

- Paddock-dump store and release cover material on top of a vehicle compacted surface so that the average depth of the cover material is greater than 2 metres.
- A dozer should then be used to knock down the crest of each paddock dump pile and to fill in the depressions between piles to create a trafficable surface.
- Paddock-dump a second layer of store and release cover material on top of the first lift so that the average depth of the second lift is greater than 2 metres. Vehicle traffic during this dumping will create a compacted layer on top of the first store and release cover layer.
- A dozer should again knock down the crest of each paddock dump pile in the second layer and fill in the depressions between piles to create a surface that is nearly planar.
- Topsoil should be placed on top of the second store and release cover layer. The surface should then be ripped and seeded. Ripping needs to be deep enough (> 0.3 metres) to mix in the topsoil and to ensure that there are not compacted zones that could inhibit plant growth and rooting on top of the upper layer.

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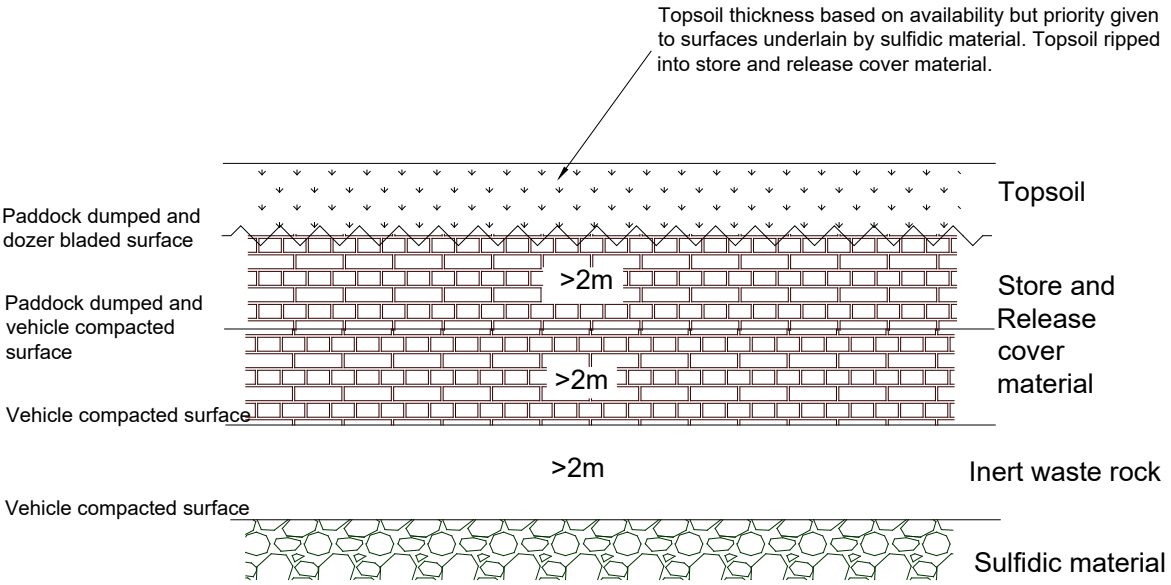


Figure 18: Detail of store and release cover design.

A3.3 Topsoil Management

Topsoil placement can greatly accelerate the establishment of native vegetation on waste rock surfaces. This in turn will help to maximise evapo-transpiration, minimise infiltration into the underlying waste rock and inhibit erosion on dump slopes. If topsoil resources are limited, the most benefit for ARD management can be gained by preferentially utilising topsoil for the revegetation of waste rock dumps that contain sulfidic material. In decreasing order of importance, topsoil should be placed on:

1. Dump slopes underlain by hot black shale/lignites material;

2. Dump slopes underlain by cold black shale/sulfidic BIF/sulfidic siderite material;

3. Flat store and release cover dump surfaces underlain by hot black shale/lignites material;

4. Flat store and release cover dump surfaces underlain by cold black shale/sulfidic BIF/sulfidic siderite material;

5. Store and release covers within open pits;

6. Waste rock dumps that were created before waste rock segregation was practiced and which may contain dispersed black shale or material containing sulfides;

7. Assessable inert waste rock surfaces within pits that contain black shale or sulfidic material exposures; and

8. Waste rock dumps that do not contain any black shale or sulfidic material.

For further information on topsoil management refer to the RTIO Soil Resource Management Work Practice.

A3.4 Open Pit Closure

The geology and hydrogeology of an open pit will largely control the potential closure issues associated with the final void. Open pits that are located above the water table and which do not contain any black shale or sulfidic material exposures should not pose any geochemical risks at closure. Open pits that intersect the water table but do not contain any black shale or sulfidic

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material exposures may ultimately contain saline water bodies with neutral pH that could impact down gradient groundwater. Open pits that contain black shale or sulfidic material exposures will likely contain ephemeral or permanent acidic and potentially saline water bodies that could impact down gradient groundwater and could represent a direct exposure risk to wildlife or humans.

Hypersaline pit lakes may be considered acceptable on relinquishment as long as down-gradient beneficial use is not impacted. Further consultation with stakeholders would be required for specific locations. Mitigation measures will likely be required if net acid generating materials such as pyritic black shale are exposed on the final pit walls. In pits with extensive exposures of pyritic black shale that will not be backfilled to above the water table, long term mitigation measures will likely be required to attain the proposed water quality criteria.

The hydrogeological and geochemical behaviour of each pit should be predicted so that it can be managed appropriately at closure to minimise significant groundwater impacts and surface water exposures to wildlife and humans. As discussed previously, the most protective pit closure strategy is to completely backfill the pit or to backfill the pit to above the estimated pre-mining water table where practicable. Backfilling to above the pre-mining water table should lead to a near complete recovery of the water table elevation and should cut off oxygen to the majority of black shale or sulfidic material exposed on the pit walls.

In order of decreasing benefit, pit backfilling should be prioritised as follows: 1) pits with black shale or sulfidic material exposures that intersect the water table and will discharge to groundwater at closure, 2) pits with black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, 3) pits with black shale or sulfidic material exposures that are above the water table, 4) pits without black shale or sulfidic material exposures that intersect the water table and that will discharge water to groundwater at closure, 5) pits without black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, and 6) pits that do not contain any black shale or sulfidic material exposures and that are above the water table. The proximity to nearby regionally significant aquifers or ecologically significant seeps and springs should also be considered when evaluating potential pit closure issues.

Extensive backfilling is not practicable for many open pits because of the size of the final void and because of pit sequencing issues. Where backfilling is not practicable the following actions should be taken:

- Haul roads and accessible benches that are underlain by inert waste rock should be ripped and seeded to minimise runoff, to promote vegetation establishment and to maximise evapo-transpiration.
- A minimum 4 metre store and release cover system should be constructed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located above the water table and that will not be periodically flooded by cyclone events.
- A minimum 5 metre lift of inert or net neutralising rock should be placed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located below the water table or that will be periodically flooded by cyclone events.
- Consideration should be given to covering black shale or sulfidic material exposed on pit highwalls with inert or net neutralising material pushed or dumped from the sides.

An example of these pit closure strategies is illustrated in Figure 33.

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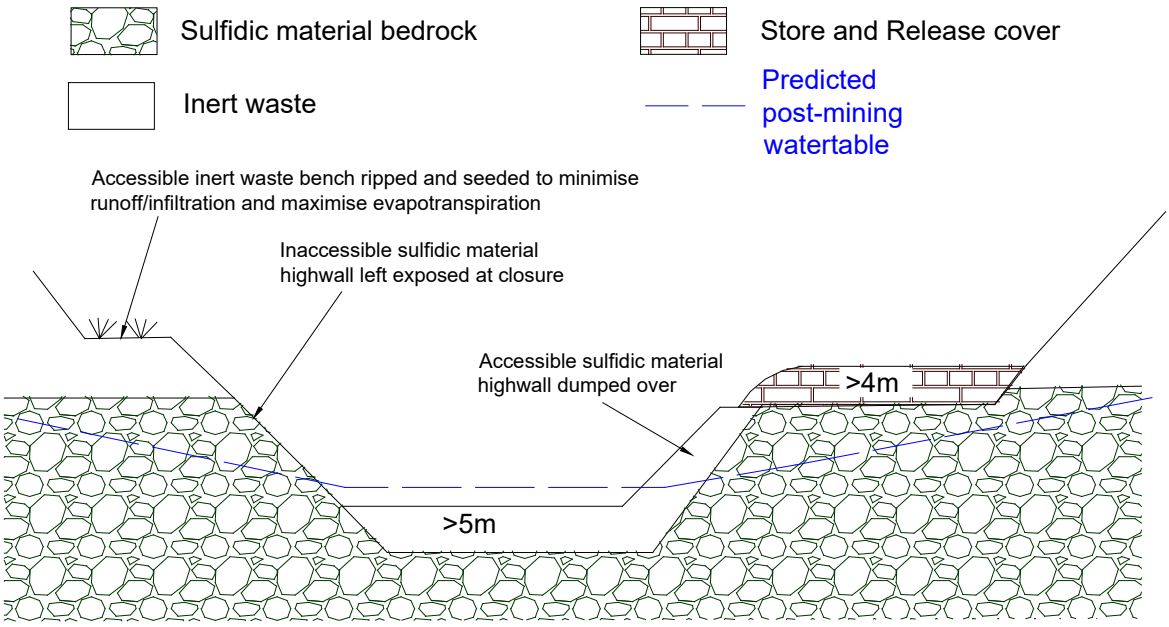


Figure 19: Examples of closure strategies for a pit with sulfidic material that will not be backfilled.

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Appendix 4 Contingency Planning

Contingency plans for most upset conditions and unexpected impacts related to sulfidic material management will need to be developed on a case by case basis. Contingency plans will generally be developed by the site Mineral Waste Management team or at a minimum they must be approved by the Team. Contingency plans for spontaneous combustion and inert materials shortages are outlined in the following sections.

A4.1 Spontaneous Combustion

Site specific pit safety procedures should be followed.

All occurrences of burning black shale or lignites must be reported to the mine supervisor and the pit safety team as soon as possible. If possible, fires should be extinguished by rapid burial of the burning material under at least five metres of inert waste rock (see relevant SWPs). For locations where this may be difficult such as beneath pit ramps, the black shale or lignite should be covered with as much inert material as practicable. The inert material should be placed so that the upper surface is well compacted and so that side slopes are adequately covered to prevent lateral convective transport of oxygen to the burning rock mass. If rapid coverage is not an option, the material can be excavated and transported to the toe of an advancing inert dump lift where it can be rapidly buried. Water should not be used to extinguish the fire because this could actually enhance the spontaneous combustion risk of black shale or lignite that is not already burning and because the volumes of water that would be required are generally prohibitively high.

A4.2 Inert Materials Shortages

Medium and short term mine plans should be designed so that inert waste rock is produced in adequate volumes and at appropriate times to allow timely encapsulation of PAF material. Hot black shale and lignite material requires the highest volumes of inert material (approximately 1:1) because of the requirement for an inert interlayer every 2.5 metres. If there were temporary shortages of inert material, hot black shale or lignite dumps could be designed with cold black shale or sulfidic BIF and siderite material if it contains a low sulfide concentration, some neutralising potential and low organic carbon (i.e. no black shale or lignite) material. The appropriate material to use in the heat dissipating interlayer should be confirmed as appropriate by Mine Geology. But under no circumstances should black shales or lignites with both elevated sulfide and organic carbon concentrations be used. If acid base accounting tests prove the material to be non-acid forming, coarse tails could be used as inert waste in dumps. If there is a shortage of inert material then inert waste in other waste dumps may need to be rehandled and transported to the black shale waste dump.

A4.3 Surface Water Management

Every endeavour should be made to divert surface water runoff from contacting black shale or sulfides exposed on pit walls. Site specific acid water and flood management plans should be developed that plan for the appropriate disposal of potentially acidic water in pits with PAF exposures. Some strategies to manage surface water runoff include:

- Slope pit floor away from pit PAF exposure
- A sump should be constructed below the PAF exposure to collect acidic water.
- Surface water runoff from inert exposures should be segregated from coming in contact with acidic water.

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- Bund upper catchment to run over competent material such as BIF rather than PAF exposures.

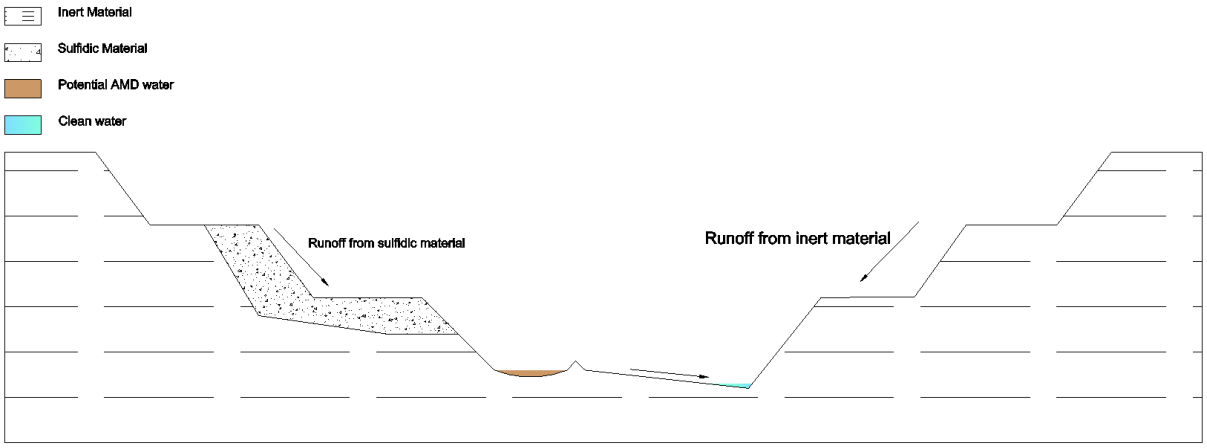


Figure 20: Suggested surface water management for sulfide exposures.

Where possible, PAF exposures in waste dumps should be covered with inert material during the wet season, particularly hot black shale and lignites. A bund at the top of the waste dump surface will reduce any surface water from travelling over the sulfidic material and transporting contaminated drainage into the surrounding environment.

Pipelines transporting acidic water should be shut down and repaired if there is a leak. Acid water pipelines should be labelled with purple stripes and non-acidic pipelines can be labelled with green stripes (as per Australian Standards).

A4.4 Geotechnical Stability

A6.4.1 Pit Walls

Pit walls excavated in MCS are designed with the same concept as for other stratigraphic units. That is, generally the design is for a Factor of Safety of at least 1.20 and a Probability of Failure of around 10% on the inter-ramp scale and up to 30% for the batter scale. The management of slopes excavated in MCS is therefore no different from that of any other stratigraphic unit, whereby a process called Geotechnical Design Management is utilised. This involves identifying hazards and hence risks associated with the geotechnical design and undertaking a risk management strategy to minimise these risks. Actions include design review, geotechnical investigation, mapping, conformance to design and monitoring. Contingency plans are established through Slope Management Plans in consultation with mine management.

The occurrence of MCS is of little consequence to the geotechnical management process.

A6.4.2 Dump failures

Whilst no specific stability analyses have been undertaken on black shale waste dumps, they can generally be considered stable due to the process of encapsulation of the material well within a dump. Also, the process of undertaking earthworks to prepare the encapsulation is considered to add a significant contribution to the stability of the dump location. It is anticipated that future stability analyses may be documented in a Waste Dump Management Plan.

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Appendix 12: BS4 AMD Risk Assessment Review 2021

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Internal memo

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Department: WRE – Mineral Waste

To: Steven Lee

CC: Tammy Savage, Laura True

Reference: RTIO-PDE-0184850

Date: 20 August 2021

BS4 AMD Risk Assessment Review in Support of Closure

1 Introduction

A review of the acid and metalliferous draining (AMD) risk for the Brockman 4 (BS4) deposit has been undertaken to support the Greater Brockman Mine Closure Plan (MCP). This review aims to compare previously reported drillhole data, mine plan and pit shells with any updated information since the previous BS4 AMD Risk Assessment (RTIO, 2013).

2 Background

A full AMD Risk Assessment was undertaken by Rio Tinto in 2013 and encompassed Pits 1-7, 9, 11-19. Details of the mine models and pit shells used in the 2013 reporting are presented in Table 1.

The 2013 report classified the BS4 Brockman Deposit as a moderate AMD risk with the following risk applied to specific pits:

- Pit 3 (south east area) poses a high AMD risk;
- Pit 5 poses a high AMD risk;
- Pit 7 poses a moderate AMD risk; and
- Pit 18 (southern area) poses a high AMD risk.

Table 1 – Comparison of mine models and pit shells

Date of Assessment	Mine Model	Pit Shells
2013	bs4epr_bs4m_20120725_007.bmf	pit1_us_107; pit2_us210; p3f_us506; pit04_u; p5f_uf07; pit06_u; pit07_u; pit09_u; pit11_u; pit12_u; pit13_u; pit14_u; pit15_u; pit16_u; pit17_u; pit18_u; pit19_u; and bsmm_pit_hg_v1_120627
2021 Review	bs4iprdp_bs4m_20210514_001.bmf	p01_cf32, p02_05_merge_uf, p03_04_merge_uf, p07_uf03, pit6_uf14, pit8_uf01, pit09_u, pit10_us203, pit11_end_uf, pit13_cu, pit14_u, pit15_u, pit16_u, pit17_uf1, pit18_uf101, pit19_uf101

3 Data Comparison

3.1 Planned Mine Geometry

Table 1 and Figure 1 presents the mine models and pit shells used in both the 2013 and 2021 AMD risk reviews (where available). The pit shells and mine model used in the 2021 review show minor geometry variation to the 2013 pit shell geometry.

3.2 Sulfur Analysis of Drill Hole Data

A drillhole analysis has been undertaken to determine the volume of additional sulfur data that has been generated since the previous AMD Risk Assessment (2013). As detailed in Table 2, an additional 34,595 samples have been analysed for sulfur since 2013. Of those, 1.59% exceeded 0.1% sulfur and 0.25% exceeded 0.3% sulfur. Both these values are below that identified in the 2013 risk assessment. This would suggest no increase in risk based on additional sulfur data collected since 2013.

Table 2 – Drill hole analysis summary of inpit sulfur samples

	Total number of inpit sulfur samples analysed		Percentage of inpit samples with S>0.1%		Percentage of inpit samples with S>0.3%	
Pit	**≤2013**	**2013 - 2021**	**≤2013**	**2013 - 2021**	**≤2013**	**2013 - 2021**
All	92,444	34,595	2.89%	1.59%	0.3%	0.25%

3.3 Sulfide Risk within Mining Model

The amount of sulfide risk waste material predicted to be mined based on the current mine model listed in Table 1 is detailed in Table 4. A comparison of waste tonnes predicted in the model used in the 2013 Risk Assessment (bs4epr_bs4m_20120725_007.bmf) to that used in the current 2021 risk review (bs4iprdp_bs4m_20210514_001.bmf) suggest an increase in BS-oxide material, but a decrease in bs_cold and bs_hot.

Table 3 – Drill hole analysis of inpit sulfur samples

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CAL	24	0	0.00%	0	0.00%	0.01	-
DET WASTE	3740	24	0.64%	2	0.05%	0.02	0.16
DET ORE	567	7	1.23%	0	0.00%	0.03	0.12
DOR	**1218**	**41**	**3.37%**	17	1.40%	0.02	0.34
YAN WASTE	348	1	0.29%	0	0.00%	0.01	0.11
YAN ORE	11	0	0.00%	0	0.00%	0.01	-
YAN HYD	285	0	0.00%	0	0.00%	0.02	-
JOF WASTE	4870	33	0.68%	8	0.16%	0.01	0.33
JOF ORE	7125	46	0.65%	4	0.06%	0.01	0.17
JOF HYD	3747	85	2.27%	23	0.61%	0.03	0.29
WS WASTE	**1335**	**50**	**3.75%**	3	0.22%	0.02	0.17
WS ORE	**933**	**95**	**10.18%**	1	0.11%	0.03	0.15
WS HYD	**641**	**26**	**4.06%**	1	0.16%	0.03	0.17
DG WASTE	1767	12	0.68%	3	0.17%	0.02	0.19
DG ORE	5606	73	1.30%	8	0.14%	0.02	0.18
DG HYD	1895	28	1.48%	0	0.00%	0.02	0.12
FWZ WASTE	148	1	0.68%	0	0.00%	0.01	0.25
FWZ ORE	200	3	1.50%	0	0.00%	0.02	0.13
MCS WASTE	**135**	**25**	**18.52%**	**16**	**11.85%**	**0.78**	**4.13**
Total number of samples assayed for S					34595		
Total number of samples with S>0.1/0.3%					550	86	
Percentage of total with S>0.1/0.3%					1.59%	0.25%	
Total number of waste samples assayed for S [a]					13585		
Total number of waste samples with S>0.1/0.3%					187	49	
Percentage of total waste samples with S>0.1/0.3%					1.38%	0.36%	

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Table 4 -Predicted waste material across the BS4 deposits

Waste Type	Total tonnages (Mt)	
	2013 [a]	2021 [b]
Low Risk BS_Oxide	51	95
Moderate Risk BS_Cold	19	12.5
High Risk BS_Hot	2.1	1.31

[a] model used - bs4epr_bs4m_20120725_007.bmf

[b] model used - bs4iprdp_bs4m_20210514_001.bmf

3.4 Sulfide Exposure Risk in Final Pit Shells

The 2013 Risk Assessment identified predicted exposures of SR2 and SR3 material totalling at 40,750 m2 and 104, 450 m2 respectively. During a review of the existing geological model, a significant error was identified in the sulfide risk variable script that required rectification. This is currently being incorporated into a revision of the mine model. In the interim, a black shale oxidation surface triangulation has been compiled based on pit mapping and oxidation front tracking, which can be used to estimate elevated sulfide risk material exposures on the pit walls. This information is presented in Table 3.

Table 5 – Comparison of sulfide risk across the BS4 project area

Pit	2013 Risk Assessment		2021 Update
	Sulfide Risk 2 (m^2)	Sulfide Risk 3 (m^2)	Black shale exposure (m^2)
Pit 2	-	-	167
Pit 3	11,300	23,300	64,704
Pit 5	13,900	67,700	72,167
Pit 6	-	-	1,748
Pit 7	5,000	2,600	33,416
Pit 18/12	10,550	10,450	2,054
Total	**145,200**		**174,256**

4 Discussion and Conclusions

This review has identified that an additional 34,595 sulfur analyses has been undertaken since the previous AMD Risk Assessment. Overall, this data is within the range of elevated concentration values observed during the 2013 Risk Assessment. Total tonnages are similar to that reported in 2013, although the proportions of BS_oxide, BS_cold and BS_hot have been altered.

Due to inaccuracies with the sulfide risk scripting in the geology model, an accurate estimation of SR2 and SR3 exposures is not possible at this point in time. Pit mapping of existing black shale exposures in addition to drill hole data however, has been utilised to predict black shale exposures throughout the BS4 deposit. This suggests a 17% increase in high sulfide risk material likely to be exposed on the pit walls throughout BS4 deposit. The exposure locations are similar to that identified in 2013 (pits 3, 5, 7, 18/12) however, two additional pits are now predicted to encounter high sulfide risk material (Pits 2 and 6).

Based on this review, the risk rating detailed in the 2013 AMD Risk Assessment for the BS4 deposits remain unchanged.

5 Recommendations

Given the issues related to the mine model and sulfide risk scripting, it is recommended that a review of exposures is undertaken following the incorporation of the modified script in the updated BS4 mine model.

6 References

RTIO, 2013, Brockman Syncline 4 – AMD Risk Assessment, May 2013, (Update from 2010), RTIO-PDE-0072290, May 2013.

Figure 1 – Pit outline comparison

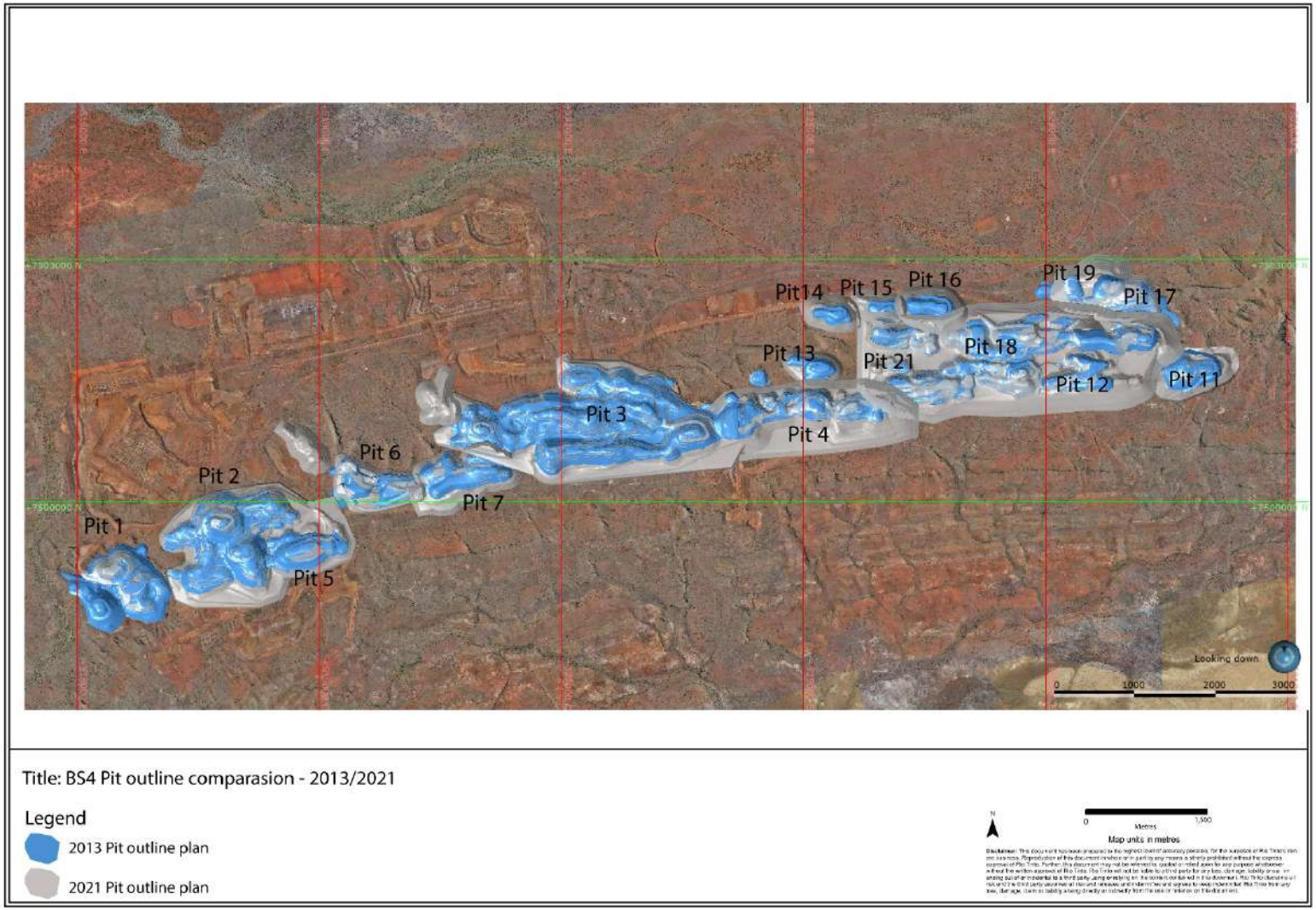
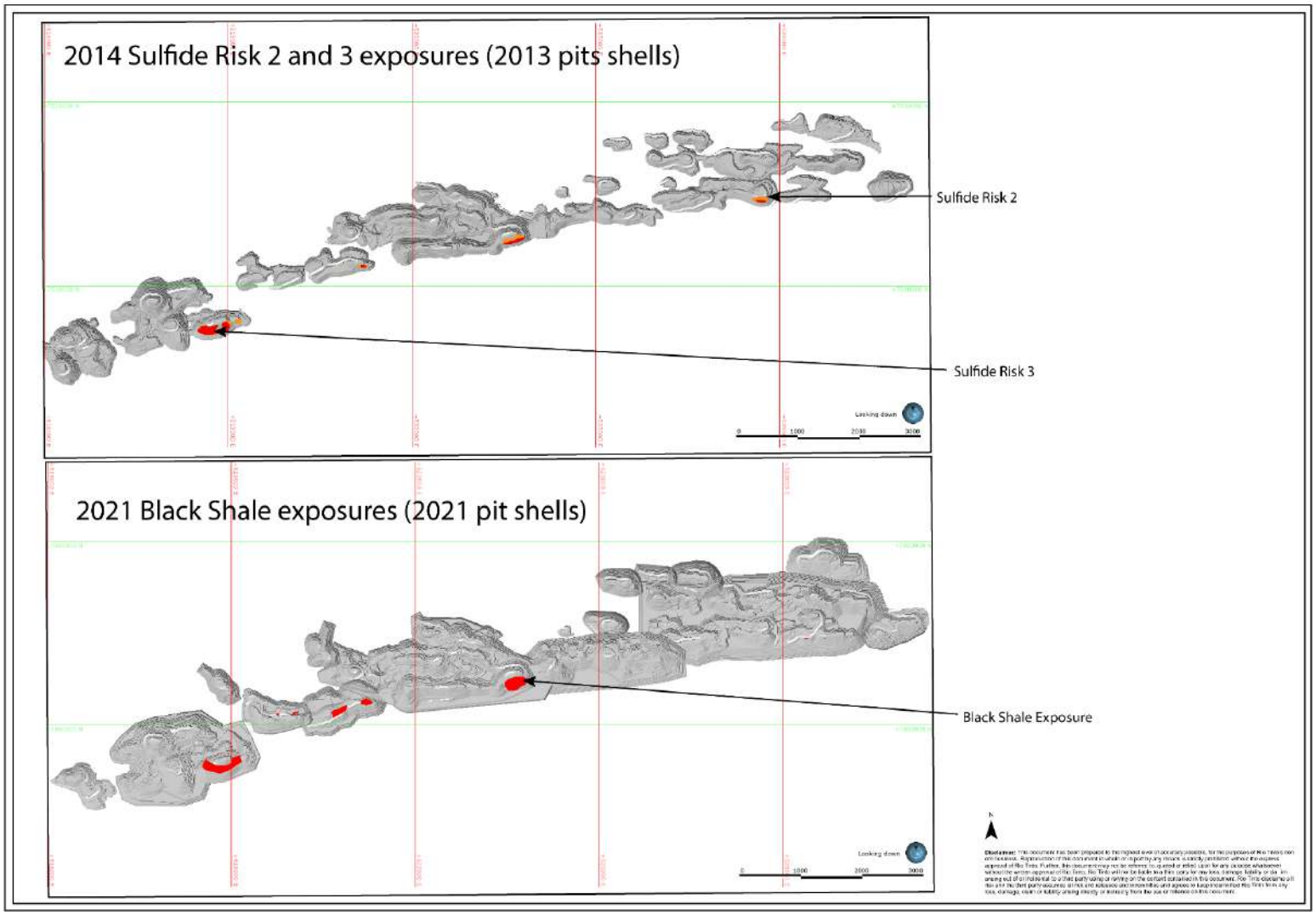


Figure 2 – BS4 sulfide risk exposure comparison



Appendix 13: Nammuldi AMD Risk Assessment Review 2021

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Reference: RTIO-PDE-0184848

Date: 20 August 2021

Nammuldi AMD Risk Assessment Review 2021

1 Introduction

A review of the acid and metalliferous drainage (AMD) risk for the Nammuldi (NAM) deposit has been undertaken to support the Greater Brockman Mine Closure Plan (MCP). This review aims to compare previously reported drillhole data, mine plan and pit shells with any updated information since the 2010 NAM AMD Risk Assessment (RTIO, 2010).

2 Background

A full AMD Risk Assessment was undertaken by Rio Tinto in 2010 and encompassed pits Lens AB, Lens CD and Lens EF. Details of the mine models and pit shells used in the 2010 reporting are presented in Table 1. The 2010 Risk Assessment identified the overall AMD risk of Lens AB, Lens D and Lens EF as Low. Lens C (BWT) was identified as a Moderate AMD risk with sulfidic (potentially acid forming) lignite and siderite scheduled to be mined and exposed on the pit walls.

It is noted that Lens F Pit 5 has not been previously assessed for AMD risks. This review will include a limited assessment of sulfur concentrations within waste rock units and Sulfide Risk (SR) in the mine model with respect to final pit walls.

Table 1 – Comparison of mine models and pit shells

Date of Assessment	Mine Model	Pit Shells
2010	namipr_lab_20100419_034 namiprd_lcd_20100704_001 namipr_lef_20100420_001	ensa_bwt_09pfs1_c.00t lensb_bwt_09pfs2_c.00t bc_2023.00t ensef_bwt_09pfs5_c.00t
2021	namiprdp_lab_20210216_005 nbamipr_lcd_20200914_017 namiprdp_lef_20200914_015 namiprdp_lf5_20190918_015	labwt_us202_v6.00t labwt_us302i_v1.00t LABWT_US402_V1.00t lbbwt_us101.00t lcdbwt_us1003.00t lef_uf25.00t lenb_us401_v1.00t lf5_uf01.oot

3 Data Comparison

3.1 Planned Mine Geometry

Table 1 presents the mine models and pit shells used in both the 2010 and 2021 reviews. Figure 1 presents a comparison of the 2010 and 2021 pit shells and closure pit outlines, showing variations to the geometry of all planned pits and mine models since the 2010 report. The pit shells utilised in this report correlate with the closure pit outlines. It is noted that this review includes Lens F Pit 5, which was not included in the 2010 Risk Assessment.

The mine models listed in Table 1 encompass the pit shells except for Lens B. The current mine model for Lens B (namiprdp_lab_20210209_005) has not yet been updated to reflect the planned pit shell (lenb_us401_v1). As a result, the previous pit shell ibbwt_us101.oot has been utilised in this assessment as it represented the latest mine model.

3.2 Sulfur Analysis of Drill Hole Data

A drillhole analysis has been undertaken to determine the volume of additional sulfur data that has been generated since the previous AMD Risk Assessment in 2010. As can be observed in Table 2, a total of 49,510 addition samples have been analysed for sulfur since the previous AMD Risk Assessment. The number of elevated sulfur samples are within the range of concentrations seen during the 2010 Risk Assessment. Len F Pit 5, which has not been previously assessed identified elevated sulfur concentrations in DET WASTE, NEW WASTE, NEW HYD and MAC WASTE, similar to that identified in deposits Lens AB, CD and EF. Given the proximity to these deposits and similar geology, it is unlikely that the AMD risk for Lens F Pit 5 will differ greatly from the rest of Lens EF, particularly since the high risk units (such as lignite) are absent.

Table 2 – Drill hole analysis of in pit sulfur samples

	Total number of in pit sulfur samples analysed		Percentage of in pit samples with S>0.1%		Percentage of in pit samples with S>0.3%	
Pit	**≤2009**	**2010 - 2021**	**≤2009**	**2010 - 2021**	**≤2009**	**2010 - 2021**
Lens AB	4,485	11,414	*	1.25%	0.15%	0.18%
Lens CD	42,842	727	*	1.79%	1.35%	1.24%
Lens EF	43,832	36,749	*	0.41%	0.11%	0.12%
Lens F Pit 5	-	620	-	6.77%	-	1.61%

*Value not reported within the 2010 AMD Risk Assessment.
Note Lens F Pit 5 was not included within 2010 AMD Risk Assessment

Table 3 -Summary in pit sulfur data for Lens F pit 5

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
DET WASTE	**110**	**4**	**3.64%**	0	0.00%	0.03	0.12
DET ORE	10	0	0.00%	0	0.00%	0.03	-
NEW WASTE	**32**	**8**	**25.00%**	0	0.00%	0.09	0.19
NEW ORE	90	0	0.00%	0	0.00%	0.02	-
NEW HYD	**240**	**8**	**3.33%**	0	0.00%	0.04	0.12
MAC WASTE	**60**	**22**	**36.67%**	10	**16.67%**	**0.17**	**0.39**
MAC ORE	78	0	0.00%	0	0.00%	0.03	-
Total number of samples assayed for S					620		
Total number of samples with S>0.1/0.3%					42	10	
Percentage of total with S>0.1/0.3%					6.77%	1.61%	
Total number of waste samples assayed for S [a]					202		
Total number of waste samples with S>0.1/0.3%					34	10	
Percentage of total waste samples with S>0.1/0.3%					16.83%	4.95%	

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

3.3 Sulfide Risk within Mining Model

The amount of sulfide risk waste material predicted to be mined based on the current mine models listed in Table 1 is presented in Table 4.

Table 4 - Predicted waste material across the Nammuldi deposits

Waste Type	Total tonnages (Mt)				
	Lens AB	Lens CD	Lens EF	Lens F Pit 5	Total
Low Risk BS-Oxide	18.36	0.0	146	0.43	164.79
Moderate Risk BS-Cold	0.0	1.79	0.03	0.01	1.83
High Risk BS-Hot	0.0	4.3	0.01	0.0	4.31
Neutralising BS_neut	23.31	0.0	33	0.0	56.31

3.4 Sulfide Exposure Risk on Final Pit Walls

The 2010 Risk Assessment did not consider sulfur risk (SR) for Lens AB or Lens EF as the SR had not yet been allocated within the mine model. Lens CD was assessed and predicted to result in 9,700 m^2 of SR2 (siderite) and 20,100 m^2 of SR3 (lignite) exposures. SR2 material was identified as underlying Lens EF however none within the pit itself.

This review has assessed the exposures on all the designed pit walls within the Nammuldi deposit. Table 2 presents a comparison of sulfide risks across Lens AB, CD and EF. Figure 2, Figure 3, and Figure 4 present the locations of exposures and compares to the 2010 risk assessment, if available.

Mining of Lens AB is not predicted to result in any exposures of SR 2 or 3 material on the final pit wall. As reported in the 2010 Risk Assessment, mining of Lens CD is expected to result in exposures of SR 2 and 3 materials on the final pit wall. A review of the updated pit shells and mine model suggests a significant increase of SR 2 area and a slight decrease in SR 3 for Lens CD. The location of this SR material is similar to that reported in 2010 (south east corner of pit) with the variation likely due to the variation in pit shell (push back to the east) design as shown on Figure 1.

Sulfide risk for Lens EF was not reported in 2010, although several SR 2 areas were identified underlying the pit shell. This review has identified approximately 592 m^2 of SR 3 material situated on the south east corner of the pit. Lens F Pit 5 is predicted to include 300 m^2 of exposed SR 2 material.

Table 5 – Comparison of sulfide risk across the Nammuldi project area

Project	Pit	2010 Risk Assessment			2021 Update		
		Total Pit Area (m^2)	Sulfide Risk 2 - Siderite (m^2)	Sulfide Risk 3 - Lignite (m^2)	Total Pit Area (m^2)	Sulfide Risk 2 (m^2)	Sulfide Risk 3 (m^2)
Nammuldi	Lens AB	-	-	-	2.46 M	0.0	0.0
	Lens CD	2.9 M	9,700	20,100	3.2 M	24,830	17,700
	Lens EF	-	-	-	5.5 M	0.0	592
	Lens F5	-	-	-	125,400	300	-

4 Discussion and Conclusions

From this review it has been determined that SR 3 material is predicted to be present on the final pit walls at Lens CD and EF. In addition, 5.14 Mt and 1.79 Mt of BS_hot material is expected to be mined from Lens CD and EF respectively. Lens C was previously identified as Moderate Risk from the 2010 AMD risk assessment and it is recommended that Lens C maintains this risk rating. Lens EF previously identified as Low Risk and it is recommended to be upgraded to Moderate Risk due to the presence of both SR3 exposures and the expected BS_hot waste. Lens F Pit 5 has not been formally assessed for AMD risk, however given the proximity to the other deposits (which have been assessed) and similar sulfur concentrations, it is likely that this pit would be classified as Low Risk. Lens AB risk rating remains low.

5 Recommendations

It is recommended that an update to the NAM AMD Risk Assessment should be undertaken and should include Lens F Pit 5.

6 References

RTIO, 2010, Nammuldi ARD and Geochemical Risk Assessment September 2010 (Update from February 2010), RTIO-PDE-0068358, September 2010.

Table 6 – Rock units

Rock Unit / abbreviation	Explanation	Rock Unit / abbreviation	Explanation
DET WASTE	Detrital waste	NEW HYD	Mt Newman hydrated ore
DET ORE	Detrital ore	MAC WASTE	MacLeod Waste
NEW WASTE	Mt Newman waste	MAC ORE	MacLeod ore
NEW ORE	Mt Newman ore		

Figure 1 – Pit outline comparison

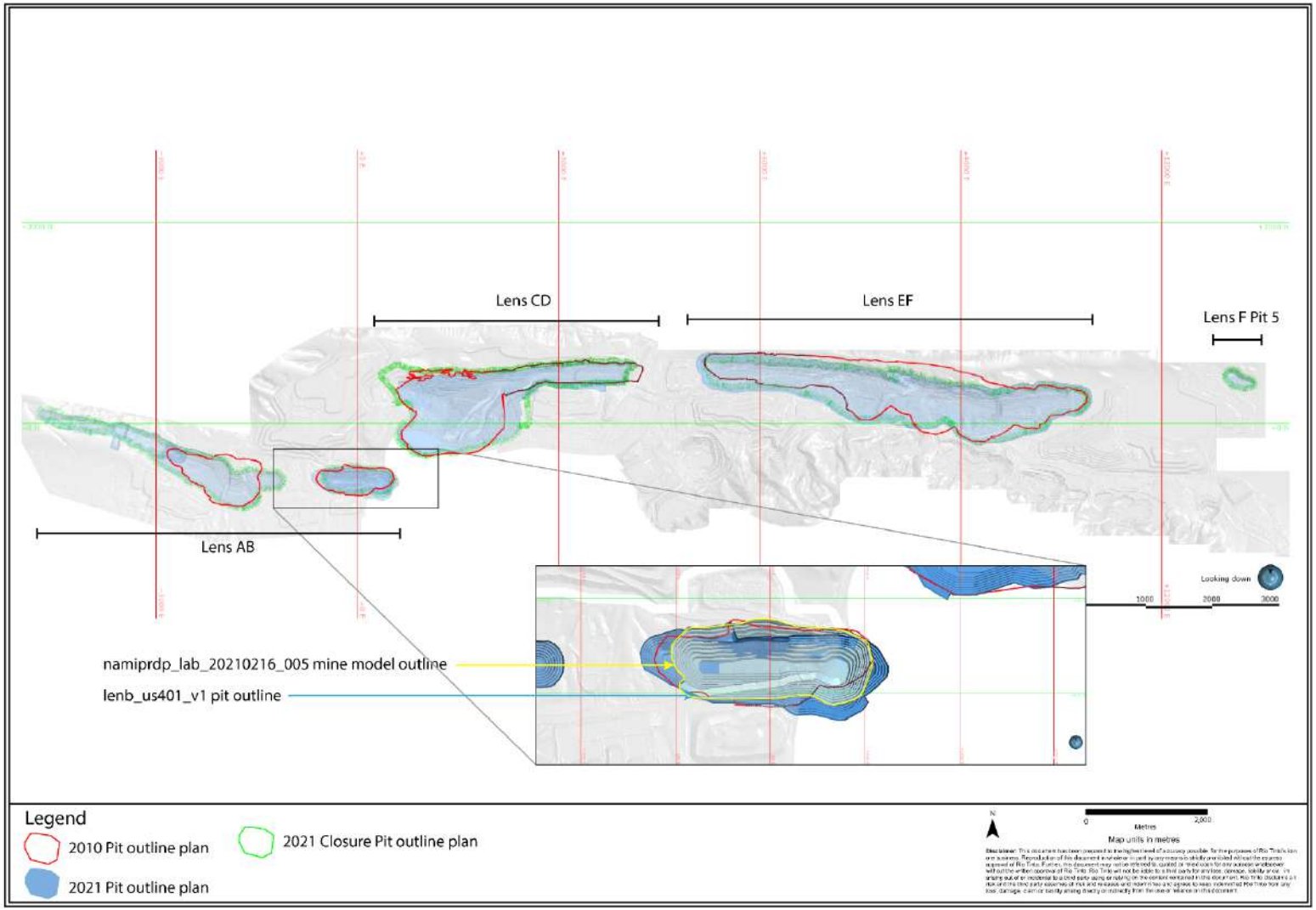


Figure 2 – Lens CD sulfide risk exposure comparison

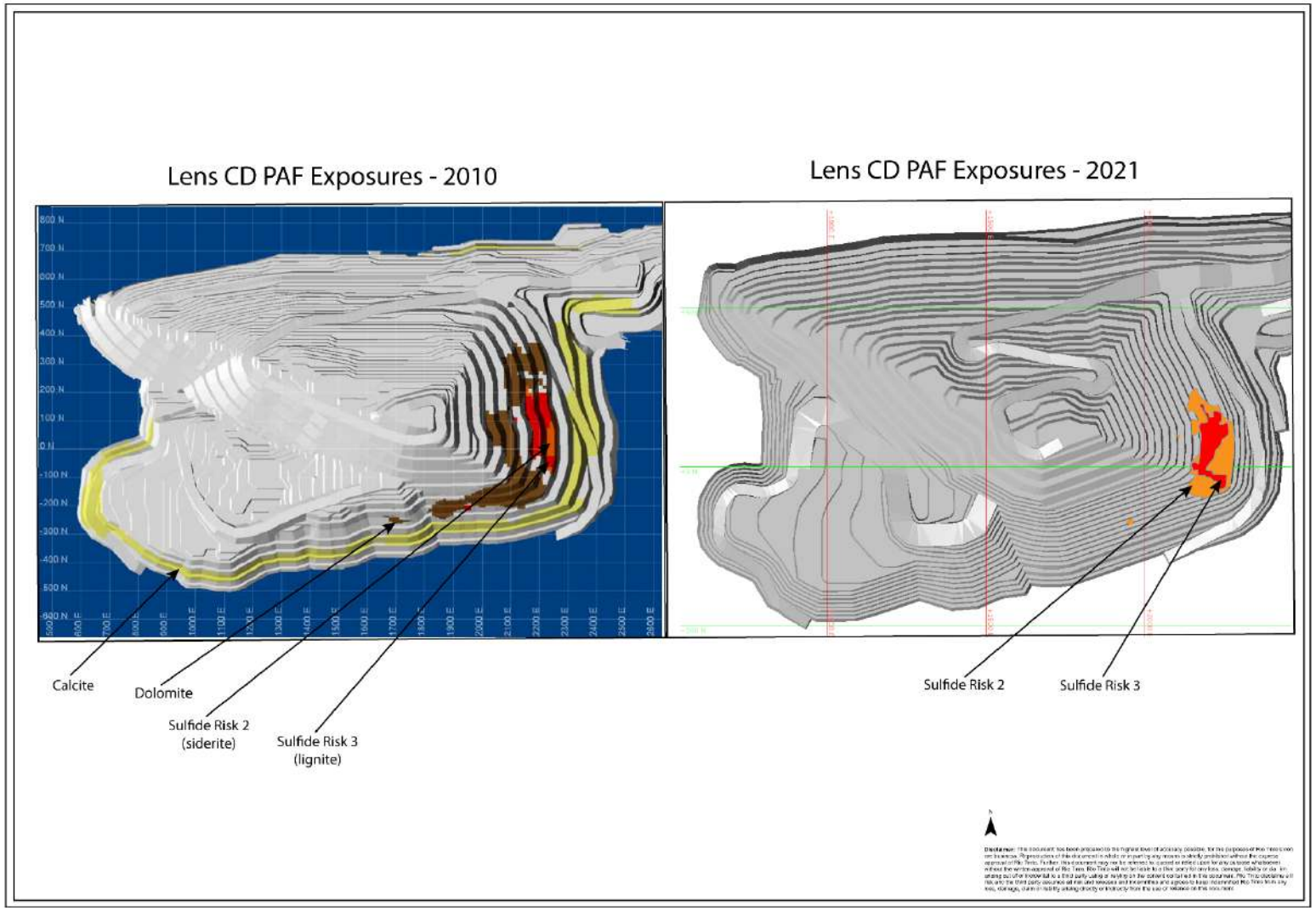


Figure 3 – Lens EF sulfide risk comparison

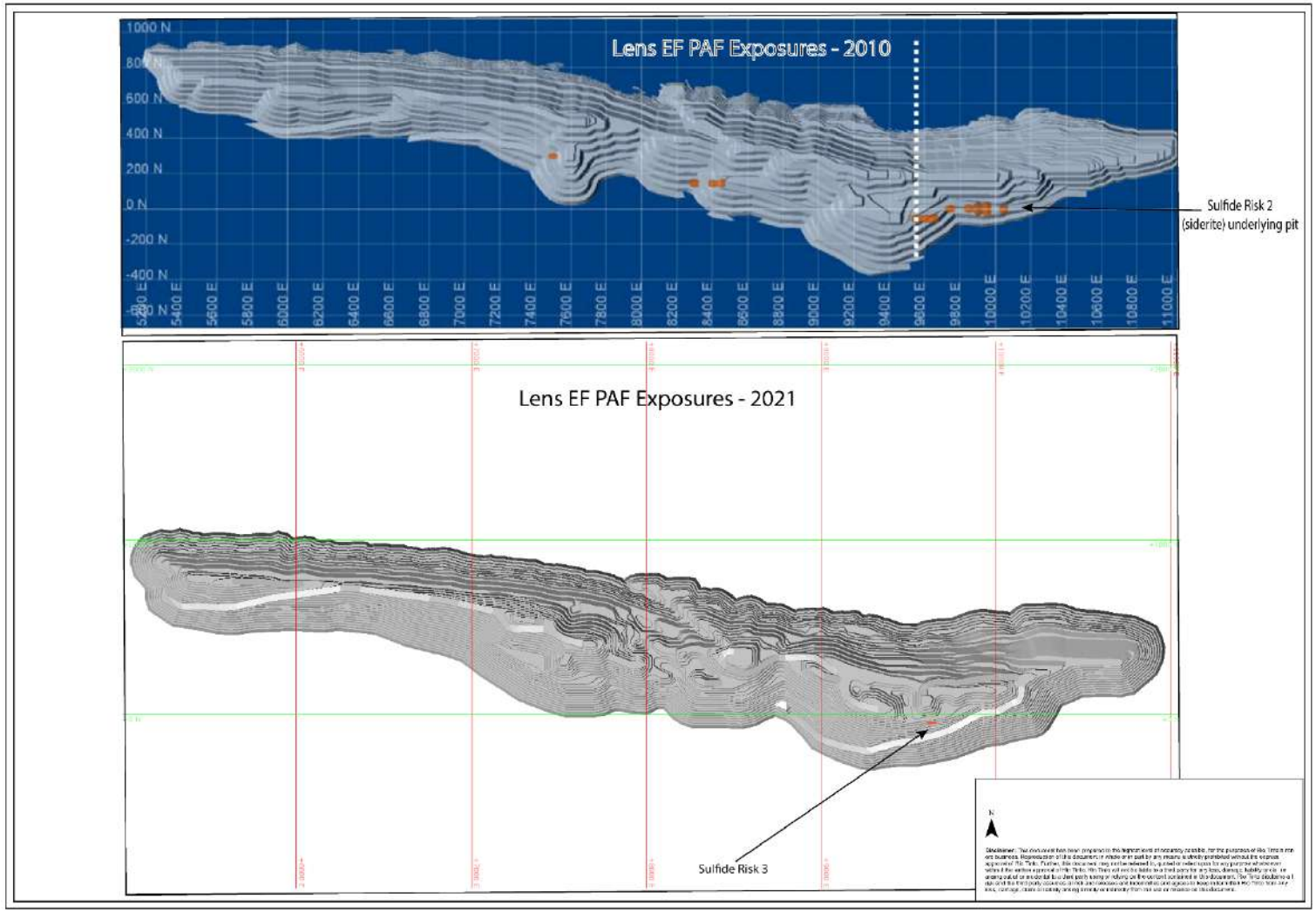
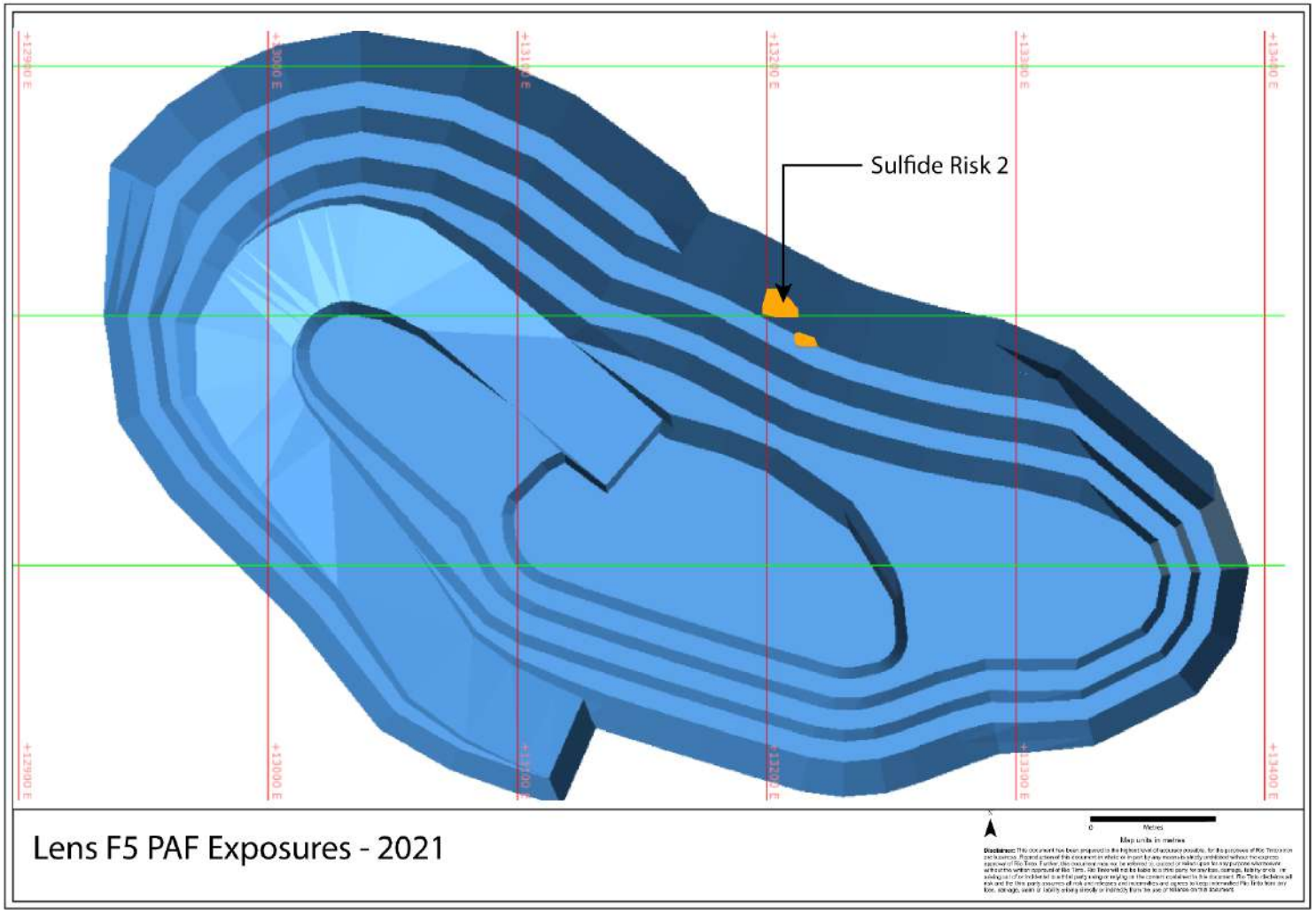


Figure 4 – Lens F Pit 5 sulfide risk comparison



Appendix 14: BS2 AMD Risk Assessment Review 2021

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Reference: RTIO-PDE-0184849

Date: 20 August 2021

BS2 AMD Risk Assessment Review 2021

1 Introduction

A review of the acid and metalliferous draining (AMD) risk for the BS2 deposit has been undertaken to support the Greater Brockman Mine Closure Plan (MCP). This review of the AMD risks associated with BS2 aims to compare previously reported drillhole data, mine plan and pit shells with any updated information since the previous AMD Risk Assessments (RTIO, 2013), (RTIO, 2014) and AMD Risk Reconciliation (RTIO, 2016).

2 Background

A full AMD Risk Assessment was undertaken by RTIO on the eastern half of the BS2 deposit (known as BS2 East Detritals or BS2ED) in 2013 and on the western half (BS2W and BS2C) of the deposit in 2014 and 2016. The Risk Assessment undertaken in 2013 identified potentially acid forming material on the surface of pit walls in Pits 8, 10, 12 and possibly 9 and 13. The BS2E deposit was given a low risk rating with Pit 8 designated high risk.

The 2014 Risk Assessment identified black shale exposures within Pit 4/6 and modelled predicted exposures in Pit 6x. Risk ratings included low risk (Pits 1,2, 3, 5/5x), moderate (Pit 6x and 7) and high (Pit 4/6).

A 2016 AMD Risk Reconciliation report downgraded the risk of Pit 4/6 from high to moderate.

Table 1 – Comparison of mine models and pit shells

Date of Assessment	Mine Model	Pit Shell Triangulations
2013	bmanipr_b2ed_20130429_018.bmf	*pit08_cs.00t*
214	bmanepr_bs2_20120802_035.bmf	p1minedoff.00t, p2minedoff.00t and p3minedoff.00t, bs2.00t and bs2_us218.00t, pit7_us220.00t, pit5_cs201.00t, pit6x_cs308.00t
2016	-	-
2021	bmaniprdp_b2ed_20210719_001.bmf bmaniprdp_bs2_20200916_014.bmf	b2ed_p10s5_us, b2ed_pit08_us256, b2ed_pit12_us304, bs2w_minedoff_complete, pit6_cb_sol_20080528, pit7_ver3_Dec2010, pit08_us256_v5, pit9_us112, pit10_us314, pit11_us326a, pit13_us214, pit10b_us242, pit13d_us410, pit6x_us332, pit9b_draft_south_ext, b2ed_pit14_whitcog_base (conceptual), b2ed_pit10s4_i102 (conceptual), BS2W_Pits_base (conceptual)

3 Data Comparison

3.1 Planned Mine Geometry

Table 1 presents the pit shells and mine models used in the 2013, 2014 and 2021 AMD Risk Assessment / Review. Figure 1 presents a comparison of the pit shells used in the 2013 and 2014 Risk Assessments in comparison to the closure pit geometries. There is minimal variation observed. A number of pits are still 'conceptual' meaning they do not have pit shells associated with them at the time of reporting. These pits will need to be assessed for AMD risk once planning has advanced past the conceptual phase.

Figure 2 presents the closure pit outlines in comparison to the operation pit outlines utilised in this report. There is some variation in the closure and operational pit outlines, however this is not expected to impact the review of AMD risks within the closure pit outlines.

3.2 Sulfur Analysis of Drill Hole Data

A review of drillhole data identified an additional 13,671 sulfur samples analysed across the BS2 deposit (Table 2). The percent of in pit samples with sulfur concentrations >0.1% and 0.3% were within the range identified in previous assessments. Pits 1-8 did see an increase of samples with S>0.1% from 1.03% to 3.82% however rock units with elevated sulfur are similar to that presented in the 2013 Risk Assessment (Table 2).

Table 2 – In pit sulfur analysis summary for BS2

	Total number of in pit sulfur samples analysed		Percentage of in pit samples with S>0.1%		Percentage of in pit samples with S>0.3%	
Pit	**2013/2014**	**2014 - 2021**	**2013**	**2014 - 2021**	**2013**	**2014 - 2021**
Pits 8-13	17,199	12,182	1.03%	3.82%	0.06%	0.37%
Pits 4-7	19,526	1,401	8.98%	9.14%	0.57%	0.21%
Pits 1-3	4,507	88	1.84%	2.27%	0.04%	0.0%

Table 3 – Summary in put sulfur data for BS2 (data 2014 – 2021)

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	43	0	0.00%	0	0.00%	0.01	-
CAL	5	0	0.00%	0	0.00%	0.01	-
DET WASTE	1629	0	0.00%	0	0.00%	0.02	-
DET ORE	1710	26	1.52%	0	0.00%	0.03	0.15
DOR	**70**	**21**	**30.00%**	0	0.00%	0.07	0.14
JOF WASTE	2	0	0.00%	0	0.00%	0.05	-
JOF HYD	8	0	0.00%	0	0.00%	0.06	-
WS WASTE	**484**	**46**	**9.50%**	14	2.89%	0.08	0.42
WS ORE	**168**	**11**	**6.55%**	0	0.00%	0.05	0.13
WS HYD	**506**	**69**	**13.64%**	11	2.17%	0.07	0.22
DG WASTE	1803	34	1.89%	2	0.11%	0.03	0.18
DG ORE	3311	97	2.93%	10	0.30%	0.03	0.19
DG HYD	**2242**	**158**	**7.05%**	8	0.36%	0.05	0.17
FWZ WASTE	34	0	0.00%	0	0.00%	0.01	-
FWZ ORE	128	3	2.34%	0	0.00%	0.03	0.12
MCS WASTE	35	0	0.00%	0	0.00%	0.01	-
MTS WASTE	4	0	0.00%	0	0.00%	0.03	-
Total number of samples assayed for S					12182		
Total number of samples with S>0.1/0.3%					465	45	
Percentage of total with S>0.1/0.3%					3.82%	0.37%	
Total number of waste samples assayed for S [a]					4109		
Total number of waste samples with S>0.1/0.3%					101	16	
Percentage of total waste samples with S>0.1/0.3%					2.46%	0.39%	

3.3 Sulfide Risk in Mining Model

The amount of sulfur risk material that is scheduled to be excavated from the BS2 mining areas are presented in Table 4.

Table 4 – Summary tons of sulfur risk material to be excavated from BS2 deposits

Waste Type	Total tonnages (Mt)	
	Pits 1-7 [A]	Pits 8-13 [B]
Low Risk BS-Oxide	4.75	21.63
Moderate Risk BS-Cold	0.5	0.44
High Risk BS-Hot	0.0	0.2
Neutralising BS_neut	0.0	1.2

[A] Mine model used mpas_bmaniprdp_bs2_20210809_003

[B] Mine model used mpas_bmaniprdp_b2ed_20210719_001

3.4 Sulfide Exposure Risk in Final Pit Shells

Based on the operational pit shells, it is predicted that there will be approximately 950 m^2 of SR 2 material exposure on the pit walls of Pit 3. This material is logged as Wittenoom Formation and this formation has not been identified as elevated in sulfur within the BS2 area. Mining at Pit 3 has now been completed and it remains an open pit void at the time of reporting. This material is not considered to pose an elevated risk.

There are approximately 9,500 m^2 of SR2 and 6,000 m^2 of SR3 material exposure in the pit walls of Pit 8 (Figure 3). No other exposures are predicted in the remain pits.

It is noted that the pits listed as ‘conceptual’ in Figure 1 have not yet been assessed.

4 Discussion and Conclusions

This review has identified an additional 13,671 sulfur samples analysed across the BS2 deposit since 2014. Although an increase in the number of samples with S>0.1% was observed for Pits 1-8, the rock units exhibiting elevated sulfur were similar to that observed during the 2013 Risk Assessment. There are no additional exposures noted in the 2021 Review with only Pit 3 and Pit 8 identified as likely to intersect elevated sulfur risk material. Pit 3 has finished mining and no black shale was observed in the pit walls. Pit 8 currently has black shale exposed on the north wall.

Based on this review the risk ratings assigned to the BS2 deposit remain current. It is recommended that the AMD Risk Assessment for BS2 be updated when the pits listed in Figure 1 progress past the conceptual phase.

5 References

RTIO, 2013, Brockman Syncline 2 East Detritals – AMD Risk Assessment, RTIO-PDE-0090687, June 2013.

RTIO, 2014, Brockman 2 AMD Risk Assessment, RTIO-PDE-0069926, January 2014.

RTIO, 2016, Brockman 2 (BS2 Pit) AMD Risk Reconciliation, Internal Memo, RTIO-PDE-0147280, November 2016.

Figure 1 – BS2 Pit outline comparison

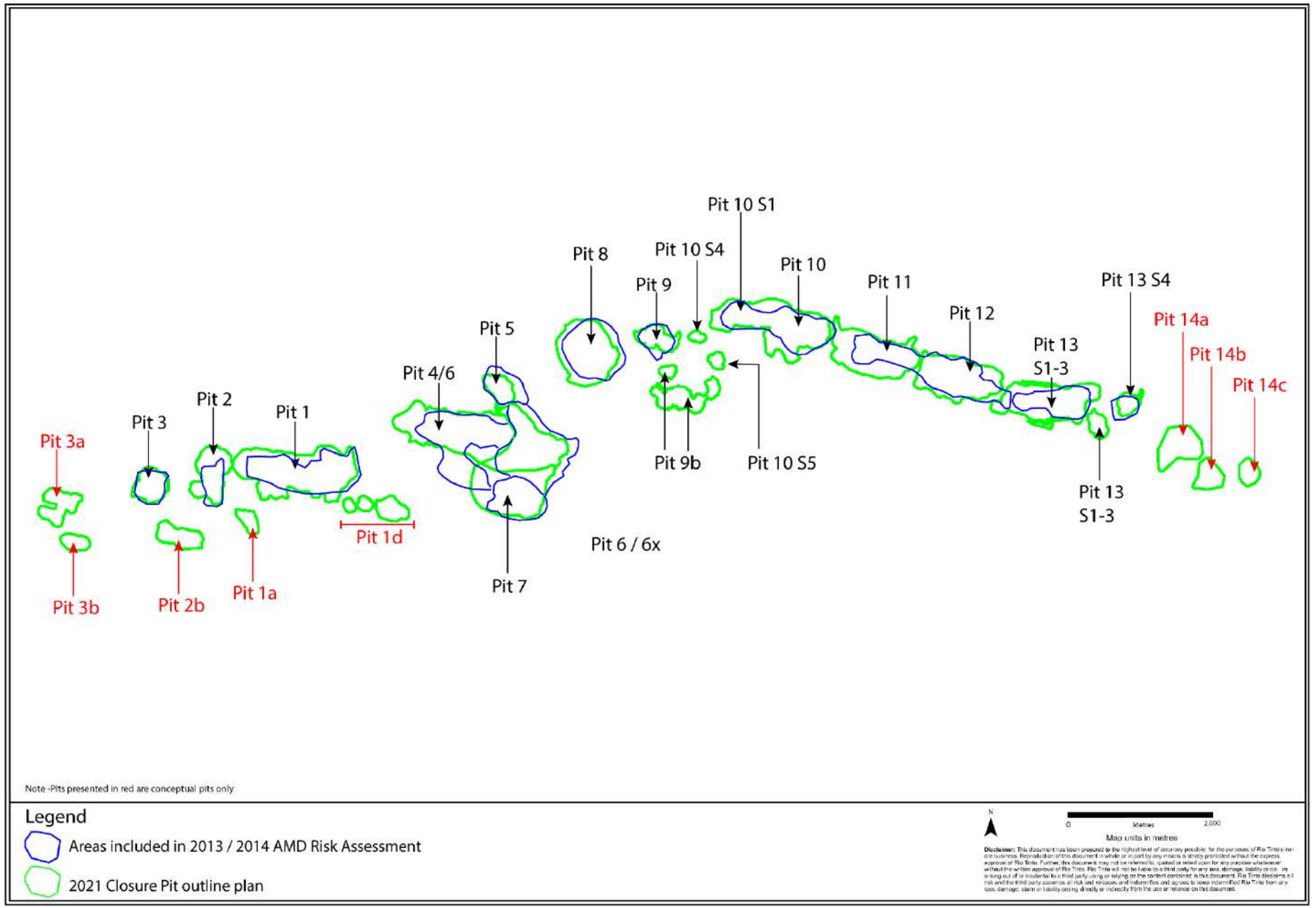


Figure 2 – BS2 Pit outline and pit shell comparison

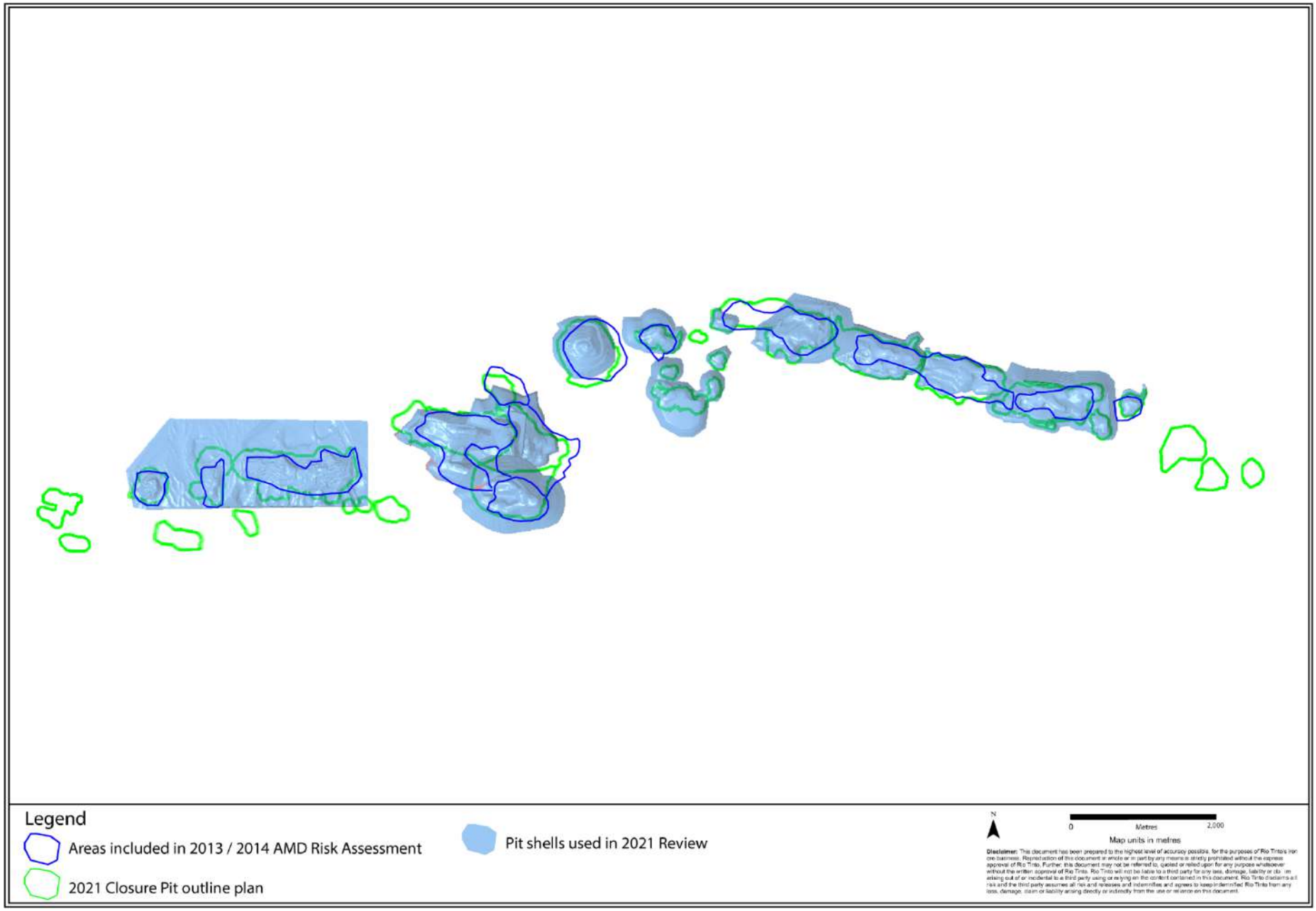
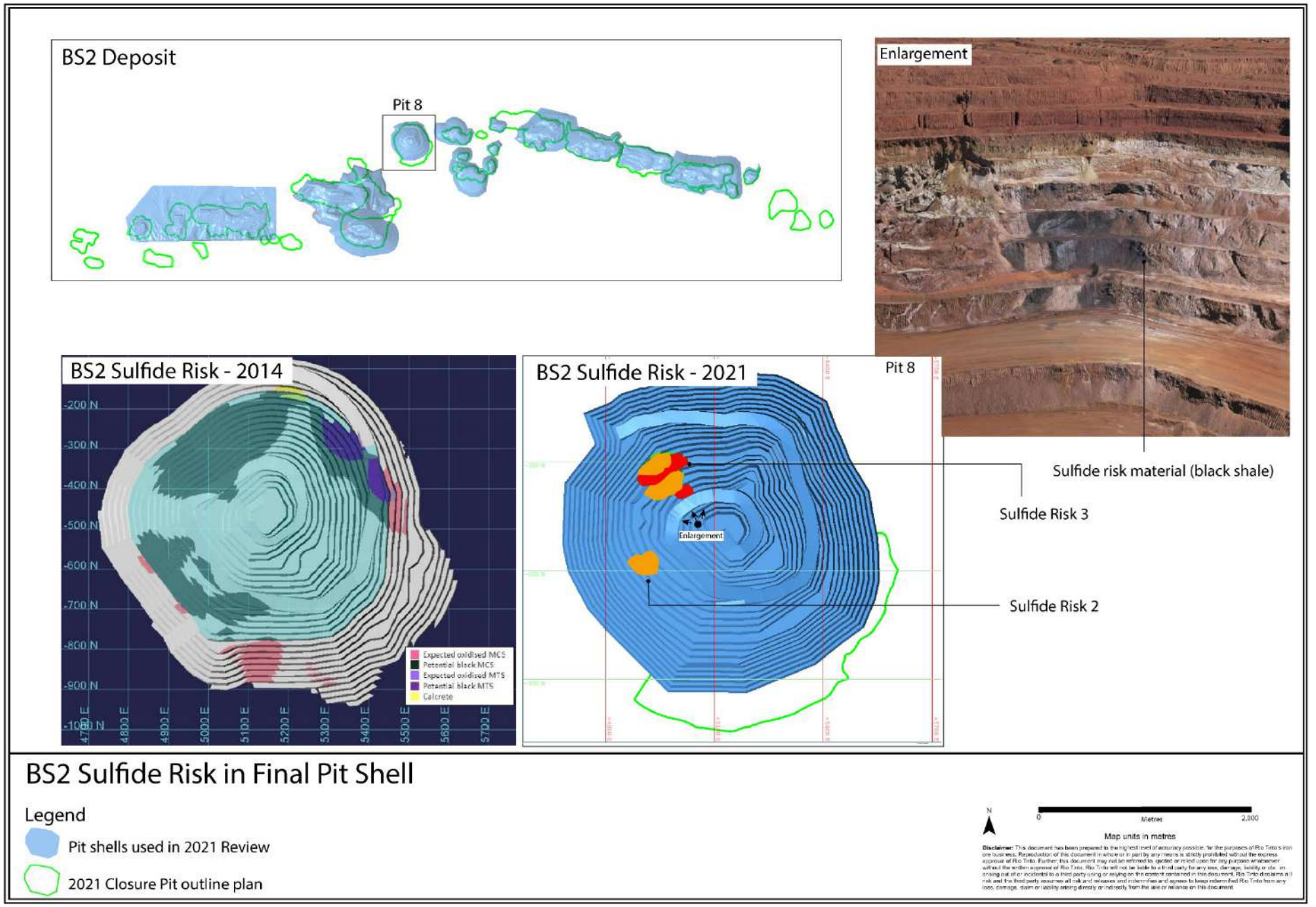


Figure 3 – BS2 Sulfide Risk areas in Pit 8



Appendix 15: Silvergrass East AMD Risk Assessment Review 2021

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Internal memo

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CC: Steven Lee

Reference: RTIO-PDE-0184847

Date: 20 August 2021

Silvergrass East AMD Risk Assessment Review 2021

1 Introduction

A review of the acid and metalliferous draining (AMD) risk for the Silvergrass East (SGE) deposit has been undertaken to support the Greater Brockman Mine Closure Plan (MCP). This review aims to compare previously reported drillhole data, mine plan and pit shells with any new updated information since the AMD Risk Assessment (RTIO, 2010) and Review (RTIO, 2014).

2 Background

A full AMD Risk Assessment was undertaken by Rio Tinto in 2010 and encompassed pits 1,2,4,5. A review of this Risk Assessment was undertaken in 2014 and included any updated/significantly altered mine data (Table 1 and Figure 1). The 2021 Review provides information on the variations in the pit shell geometry (as to July 2021) and updates to the mine models since 2014 and includes all the pits previously assessed in the 2010 and 2014 SGE AMD risk review along with the newly added Pit 7, situated to the south west of the mine area. Pit 8 was still conceptual at the time of reporting and therefore is neither included in the mine model nor in this review.

As detailed in the 2010 AMD Risk Assessment and the 2014 Review, SGE is classified as Low Risk for AMD.

Table 1 – Comparison of mine models and pit shells

Date of Assessment	Geological Model	Mine Model	Pit Shell Triangulations
2010	-	silvipr_slve_20100506_001	sge_pit1_c.00t, sge_pit2_c.00t, sge_pit4.00t, sge_pit5_c.00t
2014	-	silvepr_slve_20140422_002	slve_fs_pit1_v3_cut.00t slve_fs_pit1e_v1_cut.00t slve_fs_pit2_v3_cut.00t slve_fs_pit3_4_v3_cut.00t slve_fs_pit5_v1_cut.00t slve_fs_pit6_v1_cut.00t
2021	silv_slve_201907_01.bmf	silviprdp_slve_20201029_015	slve_pit1_us408.00t slve_pit2_uf05.00t slve_pit3_uf05.00t slve_pit5_uf02.00t slve_pit7_ui101.00t

3 Data Comparison

3.1 Planned Mine Geometry

Table 1 presents all the mine models and pit shells used in the previous (2010 and 2014) and current (2021) SGE AMD Risk Assessment Reviews. Figure 1 presents a comparison between the 2014 and 2021 planned pit shells, showing the variations and updated geometry. Figure 1 also shows the closure pit outlines in comparison to the operational pit outlines utilised in this report. Figure 2 presents a comparison between the outlines of the latest mine model and closure pits shells. There is some variation in the closure and operational pit outlines, most notably at Pit 5 extension and Pit 8. The inclusion of these areas within the mine model and / or AMD risk analysis will be updated when data becomes available.

3.2 Sulfur Analysis of Drill Hole Data

A review of drillhole database identified 8 new drill holes advanced in pit (inside the pit design) since 2014. This resulted in an additional 184 assayed geology samples, as detailed in Table 2. The number of elevated sulfur samples are within the range of concentrations seen during the 2014 Risk Assessment. Table 3 summarises the sulfur concentrations per rock type. Elevated concentrations of sulfur were identified in CAL, DET and NEW rock units, similar to that seen during the 2014 AMD risk review.

Table 2 – In pit sulfur analysis summary for SGE

	Total number of in pit sulfur samples analysed		Percentage of in pit samples with S>0.1%		Percentage of in pit samples with S>0.3%	
Pit	**1973 - 2014**	**2015 - 2021**	**1973 - 2014**	**2015 - 2021**	**1973 - 2014**	**2015 - 2021**
All pits	50,740	184	1.32%	3.80%	0.22%	1.09%

Table 3 – Summary in pit sulfur data for SGE

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	25	0	0.00%	0	0.00%	0.02	-
CAL	**36**	**2**	**5.56%**	1	2.78%	0.05	0.45
DET WASTE	**39**	**3**	**7.69%**	1	2.56%	0.05	0.31
DET ORE	7	0	0.00%	0	0.00%	0.02	-
ANG ORE	1	0	0.00%	0	0.00%	0.02	-
WF WASTE	10	0	0.00%	0	0.00%	0.01	-
NEW WASTE	**37**	**2**	**5.41%**	0	0.00%	0.03	0.21
NEW ORE	11	0	0.00%	0	0.00%	0.01	-
NEW HYD	18	0	0.00%	0	0.00%	0.01	-

Total number of samples assayed for S	184	
Total number of samples with S>0.1/0.3%	7	2
Percentage of total with S>0.1/0.3%	3.80%	1.09%
Total number of waste samples assayed for S [a]	147	
Total number of waste samples with S>0.1/0.3%	7	2
Percentage of total waste samples with S>0.1/0.3%	4.76%	1.36%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

3.3 Sulfide Risk within Mining Model

From the mining model (silviprdp_slve_20201029_015), approximately 476 Mt of BS_oxide is scheduled to be mined from SGE. There is no BS_hot material expected and only 0.08 Mt of BS_cold predicted to be mined (Table 4).

Table 4 - Predicted waste material across the SGE deposits

Waste Type	Total tonnages (Mt)	
	2010/2014	2021 [a]
Low Risk BS_Oxide	Not reported	476
Moderate Risk BS_Cold	Not reported	0.08
High Risk BS_Hot	Not reported	0.00

[a] model used - silviprdp_slve_20201029_015

3.4 Sulfide Exposure Risk on Final Pit Walls

Based on the operational pit shells, there will be no exposure of SR2 or SR3 material on the final pit walls. Figure 3 depicts the SR2 blocks expected to be mined, but these blocks are not situated adjacent to the final pit wall and will not result in exposures.

4 Discussion and Conclusions

From this review, it has been determined that the low acid and geochemical risk assigned to the SGE deposit in 2010 and 2014 remains current. The AMD risk assessment should be reviewed if significant quantities of elevated sulfur Newman and MacLeod waste is expected to be mined to ensure that sulfidic material is not exposed. This review should also be updated when Pit 5 extension and Pit 8 are included within the mine model. No SR2 or SR3 material is expected to be encountered on the final pit walls with only minor quantities (0.08 Mt) of BS_oxide material predicted to be mined from Pit 5.

5 References

RTIO, 2010, Silvergrass East ARD and Geochemical Risk Assessment, RTIO-PDE-0079188, September 2010.

RTIO, 2014, Review of Acid and Metalliferous Drainage risk at Silvergrass East, May 2014.

Figure 1 – SGE Pit outline comparison

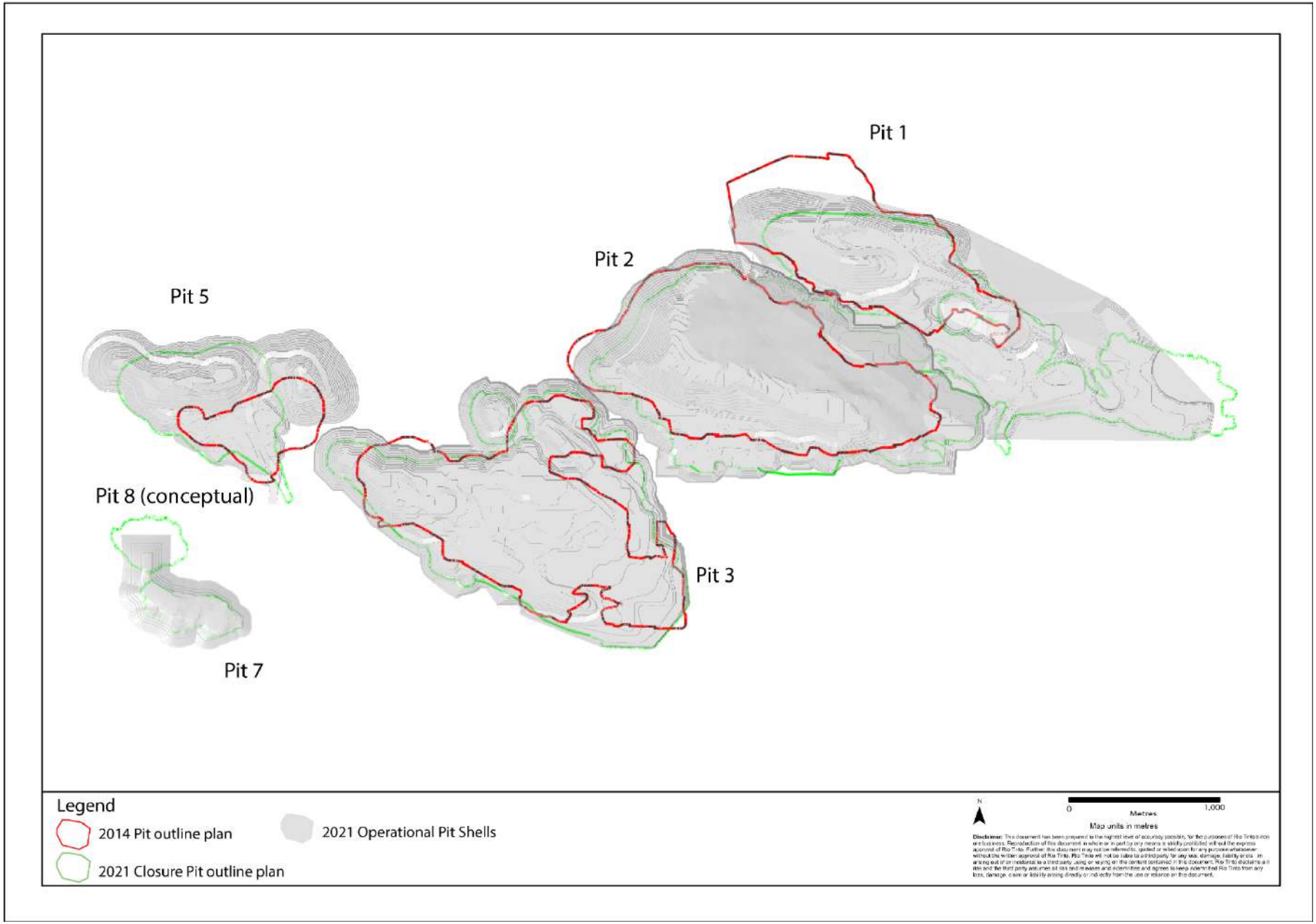


Figure 2 – SGE Pit outline and mine model comparison

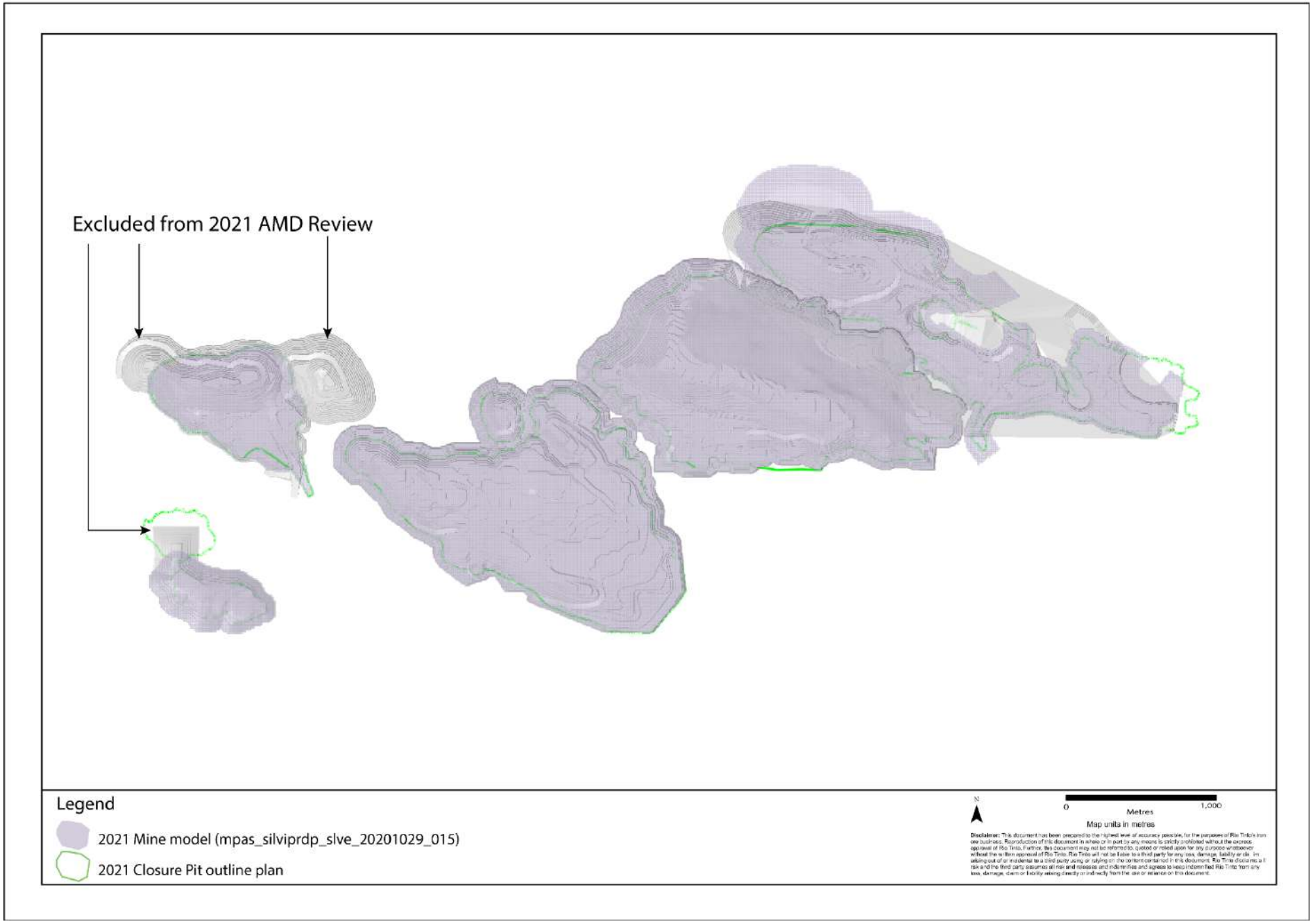
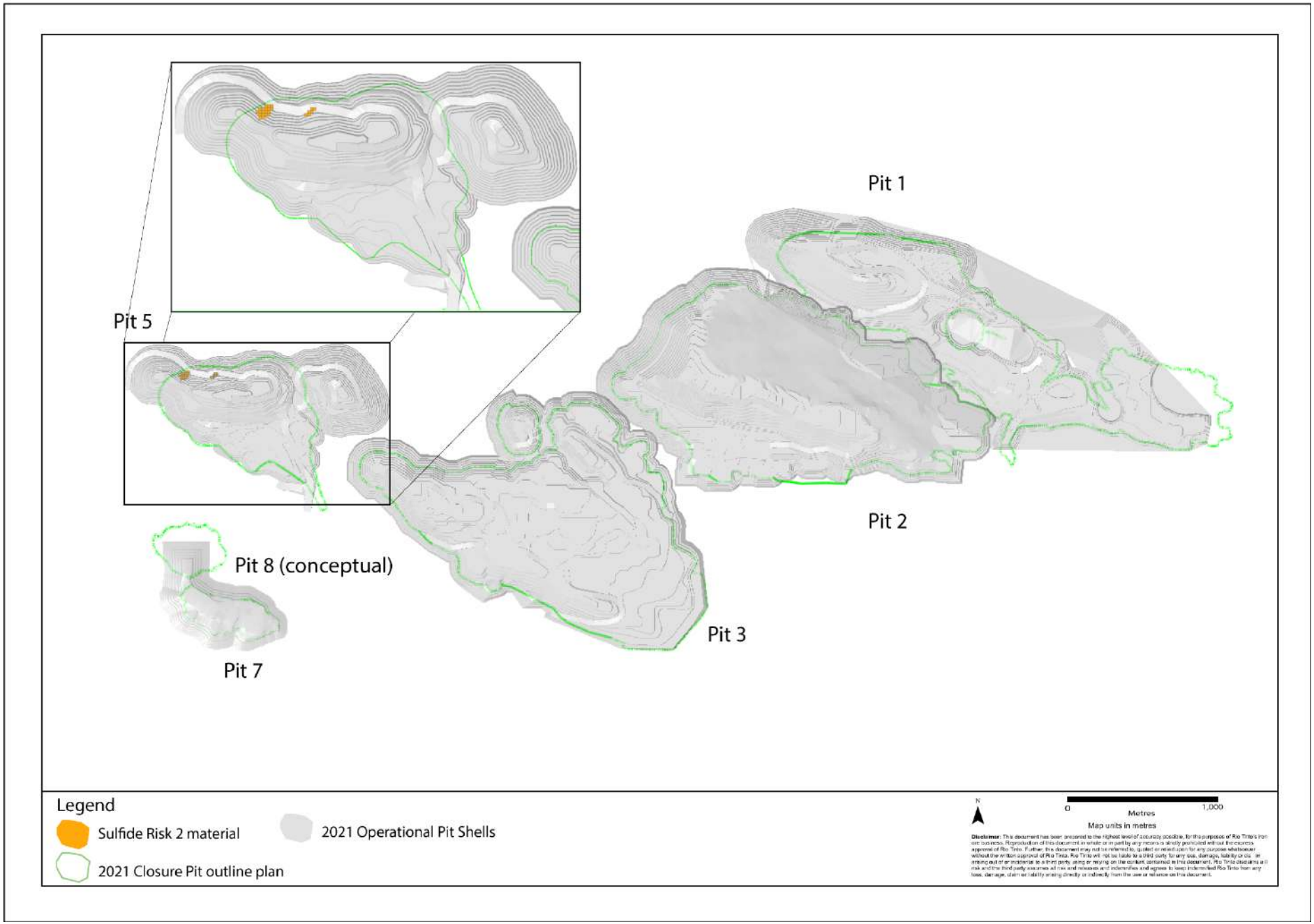


Figure 3 – SGE Sulfide Risk areas. Note, the SR2 material shown in Pit 5 are not adjacent the Pit wall (i.e. not exposures).



Appendix 16: Greater Brockman 2021 AMD Risk Assessment to support the Brockman Syncline Proposal

Rio Tinto Iron Ore
Pilbara Operations

2021 AMD Risk Assessment

Greater Brockman

March 2021

Author: Sam McHarg

Review: Keith Brown

Distribution List	Document Control
Laura True - Specialist Closure Planning, Studies & Technology	Version: 1.0
Jonathon Barker - Senior Advisor, Environmental Approvals	Reviewed by: Keith Brown
	Date: March 2021
	Improvement Driver:

Approved for Internal Circulation Only

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Executive Summary

As part of its mining operations within the Pilbara region of Western Australia, Rio Tinto Iron Ore are required to undertake characterisation of waste rock, including the assessment of risks associated with acid and metalliferous mine drainage (AMD) and spontaneous combustion. This report aims to assess the AMD risk associated with the Greater Brockman region which includes all/a portion of the following project areas: BS1, BS2, BS3/4, BS33X/Lens G and BSMM. This report supersedes the AMD risk assessment previously undertaken for the BS4 deposits (RTIO, 2015).

The assessment has taken into account sulfur concentrations within drillhole samples, logging data to indicate the presence of sulfide or sulfate minerals, estimated tonnages and pit shells, ABA data from regional investigations and geochemical data to identify enriched concentrations of elements which may pose an environmental risk.

Considering ABA data compiled from a number of investigations including RGS (2021), RTIO (2017), SRK (2016), SRK (2015) and SRK (2013) the majority of samples collected representing the geological formations likely to be encountered during mining are broadly Non Acid Forming with only a small portion classified as Potentially Acid Forming. Sequences with samples identified as Potentially Acid Forming include detritals, Mt McRae Shale and Wittenoom Formation and those samples typically containing lignite (within the detrital sequence and not identified within the Greater Brockman area) and pyrite. This would suggest the risk of AMD from across the Greater Brockman project area as low.

The project area and in-pit sulfur analysis identified a number of low and moderate risk sequences, with high risk sequences limited to MCS WASTE (Black) and NAM WASTE within BS1, BS2 and BS3/4 at the project level sulfur analysis. The in-pit sulfur analysis identified only a single high risk sequence and was based on the project level risk due to an absence of pit shell data for the BS2 project.

Considering the mine models / pit shells for the Greater Brockman area, sulfur Risk 2 and 3 material was identified in BS1, BS3/4 and BSMM pits, with BS1 containing the largest quantity Risk 2 and 3 waste. A review of the likely exposure of Risk 2 and 3 material in the final pit void identified BS1, BS3/4 and BSMM likely exposing Risk 2 and 3 material. Based on this assessment, the existing sulfur cut-off levels of 0.1% and 0.3% in defining Risk 2 and 3 material are considered appropriate until additional site specific data are collected. It should be noted that the pit shells will change over time and updates to the geological and mining models will be made; the tonnages reported in this document are subject to change.

Geochemical data suggests a number of elements, including Fe, As, Sn, Co, Cr, Cu, Mn, Ni, Pb, V and Zn are enriched or elevated in relation to GAI and/or DEC triggers. Given the mineralised nature of the Pilbara, elevated concentrations of metals are not unexpected and it is considered likely that surrounding receptors have adapted to the naturally elevated concentrations. Regular groundwater monitoring in and around mining activities should be undertaken to determine background groundwater concentrations and confirm any impact from waste rock dumps.

On the basis of the above data, an AMD hazard scorecard ranks each deposit as follows:

- BS1 – Moderate AMD risk
- BS2 – Moderate AMD risk
- BS3/4 – Moderate AMD risk
- BS3X/Lens G – Low AMD risk
- BSMM – Moderate AMD risk

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1. Introduction

As part of its mining operations within the Pilbara region of Western Australia, Rio Tinto Iron Ore are required to undertake characterisation of waste rock, including the assessment of risks associated with acid and metalliferous mine drainage (AMD) and spontaneous combustion. This report aims to assess the AMD risk associated with the Greater Brockman region. This report supersedes the AMD risk assessment previously undertaken for the BS4 deposits (RTIO, 2015).

Acid and metalliferous drainage and spontaneous combustion risk within the Pilbara is associated with disturbance and subsequent oxidation of certain mineral groups (i.e. sulfides/sulfates) known to be present within the Hamersley Group and overlying detrital sequences. This assessment includes the analysis of:

- Total sulfur concentrations within rock types in the general mining area (based on drillhole data);
- Total sulfur concentrations within rock types in the individual pit shells;
- Logging data to indicate whether sulfur is in the form of sulfide or sulfate minerals;
- Acid base accounting data including the measured acid neutralising capacity of waste rock types;
- The calculated net potential ratio (NPR) to assess the overall risk of acid generation from waste rock exposed in each mining area;
- The estimated tonnes and pit wall exposures of black Mount McRae Shale (MCS) expected during mining and upon closure, based on the recent mining models and proposed pit shells;
- Geochemical data to identify enriched concentrations of elements which may pose an environmental risk; and
- A review of previous investigations undertaken for the Greater Brockman area.

2. Background Information and Surrounding Environment

The Greater Brockman Project Area is located approximately 60 km northwest of Tom Price and 300 km southeast of Dampier in Western Australia (Figure 1). The area is dominated by the Brockman Syncline, a north west trending structure hosted by Archaean to Lower Proterozoic Fortescue and Hamersley Group sequences.

The basement geology of the Brockman Syncline comprises the three Groups of the Mount Bruce Supergroup; the Fortescue, Hamersley and Turee Creek Groups. The Turee Creek Group is inferred in the centre of the syncline beneath Cainozoic transported sediments. These groups are arranged in a large syncline structure with a broadly east to west axis.

The upper most member of the Fortescue Group is the Roy Hill Shale Member of the Jeerinah Formation comprising dark grey to black shale, commonly with spheroidal pyrite concretions (MacLeod and de la Hunty 1966). An abundance of dolerite sills is a common feature of the upper units of the Fortescue Group and is commonly encountered around the Brockman Syncline.

The lowermost unit of the Hamersley Group is the Marra Mamba Iron Formation, which is separated into three constituent members; Nammuldi, MacLeod and Mount Newman Members. Within the Hamersley Group, the upper most Mount Newman Member is most commonly enriched with iron ore by supergene enrichment. The lower most Nammuldi Member comprises cherty, banded iron formation interbedded with thin shales. The un-mineralised Nammuldi Member is between 75 and 100 m thick, with the hard, resistant cherty nature of the banded iron generally forming the high points of the Marra Mamba Iron Formation ridges that parallel the higher peaks of the Brockman Iron Formation. The MacLeod Member conformably overlies the Nammuldi Member and comprises banded iron, chert and carbonate along with interbedded shales. The MacLeod Member when un-mineralised is 25 to 45 m thick. The upper most section contains shale units, closely spaced together, which give a characteristic gamma signal separating it from the upper Mount Newman Member. The Mount Newman Member conformably overlies the MacLeod Member and comprises banded iron interbedded with carbonate and shale. It is commonly the most iron enriched unit in the Marra Mamba Iron Formation within the Hamersley Group. The un-mineralised Mount Newman Member is between 45 and 60 m thick. There are eight identified shale bands within the Mount Newman Member, the most significant being the twin bands of shale known as NS3 and NS4, that owing to their thickness, generally prevent the supergene enrichment of banded iron in the lower Mount Newman Member.

The Wittenoom Formation is separated into three members; the West Angela, Paraburdoo and Bee Gorge Members. The West Angela Member contains predominantly massive to laminated dolomite interbedded with shaley dolomite with pyrite and chert. Chert is a minor component in the upper part of the member but increases with depth (Blockley, et. al. 1993). The shaley dolomite comprises thinly bedded grey crystalline dolomite interbedded with carbonaceous shale and siltstone. This member conformably overlies the Mount Newman Member of the Marra Mamba Iron Formation and is between 30 and 50 m thick. The Paraburdoo Member comprises dolomite with minor amounts of chert. The exact thickness of the Paraburdoo Member is not well known, it may be between 260 and 420 m thick, however weathering and dissolution of carbonate rock has resulted in significant thinning in the Brockman Syncline (Simonson et. al., 1993). The Bee Gorge Member is described as a thinly laminated fissile argillite (Simonson et. al. 1993). Besides the argillite, it contains subordinate thicknesses of carbonate, chert, volcaniclastic and iron formation. It also contains distinct marker beds, the most recognisable in the field being the Main Tuff Interval, comprising a 4 to 16m thick sequence of pyroclastic turbidite (Simonson, et. al., 1993). The Bee Gorge Member ranges in thickness from 100 to

220 m. Dissolution of the thin carbonate beds has resulted in significant thinning of the Bee Gorge Member around the Brockman Syncline.

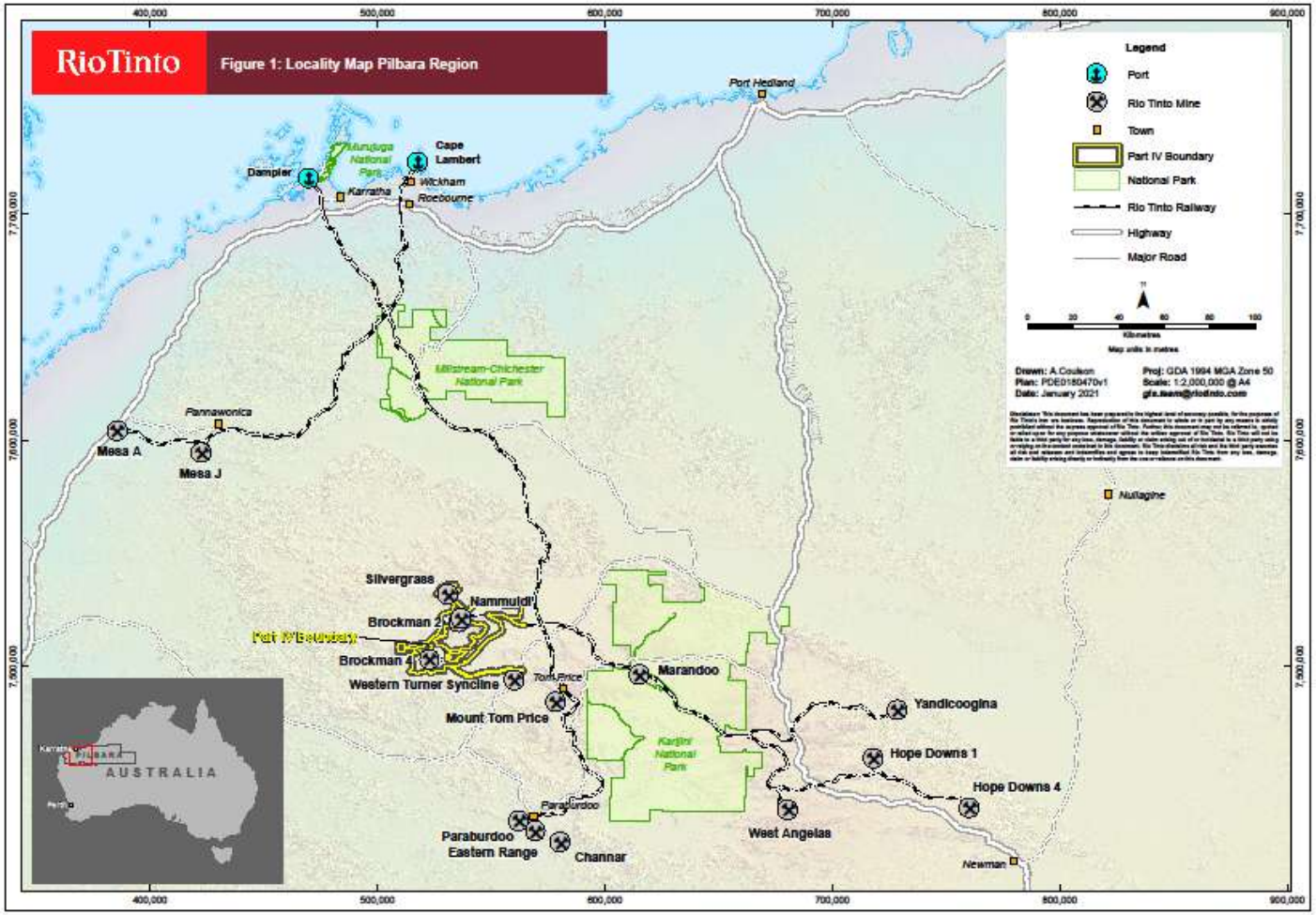
The Mount Sylvia Formation conformably overlies the Wittenoom Formation and consists of three prominent banded iron formation (BIF) bands, separated by laminated mudstone, minor chert and dolomite (Seymour, et. al., 1988). The most prominent BIF band lies at the top of the Mount Sylvia Formation and is known colloquially as Bruno's band, the two lower bands are known as the "tram tracks" and these form recognisable regional markers beds on the slopes of the Hamersley Group. The thickness of the Mount Sylvia Formation is variable from 30 to 45 m. The Mount McRae Shale conformably overlies the Mount Sylvia Formation and comprises thinly laminated, fissile shale with minor subordinate amounts of chert, dolomite and BIF. Where unweathered it comprises a black graphitic and chloritic shale (Tyler, et. al., 1991). The unweathered Mount McRae Shale also contains significant pyrite, and represents a potential spontaneous combustion and acid forming material risk when exposed through mining.

The Brockman Iron Formation comprises of four members, the Dales Gorge, Whaleback Shale, Joffre and Yandicoogina Shale Members. The Brockman Iron Formation hosts the largest and highest-grade bedded iron deposits. The iron ore is mostly hosted within the Dales Gorge and Joffre Members. The BIF of the Brockman Iron Formation are typically hard, fine grained and have well developed vertical joint systems. The Dales Gorge Member conformably overlies the Mount McRae Shale and comprises an alternating sequence of BIF and shale macro-bands. The BIF bands comprise centimetre thick bands of chert and iron rich material in a chert matrix. The shale bands comprise shale like material, which is primarily volcanogenic and carbonate turbidite. The Dales Gorge Member type section is 140 m thick, however when mineralised thinning of the unit occurs. The Whaleback Shale conformably overlies the Dales Gorge Member and is approximately 50 m thick. This member consists of thinly bedded shales with thicker chert or BIF bands. The Whaleback Shale is often weathered along with the supergene enrichment of the BIF bands both above and below it. The Joffre Member conformably overlies the Whaleback Shale Member. The Joffre member is characterised by its homogeneity, with approximately 330 m of alternating banded iron formation and shale bands. The banded iron comprises interbedded chert and iron rich material. The Joffre Member of the Brockman Syncline is noted for a significant dolerite sill within the upper half of the member that forms a prominent gully along the edge of the high ridges. The Yandicoogina Shale conformably overlies the Joffre Member and comprises alternating chert and shale up to 60 m thick. The Yandicoogina Shale has also been intruded by multiple dolerite sills.

The upper Hamersley Group above the Brockman Iron Formation comprises the Weeli Wolli Formation, the Woongarra Volcanics and the Boolgeeda Iron Formation. The Weeli Wolli Formation conformably overlies the Brockman Iron Formation and comprises thinly laminated cherty and jaspilite banded iron, mudstone, siltstone and numerous thick dolerite sills. The Woongarra Volcanics comprises rhyodacite to rhyolitic volcanic rocks and jaspilite banded iron formation. At the top of the Hamersley Group is the Boolgeeda Iron Formation comprising fine-grained, finely laminated, dark grey-brown to black flaggy iron-formation, minor chert, jaspilite and shale.

Dolerite dykes are present across the Pilbara, and in particular, across the Brockman Syncline. The dykes generally trend NW-SE, NNW-SSE and NE-SW. The dykes are generally believed to be near vertical and intruded post the D3 Panhandle Orogeny (Müller, et. al., 2005). Associated with or post-dating the Panhandle Orogeny, reactivation of NW striking faults coupled with NW striking SW dipping normal faults formed horst and graben structures in the Brockman Syncline (Dalstra 2006).

Figure 1 – Greater Brockman Part IV project and prospect areas.



2.1 Mineralisation

Mineralisation within the study area is typically hosted by the Brockman Iron Formation (Joffre (JOF), Dales Gorge (DG) and the Whaleback Shale (WS) Members) and Marra Mamba Formation (Mount Newman and MacLeod Members). In addition, small accumulations of detrital (DET) iron ore occur as cover over the bedded mineralisation. Late-stage weathering processes have modified the second generation ores resulting in a highly variable zone of hydrated hematite goethite material. Waste rock includes DET cover, Joffre Member banded iron formation (BIF), WS BIF and shale, DG BIF and shale, Footwall Zone (FWZ) BIF, and MCS. Drillholes in the area have also intersected the Weeli Wolli Formation and Woongarra Volcanics. The area is also dissected by NW trending, high-angle, normal faults which are often intruded by NW-SE trending dolerite (DOR) dykes.

Sulfide minerals occur through the sequence however the MCS, dominated by pyritic shale is typically the highest AMD risk material within the sequence. Depending on the quantity of pyritic sulfur in the material, MCS should be delineated into either cold or hot MCS; both pose an acid drainage risk, but the hot MCS poses an additional self-heating and spontaneous combustion risk due to higher pyrite concentrations.

2.2 Study Project Areas

The AMD Risk Assessment has been divided into a number of areas, based primarily on Rio Tinto project areas while considering the deposit type. Details are provided in Table 1 and presented in Figure 3.

Table 1 – Summary of deposit type and project area

Project area	Deposit type	Prospect Area
BS1	Brockman	BS1W
		BS1E
BS2	Brockman	BS2W
		BS2E
BS3/BS4	Brockman	BS3
		BSMM
		BSMN
		Endeavour
		BS4E
BS3X/BSNA (Lens G)	Marra Mamba	Lens G
		Sandringham
		Diesel
		Lauriston
		Monkey
		Creekside
		Brokenwood
		BSMJ
BSMM	Marra Mamba	BSMO
		BSMQ
		BSMR

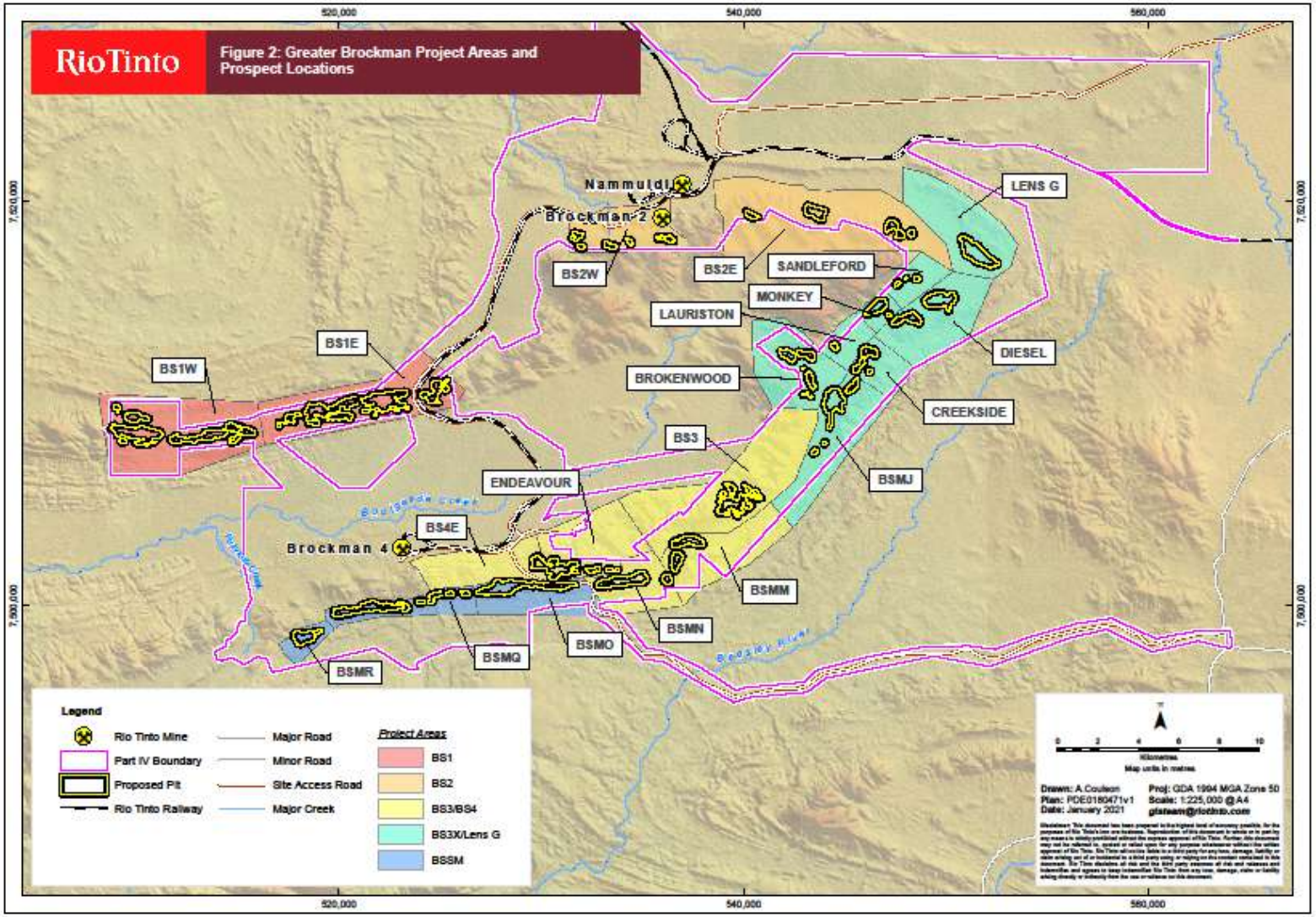
2.3 Rock units

This report will reference a number of rock units that are closely aligned to the stratigraphy of the Greater Brockman region. Table 2 details the abbreviation and an explanation for each rock unit.

Table 2 – Rock units utilised in this assessment

Rock Unit / abbreviation	Explanation	Rock Unit / abbreviation	Explanation
CLA	Detrital – clay (waste)	FWZ ORE	Footwall Zone ore
CAL	Detrital – calcrete (waste)	MCS WASTE (oxidised)	Oxidised Mt McRae Shale waste
DET WASTE	Detrital waste	MCS WASTE (black)	Unoxidised Mt McRae Shale waste
DET ORE	Detrital ore	MCS ORE	Mt McRae Shale ore
DOR	Dolerite (waste)	MCS HYD	Mt McRae Shale hydrated ore
WW WASTE	Weeli Wolli waste	MTS WASTE	Mt Sylvia waste
YAN WASTE	Yandicoogina Shale waste	MTS ORE	Mt Sylvia ore
YAN ORE	Yandicoogina Shale ore	WF WASTE	Wittenoom waste
YAN HYD	Yandicoogina Shale hydrated ore	ANG ORE	West Angela ore
JOF WASTE	Joffre waste	ANG HYD	West Angela hydrated ore
JOF ORE	Joffre ore	NEW WASTE	Mt Newman waste
JOF HYD	Joffre hydrated ore	NEW ORE	Mt Newman ore
WS WASTE	Whaleback Shale waste	NEW HYD	Mt Newman hydrated ore
WS ORE	Whaleback Shale ore	MAC WASTE	Macleod waste
WS HYD	Whaleback Shale hydrated ore	MAC ORE	Macleod ore
DG WASTE	Dales Gorge waste	NAM WASTE	Macleod hydrated ore
DG ORE	Dales Gorge ore	NAM ORE	Nammuldi ore
DG HYD	Dales Gorge hydrated ore	FOR WASTE	Fortescue Group Waste
FWZ WASTE	Footwall Zone waste		

Figure 2 – Project/prospect locations and proposed pit geometries.



3. Risk Assessment and Mineral Waste Classification Process

The risk assessment process followed within this assessment is detailed in the Geochemical Risk Assessment Process for Rio Tinto's Pilbara Iron Ore Mines (Green and Borden, 2011) and in Mineral Waste Management in the Pilbara: A Position Statement (RTIO, 2012). A risk-based process is used to identify those rock types which require specific management to mitigate the impacts associated with AMD.

It is recognised that sulfur-related AMD includes acid drainage (elevated concentrations of contaminants (metals and metalloids) at low-pH) and neutral drainage (elevated concentrations of contaminants at near-neutral pH) (INAP, 2010). For those rock types associated with sulfides or some sulfate minerals, it is understood that metalliferous drainage requires, at a minimum, low-pH conditions on a microscopic scale as a mechanism to initially solubilise contaminants. If the potentially acid forming (PAF) rock also has sufficient acid neutralising capacity (ANC), the acid generated is subsequently neutralised; however, it is noted that concentrations of some contaminants (e.g. Zn, As, Ni, and Cd) may not precipitate at near-neutral pH and remain in solution resulting in poor-quality drainage.

An analysis of total sulfur in mineral waste will identify the likelihood for that rock type to generate acidity which may lead to poor quality drainage characterised by either low-pH or near-neutral pH. Mineral waste is defined as waste rock and tailings that are exposed or produced during operations, as well as pit voids which remain upon closure. The innate AMD hazard associated with a project area and its type of mineral waste is assessed by the Rio Tinto AMD Hazard Score. This score takes into account geology/geochemistry, incipient risk, the scale of disturbance, transport pathways, and receiving environments. It should be noted that the AMD Hazard Score used as part of this assessment has been modified specifically for RTIO Pilbara operations to be more reflective of conditions at those sites; for instance, an iron ore operation may have attained a score such that it poses a high AMD hazard relative to other RTIO (WA) operations, however it may only pose a moderate AMD hazard relative to a copper operation.

With regards to sulfur-related AMD as defined above, mineral waste is characterised by undertaking a geochemical assessment based on an analysis of total sulfur assay values. Sulfur trigger values are predetermined based on the results of static ABA, mineralogy, and kinetic column leach tests which RTIO (WA) has completed to identify the potential for certain rock types to generate acidity. These tests are completed using nationally and internationally recognised methods (e.g. Sobek, 1978; Miller, 1997, as referenced in Maest et al., 2005, AMIRA, 2002).

The analysis of the existing ABA data for Pilbara-wide black MCS confirms that a sulfur cut-off of 0.1% could be adopted as the boundary value to delineate potential acid forming (PAF) material from inert/non-acid forming (NAF) material. For other lithologies such as BIF and detrital rock types, including lignite (LIG) and siderite (SID), a 0.3% total sulfur concentration may be the most appropriate trigger value (RTIO, 2008); the applicability of this higher trigger value is based on low net acid generation derived from sulfate minerals and relatively high ANC. Sulfur cut-off levels of both 0.1% and 0.3% are considered for the purpose of this assessment, where a sulfur cut-off of 0.1% may be more relevant to the Brockman deposit area and a cut-off of 0.3% may be more relevant to the Marra Mamba deposit area. For some rock types such as Wittenoom Formation dolomite which may be common to both areas, a sulfur cut-off of 0.3% may be applicable. The risk classification adopted for Greater Brockman is presented in Table 3.

In oxidised material, it has been shown that sulfur may be in the form of the sulfate mineral alunite ((KAl3(SO4)2(OH)6)). There is potential for relatively low levels of acid release from elevated-sulfate material (when compared against acid release from sulfide minerals), since the low solubility of alunite may result in a low flux of acid (and contaminant) release. Oxidised samples associated with elevated sulfate (where sulfur values may range from 0.1% to greater than 1%) have been classified as

potentially acid forming in a low-capacity (PAF-LC). A sulfur cut-off value of 0.1% is used to characterise elevated sulfur (sulfate) material (SRK, 2013).

Poor quality drainage (not related to sulfur) may also result from contaminants soluble at neutral pH. Many minerals are unstable when exposed to the atmosphere after disturbance; dissolution of readily soluble salts may mobilise minor and trace elements into pore water that may then be transported into the surrounding environment via surficial or internal drainage. Mineral waste is characterised for this risk by considering elemental assay analysis (elemental enrichment), as well as results from liquid extract tests, kinetic column leach tests, and mineralogy (e.g. the oxidation state of minerals characterising the rock type). The assessment for this risk is addressed in Section 9.

Table 3 – Sulfide risk classification definition

Waste Type	Definition
Sulfur risk 1 (Low Risk BS-Oxide)	Oxidised shale which is typically above the water table, contains few intact sulfides, has less than 0.1% total sulfur, and is characterised by red, yellow, orange, and white colours. The potential for reactivity occurs due to the spontaneous oxidation of pyrite and carbon within fresh shale. This reaction has reached equilibrium in oxidised shale, therefore the shale poses little ARD risk and no self heating risk. This material is classified as non-acid forming by acid base accounting test work.
Sulfur risk 2 (Moderate Risk BS-Cold)	Non-reactive (cold) black shale which is located below the water table and locally immediately above the water table and has total sulfur concentrations less than 0.1% common. This shale may represent a partially oxidised zone containing material which is neither all black nor the typical oxidised colours. This shale poses a low ARD risk, and low self heating risk. This material is classified is either non-acid forming or is potentially acid forming with a low capacity by acid base accounting test work.
Sulfur risk 3 (High Risk BS-Hot)	Reactive (hot) black shale which is located below the water table and locally immediately above the water table and has total sulfur concentrations greater than 7% common. This shale may be completely fresh, or represent a partially oxidised zone, and poses both a high ARD risk and self heating risk.

4. Acid Base Accounting and Geochemical Test Work

A number of previous investigations have been carried out regarding geochemical characterisation and ABA test work across the Greater Brockman area. A selection of these reports are identified below and summarised in Sections 4.1 - 4.5. Figure 3 presents the locations of samples of these investigations in relation to the Greater Brockman AMD Risk Assessment project area.

- RGS (2021), Technical Report – Greater Brockman Geochemistry Assessment (2021).
- Rio Tinto (2017) – Greater Brockman AMD Assessment
- SRK Consulting (2016) - Brockman Syncline 4 – Geochemical Characterisation of Mount McRae Shale Samples, RTS122, November 2016.
- SRK Consulting (2015) - Brockman Syncline 4 – Geochemical Characterisation of Samples from the Marra Mamba Deposit, RTS128, December 2015.
- SRK Consulting (2013) - Geochemical Characterisation of Nammuldi / BS2 Low Sulfur Material, RTS056, June 2013.

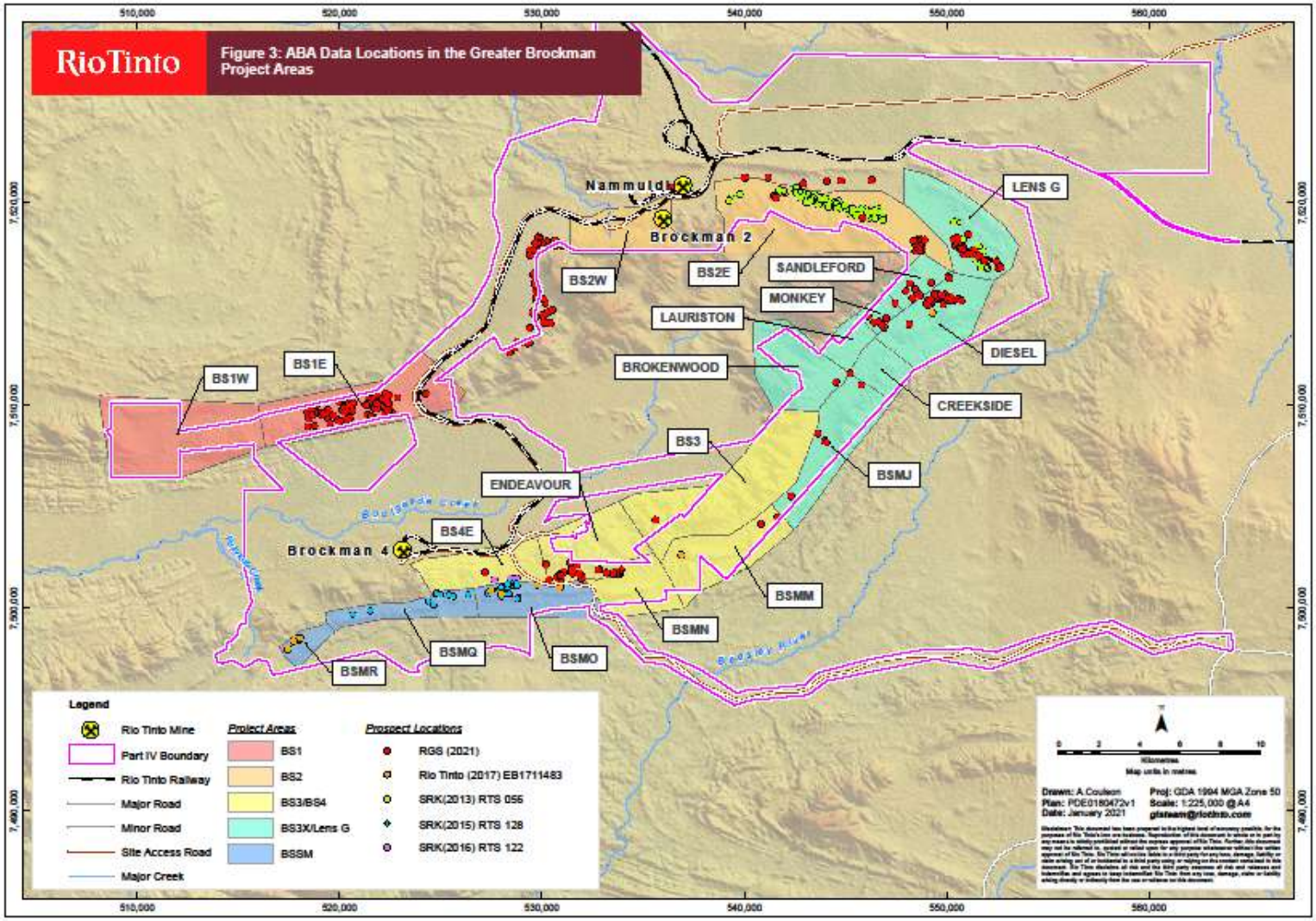
4.1 RGS Technical Report (2021) – Greater Brockman Geochemistry Assessment

RGS were commissioned to undertake a geochemical assessment across the Greater Brockman project area. The RGS scope of work includes samples sourced from the areas both internal and external to this AMD Risk Assessment project area. The locations of the samples included in the RGS Technical Report in relation to the Greater Brockman project area are depicted in Figure 3.

The main findings of the RGS assessment are summarised below. A full copy of the assessment is provided in Appendix 1.

- A selection of 390 samples were analysed for a number of parameters, including; paste pH and EC, net acid production potential (NAPP), net acid generating (NAG) tests, multi element chemical assay, sulfur and carbon speciation, acid buffering characteristic curve (ABCC), x-ray diffraction (XRD), sulfur speciation, nitrogen analysis and leachate analysis.
- The total sulfur content of the samples was <0.01% S to 1.8% S, with an average value of 0.04 % S. Of the 390 samples, 366 have low total sulfur concentrations that are comparable to the average crustal abundance for sulfur of 0.1 % (INAP, 2009). Materials with a sulfur content less than or equal to 0.1% S are essentially barren of sulfur and have negligible capacity to generate acidity.
- Sulfur speciation tests using the chromium reducible sulfur method verify that ~63 to 100% of the total sulfur is present as sulfide sulfur in samples with a total sulfur content >0.5% S. A 1:1 (total sulfur: sulfide sulfur) relationship is more evident for the Mount McRae Shale and the Marra Mamba Formation.
- Samples with higher ANC are generally associated with the Wittenoom Formation (dolomite lithology) (mean = 139.6 H_2SO_4/t) and detrital (calcrete lithology) (mean = 58.8 kg H_2SO_4/t). The corresponding ABCC results indicate that the majority of measured ANC is readily available to buffer acidification; this is particularly evident for samples associated with detrital (average = 94% available) and Wittenoom Formation (average = 93 % available). These samples correspond well with the presence of dolomite and/or calcite in the XRD results. The other stratigraphic units have mean measured ANC values of <11.5 kg H_2SO_4/t. The Joffre Member (mean = 2.5 kg H_2SO_4/t) and Whaleback Shale (mean = 3.1 kg H_2SO_4/t) showed the lowest average ANC values, indicating that these samples have little capacity to buffer any existing, or additional acidity generated through sulfide oxidation. The ABCC results indicate the samples associated with the Dales Gorge Member and dolerite contain less readily available ANC (average < 65%) compared to the measured ANC value.
- The calculated NAPP values ranges from -996 to +27.7 kg H_2SO_4/t. Positive NAPP values

Figure 3 – Previous investigation sample locations in relation to the Greater Brockman AMD Risk Assessment project area.



- (NAPP > +10 kg H_2SO_4/t) are generally associated with some Mount McRae Shale and detrital samples, while marginally positive NAPP values (i.e. 0 < NAPP < +10 kg H_2SO_4/t) are present in a variety of stratigraphic units with higher sample numbers contained in Whaleback Shale, Dales Gorge Member, Joffre Member and Mount McRae Shale samples.
- The NAG pH is variable for different samples from within the same stratigraphic and lithological units; however, the vast majority of samples reported circum neutral NAG pH values. Of the 390 samples tested, only 15 samples showed acidic NAG pH values (i.e. NAG pH < 4.5); these were typically associated with the Mount McRae Shale (7 samples), detrital (5 samples) and Wittenoom Formation (1 sample).
- The RGS classification criteria are consistent with AMIRA (2002) and show that 366 samples are classified as NAF-Barren, 7 samples are classified as NAF (Marra Mamba), 11 samples are classified as Uncertain (detrital, Mount McRae Shale, Whaleback Shale and Marra Mamba), 3 samples classified as PAF- low capacity (Whaleback Shale and Mount McRae Shale), and 3 samples are classified as acid forming (detrital, Mount McRae Shale and Wittenoom Formation).
- The GAI results indicate that of the metal(loid)s measured, Fe, As and Te are highly enriched compared to average crustal abundance in the majority of samples from each of the stratigraphic units (excluding As and Te in Dolerite, and Te in Mount Sylvia). Furthermore, Ca, Mg, Mn and Se are at times enriched in detrital; Mg, Mn, Hg, Se and Tl are at times enriched in the Wittenoom Formation; Mn is at times enriched in the Mount McRae Shale; and Se is at times enriched in the Dales Gorge and Joffre Member.
- The multi-element leach testing of water extracts (1:2 sample:water) have a pH range from pH 4.2 (acidic) to 9.4 (alkaline) with the majority of samples circum neutral (mean = 5.9). There are, however, 3 samples with a pH less than 6 (dolomite from Wittenoom Formation and Mount McRae Shale) and 10 samples with a pH greater than 9 (distributed in the stratigraphic units). The water extracts have EC values ranging from 91 to 2,610 µS/cm (median 369 µS/cm). There were only a few samples that showed elevated leached metal/metalloid concentrations; this included selenium, boron and arsenic from the Mount McRae Shale; and, selenium from detrital and Wittenoom Formation.
- The collective results discussed above highlight that there is a high factor of safety and generally a low potential of acid generation from these materials.

4.2 Rio Tinto (2017) - Greater Brockman AMD Assessment

Rio Tinto undertook an assessment of 26 samples from the detritals sequence, Wittenoom and Marra Mamba Formations. The main findings of the assessment are detailed below and sample locations presented on Figure 3.

- Sulfur concentrations ranged from 0.01 – 9.0% with an average of 1.2% S.
- ANC ranged from 1.2 – 948 kgH_2SO_4/t with an average of 150 kgH_2SO_4/t. Highest values were seen in samples containing calcite and/or dolomite sourced from both detritals and Wittenoom Formation.
- NAPP ranged from -948 to 248 kgH_2SO_4/t with an average of -88 kgH_2SO_4/t.
- Utilising the ARIMA (2002) classification, seven samples were classified as PAF, eight as NAF and 11 classified as uncertain.
- Four samples underwent ABCC analysis. Of the four samples, three showed poor buffering capacity with a single sample showing good buffering capacity between 5.5 – 7.5.

4.3 SRK Consulting (2016) - Brockman Syncline 4 – Geochemical Characterisation of Mt McRae Samples

SRK were commissioned to undertake a geochemical assessment including free-draining leach testing of 19 samples of waste rock from the Mount McRae Shale. The main findings of the SRK assessment are summarised below.

- Total sulfur content of the samples was 0.02 – 10.3% sulfur and comprised of sulfide (pyrite) and sulfate (alunite, jarosite and butlerite).
- ANC of samples is typically low (<10 kgH_2SO_4/t).
- Of the 19 samples submitted, seven were classified as PAF, seven as NAF and five as UC. One sample classed as UC was subsequently reclassified as PAF after generating acidic leachate in the kinetic test.
- Static leachate testing produced leachate of pH between 2.3 and 8.5, with the lower pH corresponding to samples with elevated sulfur. These samples also resulted in the highest solute concentrations.
- Element leachability did not appear to be related to the degree of enrichment in the sample.
- Kinetic leachate testing produced acidic leachate with a number of major and minor elements identified in the leachate.

4.4 SRK Consulting (2015) - Brockman Syncline 4 – Geochemical Characterisation of Samples from the Marra Mamba Deposit

SRK were commissioned to undertake geochemical characteristaion across the BS4 Marra Mamba deposits, which includes prospects BSMO, BSMQ and BSMR. The locations of the samples included in the SRK assessment in relation to the Greater Brockman project area depicted in Figure 3. The main findings of the SRK assessment are summarised below.

- The assessment involved the analysis of 48 waste rock samples from four stratigraphies (detritals, dolerite, Wittenoom and Marra Mamba Formations). The analysis included paste pH and electrical conductivity (EC) (at a 2:1 liquid to solid (L:S) ratio), total sulfur, ANC, NAG tests, multi-element chemical analysis, sulfate-sulfur, ABCC, XRD assessment and de-ionised (DI) water leach tests.
- The total sulfur content was generally low, less than 0.1%. Eight samples contained between 0.13% and 2.13% total sulfur. For seven of the eight samples, sulfur speciation was dominated by sulfate sulfur (alunite and gypsum were confirmed as minerals in a subset of samples). In the sample with the highest sulfur content, a Wittenoom Formation sample, the sulfide mineral pyrite dominated.
- The acid neutralising capacity (ANC) ranged between <0.5 kgH_2SO_4/t and 32.8 kgH_2SO_4/t and was low (<10 kgH_2SO_4/t) for the majority of samples (43 out of 48). In a subset of samples a portion of the ANC was found to be readily available to buffer above pH 6, suggesting the presence of carbonate minerals (calcite was identified in one of the samples).
- The majority of samples (41) were classified as non-acid forming (NAF), with an additional six samples classified as Uncertain (UC). Of the NAF samples, 33 were further classified in the 'barren' subclass as they contained low ANC (<5 kgH_2SO_4/t). The pyritic Wittenoom Formation sample was classified as potentially acid forming (PAF) with a low capacity (LC) to generate acidity.
- Elements that were enriched relative to average crustal abundances were As, Bi, Cd, Fe, Hg, In, Mn, Re, S, Sb, Se, Te, Tl and Zn. The greatest range of elemental enrichment occurs in samples from the Wittenoom Formation.

- Leach testing generally resulted in circum neutral leaches, pH 6.6 to 8. Most minor/trace elements leached at concentrations that were close to or below the limit of detection - but B, Ba, F, Mn, Si, Sr and Zn were readily detectable in the leachate from all samples.

4.5 SRK Consulting (2013) - Geochemical Characterisation of Nammuldi / BS2 Low Sulfur Material

SRK were commissioned to undertake a geochemical assessment across the Nammuldi / BS2 area, which includes the Lens G prospect included in this assessment. The locations of the samples included in the SRK assessment in relation to the Greater Brockman project area depicted in Figure 3. The main findings of the SRK assessment are summarised below.

- A selection of 282 samples were identified and analysed for a range of parameters including paste pH and EC, total sulfur, ANC, NAG tests, multi-element chemical analysis, sulfate-sulfur, ABCC, XRD assessment and de-ionised (DI) water leach tests.
- Twenty three of the samples were classified as potentially acid forming (PAF) and were sourced from the detritals sequence (containing lignite) and Wittenoom Formation. These samples contained between 0.2% and 7.5% total sulfur. Sulfur speciation test work identified the presence of the sulfide mineral pyrite (at concentrations up to 4%) as well as sulfate sulfur which comprised up to 13% of the total sulfur content, with NAG test work indicating that these samples could generate significant acidity (up to 248 kgH_2S0_4/t) within a short time of exposure.
- The neutralising potential of the samples was generally low, although around 37 samples had measured ANC values between 30 and 966 kg H_2SO_4/t. These samples were generally from the DET and WF stratigraphies (note that the ANC of the majority of DOR samples was low (<5 kg H_2SO_4/t) the average value is adversely influenced by a single sample with high ANC (240 kg H_2SO_4/t). The ANC test was found to overestimate the readily available neutralising potential. Carbon speciation studies suggested the presence of carbonates in a number of the samples. However, for a number of samples calculated CarbNP values were in excess of ANC values, suggesting that a portion of the carbonate was present in a form, such as siderite, that does not contribute to neutralisation. Siderite was identified in the mineralogical assessment.
- Assay data identified both Fe and Si as the most abundant elements in the samples. Geochemical abundance indicator (GAI) values calculated from the multi element assays indicated that As, Bi, Fe, S, Sb and Se were significantly enriched relative to average ‘crustal’ abundances in many of the samples (greater than 10%). Sulfur enrichment was only associated with samples from the DET (LIG) and WF stratigraphies from the Nammuldi project area.
- For the majority of samples, minor and trace element leachability was low (close to the method detection limit or below it). Whilst the final leach pH ranged between 3.8 and 8.5, for most samples it was near neutral. Most of the leach solutions contained readily detectable concentrations of major elements Ca, Cl, K, Mg, N, Na, S and Si as well as trace elements Al, B, Ba, Fe, Mn, Sr and Zn. Of the elements that were readily leachable, only Fe and S were also identified as enriched based on calculated GAI values.

5. Total Sulfur Analysis

An analysis of sulfur values in drillhole data (covering drilling from 1968 to 2020) was undertaken to identify those rock types which require further investigation related to acid-forming potential (and the related impact of metalliferous drainage). An outcome of this analysis includes determining the likelihood that a particular rock type will pose an acid drainage risk, and if so, what elements are likely to solubilise.

For the purpose of this assessment, the rock types comprise like-material assigned the same "geozone" code based on their sub-divided stratigraphies (strands) and further differentiated based on dominant material type (tag). The following factors may also influence the interpretations within this report:

- Negative assay results represent concentrations below the detection limit. The assay value for the analyte was taken to be the absolute value (i.e. the detection limit). This approach is conservative, as the true values for these assays are below the detection limit value. Assay values of zero were not considered in this assessment.
- Total sulfur was measured using XRF rather than LECO. The LECO method for determining sulfur is typically more accurate than the XRF method.
- The logging code for pyrite can be used to identify the mineral form of sulfur in samples. However, logging codes for sulfate minerals such as gypsum and alunite are rarely considered as these minerals are less identifiable; it is reasonable to also consider the concentrations of calcium and potassium within those elevated-sulfur samples to infer the presence of sulfate (e.g. gypsum or alunite), with the understanding that calcium and potassium may also be associated with various other minerals contained within the rock.
- The drillhole data for the ore body is extensive but there are less assay results on waste material.
- Information on all waste material that has or will be mined in the future may be missing due to the focus on characterisation of the ore body rather than waste material.
- Limited information exists related to the neutralising potential of the drillhole samples; the presumed risk of acid drainage may be over-stated if the available neutralising capacity of that rock type is unaccounted for. The concentration of calcium within samples may be used to indicate the presence of neutralising minerals for rock types that may be associated with those minerals.

5.1 Total Drillhole Sulfur Analysis by Project Area

5.1.1 BS1 Project Area

A total of 92,616 samples were analysed for sulfur within the BS1 project area. Sulfur concentrations ranged from below the limit of detection (0.001%) to 21.5% S (drill hole RC20BS10224 within Mount McRae Shale). A total of 1,971 samples exceeded 0.1% sulfur (2.13% of total samples) with 440 of those exceeding 0.3% S (0.48% of total samples). A total of 1.85% of waste samples have sulfur values greater than 0.1% and 0.71% of samples have sulfur values greater than 0.3%.

Those rock types where more than 3% of samples have sulfur values greater than 0.1% warrant further investigation and include CLA, CAL, DET WASTE, WS ORE, WS HYD, MCS WASTE (oxidised and black), MAC WASTE and NAM WASTE. Further details regarding the sulfur concentrations within these rock groups are detailed below. It should be noted that this analysis is considered preliminary to the subsequent in-pit analysis; which considers the geometry of the proposed pit shells and those rock units like to be disturbed.

Pyrite (PYT) was logged in 43 samples from 19 drill holes. Samples from four of the drill holes where pyrite was identified were above water table and were identified in DG HYD, DET WASTE, JOF HYD and WS WASTE. Sulfur concentrations ranged from 0.7 – 2.9% S with an average of 1.53% S. The remaining 15 drill hole locations identified pyrite in below water table (BWT) samples from the MCS and WF WASTE rock units. Sulfur concentrations within the BWT samples where pyrite was observed ranged from 0.01 – 16.7% S with an average of 3.7% S.

A total of 11.33% of CLA samples exceeded 0.1% S (17 samples in total), with 2.0% exceeding 0.3% S (three samples in total). The exceedances are present within both BS1W and BS1E prospects. Of the exceedances, only two are situated BWT. Considering the average concentrations of sulfur within the samples exceeding 0.1% S is 0.23% S and the majority are AWT, **CLA is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of CLA related to the pit shells should be further investigated.*

A total of 3.38% of CAL samples exceeded 0.1% S (78 samples in total), with 1.0% exceeding 0.3% S (23 samples in total). Of these 78 samples, four are situated BWT and likely associated with sulfide minerals. The average sulfur concentration of samples exceeding the 0.1% S is 0.32% S. Considering the average concentration of sulfur within samples exceeding 0.1% S and the locations of exceedances (mostly AWT), **CAL is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell**; *the distribution of CAL related to the pit shells should be further investigated.*

Approximately 4.0% DET WASTE samples exceeded 0.1% S (121 samples in total) and are situated across the entire BS1 project area. Of the 121 samples, only a single sample was situated BWT. **DET WASTE is therefore likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of DET WASTE related to the pit shells should be further investigated.*

A total of 8.38% of WS ORE samples (359 in total) have sulfur concentrations exceeding 0.1%, although only 0.42% of samples exceed 0.3% S. The samples are situated across the entire BS1 project area. All samples are situated AWT. Considering the average concentration of the 359 samples exceeding 0.1% S is 0.17% and that all exceedances are AWT, **WS ORE is considered to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 5.74% of WS HYD samples (103 samples in total) exceeded 0.1% S, although only 0.89% of those exceeded 0.3% S. All samples are situated AWT. The average sulfur concentration of the 103 samples is 0.21% and hence, **WS HYD is likely to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

The MCS WASTE was further divided into two sub-units; MCS WASTE (oxidised) and MCS WASTE (black). The MCS WASTE (black) samples were delineated from the oxidised MCS samples by filtering the TAG code by SHC (carbonaceous shale) and the COLOUR code black (BK). In addition, any non-SHC samples of MCS which have been identified as being black or containing SHC in the logged lithology, were also assumed to represent black MCS.

Approximately 5.32% of MCS WASTE (oxidised) samples (127 samples in total) exceeded 0.1% S, with 3.6% of those exceeded 0.3% S. Samples are well distributed across the BS1 project area and 116 of the 127 samples are situated BWT and likely associated with sulfide minerals. The average sulfur concentration of the 127 samples is 3.05% S and hence, **MCS WASTE (oxidised) is likely to pose a moderate to high acid drainage risk, however, this risk change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MCS WASTE (oxidised) related to the pit shells should be further investigated*.

Approximately 40.1% of MCS WASTE (black) samples (164 samples in total) exceeded 0.1% S, with 26.89% of those exceeded 0.3% S. Samples are well distributed across the BS1 project area and 152 of the 164 samples are situated BWT and likely associated with sulfide minerals. The average sulfur concentration of the 164 samples is 3.22% S and hence, **MCS WASTE (black) is likely to pose a high acid drainage risk, however, this risk change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MCS WASTE (black) related to the pit shells should be further investigated*.

Of the 138 samples analysed for sulfur within the MAC WASTE rock unit, only five samples (3.62%) exceeded 0.1% sulfur and four samples (2.9%) exceeded 0.3% sulfur. Of the five samples exceeding 0.1% sulfur, only a single sample was situated below the water table and therefore likely to be associated with sulfide minerals. The average sulfur concentration of all samples within the MAC WASTE unit is 0.71% and therefore **MAC WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MAC WASTE related to the pit shells should be further investigated.*

A total of 10.53% of NAM WASTE samples exceeded 0.1% S (10 samples in total) and 3.16% of samples exceeded 0.3% S (three samples in total). All samples exceeding 0.1% S are situated below the water table and therefore likely to be associated with sulfide minerals. The average sulfur concentration of all samples within the NAM WASTE unit is 0.04% and the average of the 10 samples exceeding 0.1% S is 0.24% S. Considering the above, **NAM WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of NAM WASTE related to the pit shells should be further investigated.*

Table 4 – Total sulfur analysis for BS1 drill hole samples

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	**150**	**17**	**11.33%**	3	2.00%	0.05	0.23
CAL	**2306**	**78**	**3.38%**	23	1.00%	0.03	0.32
DET WASTE	**3017**	**121**	**4.01%**	41	1.36%	0.04	0.37
DET ORE	2731	53	1.94%	4	0.15%	0.03	0.16
DOR	1425	28	1.96%	4	0.28%	0.02	0.18
YAN WASTE	29	0	0.00%	0	0.00%	0.02	-
JOF WASTE	10389	58	0.56%	3	0.03%	0.01	0.15
JOF ORE	6061	115	1.90%	10	0.16%	0.02	0.17
JOF HYD	3270	75	2.29%	7	0.21%	0.04	0.18
WS WASTE	9037	215	2.38%	43	0.48%	0.02	0.25

WS ORE	**4282**	**359**	**8.38%**	18	0.42%	0.04	0.17
WS HYD	**1795**	**103**	**5.74%**	16	0.89%	0.05	0.21
DG WASTE	17309	58	0.34%	12	0.07%	0.01	0.30
DG ORE	16650	232	1.39%	16	0.10%	0.02	0.16
DG HYD	4343	85	1.96%	7	0.16%	0.03	0.21
FWZ WASTE	1968	16	0.81%	5	0.25%	0.01	0.35
FWZ ORE	1804	1	0.06%	0	0.00%	0.02	0.13
MCS WASTE (oxidised)	**2389**	**127**	**5.32%**	**86**	**3.60%**	**0.18**	**3.05**
MCS WASTE (black)	**409**	**164**	**40.10%**	**110**	**26.89%**	**1.31**	**3.22**
MCS ORE	27	0	0.00%	0	0.00%	0.02	-
MCS HYD	9	0	0.00%	0	0.00%	0.04	-
MTS WASTE	845	5	0.59%	1	0.12%	0.02	0.23
MTS ORE	11	0	0.00%	0	0.00%	0.02	-
WF WASTE	1536	43	2.80%	24	1.56%	0.03	0.56
ANG HYD	9	0	0.00%	0	0.00%	0.02	-
NEW WASTE	293	3	1.02%	0	0.00%	0.01	0.12
NEW ORE	226	0	0.00%	0	0.00%	0.01	-
NEW HYD	63	0	0.00%	0	0.00%	0.02	-
MAC WASTE	**138**	**5**	**3.62%**	4	2.90%	0.03	0.46
NAM WASTE	**95**	**10**	**10.53%**	**3**	**3.16%**	**0.04**	**0.24**

Total number of samples assayed for S	92616	
Total number of samples with S>0.1/0.3%	1971	440
Percentage of total with S>0.1/0.3%	2.13%	0.48%
Total number of waste samples assayed for S [a]	51335	
Total number of waste samples with S>0.1/0.3%	948	362
Percentage of total waste samples with S>0.1/0.3%	1.85%	0.71%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Table 5 – Logged pyrite within BS1 drill holes.

Rock type	# times Pyrite logged
DET WASTE	1
JOF HYD	2
WS WASTE	3
DG HYD	1
FWZ WASTE	1
MCS WASTE	31
WF WASTE	4

5.1.2 BS2 Project Area

A total of 116,575 samples were analysed for sulfur within the BS2 project area. Sulfur concentrations ranged from below the limit of detection (0.001%) to 17.1% S (drillhole GR13BS20014 within the MCS Formation). A total of 3,206 samples exceeded 0.1% sulfur (2.75% S of total samples) with 470 of those exceeding 0.3% S (0.4% of total samples). A total of 2.28% of waste samples have sulfur values greater than 0.1% and approximately 0.57% have sulfur values greater than 0.3%.

Those rock types where more than 3% of samples have sulfur values greater than 0.1% warrant further investigation and include DOR, JOF WASTE, WS WASTE, WS ORE, WS HYD, DG HYD, FWZ ORE, MCS WASTE (black), WF WASTE and NEW WASTE. Further details regarding the sulfur concentrations within these rock groups are detailed below. It should be noted that this analysis is considered preliminary to the subsequent in-pit analysis; which considers the geometry of the proposed pit shells and those rock units like to be disturbed.

Pyrite (PYT) was logged in 42 samples from seven drillholes. Concentrations of sulfur ranged from 0.12 – 11.7% S with an average of 7.2% S within the seven drillholes. Utilising the pre-mining groundwater level for the Greater Brockman area, all locations where pyrite was identified were located BWT and all were sourced from the MCS WASTE rock unit.

A total of 10.26% of DOR samples (36 in total) exceeded 0.1% S with 1.42% (five samples) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. Five of the 36 exceedances are situated BWT and the average sulfur concentration of the exceedances is 0.3% S. ABA analysis has been performed on 18 DOR samples from across the Greater Brockman area and none were classified as PAF, although sulfur concentrations were significantly less than observed within the BS2 project area. Considering the average concentrations of sulfur within the representative samples, **DOR is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of DOR related to the pit shells should be further investigated.*

A total of 9.09% of JOF WASTE samples exceeded 0.1% S (one sample in total), with no samples exceeding 0.3% S. The average sulfur concentration within all JOF WASTE samples is 0.06% and samples are situated AWT. Considering the average concentrations sulfur within the representative samples, **JOF WASTE is likely to pose a low acid drainage risk, however, this risk may change**

depending on the spatial distribution of the material in comparison to the pit shell; *the distribution of JOF WASTE related to the pit shell should be further investigated.*

A total of 11.76% of WS WASTE samples (208 in total) exceeded 0.1% S with 2.26% (40 samples) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. All 208 exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.26% S. Considering the classification of WS WASTE within the adjacent BS2C prospect and static and kinetic test work undertaken by both EGi (2010) and SRK (2012), **WS WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of WS WASTE related to the pit shells should be further investigated.*

A total of 11.62% of WS ORE samples (53 in total) exceeded 0.1% S with 0.44% (2 samples) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. All 53 exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.15% S. Considering the classification of WS WASTE within the adjacent BS2C prospect and static and kinetic test work undertaken by both EGi (2010) and SRK (2012), **WS ORE is likely to pose a moderate acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 23.4% of WS HYD samples (245 in total) exceeded 0.1% S with 3.63% (38 samples) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. All 245 exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.23% S. Considering the classification of WS WASTE within the adjacent BS2C prospect and static and kinetic test work undertaken by both EGi (2010) and SRK (2012), **WS HYD is likely to pose a moderate acid drainage risk; however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 5.81% of DG HYD samples (544 in total) exceeded 0.1% S with 0.43% (40 samples) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. All 544 exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.17% S. Considering the average concentrations sulfur within the representative samples, **DG HYD is likely to pose a low acid drainage risk; however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of DG HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 4.77% of FWZ ORE samples (111 in total) exceeded 0.1% S with 0.04% (one sample) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. All 111 exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.14% S. Considering the average concentrations sulfur within the representative samples, **FWZ ORE is likely to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of FWZ ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 37.5% of MCS WASTE (black) samples (153 in total) exceeded 0.1% S and 34.31% exceed 0.3% S (140 samples). Samples are concentrated within the BS2E project area and 152 samples are located BWT. Given the average of samples exceeding 0.1% S is 6.35% S, **MCS WASTE (black) is likely to pose a high acid drainage risk, however, this risk change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MCS related to the pit shell should be further investigated.*

A total of 4.36% of WF WASTE samples (256 in total) exceeded 0.1% S with 1.57% (92 samples) exceeding 0.3% S. The exceedances are spread across the entire BS2 area and not concentrated in any particular prospect. The majority (205) of samples are situated BWT and hence, may be associated with sulfide minerals. The Wittenoom Formation is not typically classified as PAF, mainly due to higher than average ANC associated with dolomitic sequences within the Formation. It is noted however both SRK (2015) and RGS (2021), observed PAF material within the Wittenoom Formation, although at far lower frequency than NAF material was observed. Considering the above and the absence of pit shell information for the BS2 project area, **WF WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of WF WASTE related to the pit shells should be further investigated.*

Only four representative samples of NEW WASTE were analysed for sulfur with one exceeding 0.1% S. ABA data for the Newman Member (SRK, 2013 and RGS, 2021) identified 36 samples as NAF. Considering the average concentration of sulfur within the four samples (0.1% S), **NEW WASTE is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of NEW WASTE related to the pit shells should be further investigated.*

Table 6 – Total sulfur analysis for BS2 drill hole samples

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	1692	15	0.89%	2	0.12%	0.02	0.22
CAL	1982	1	0.05%	0	0.00%	0.01	0.11
DET WASTE	23256	300	1.29%	15	0.06%	0.02	0.16
DET ORE	24640	423	1.72%	4	0.02%	0.03	0.15
DOR	**351**	**36**	**10.26%**	5	1.42%	0.06	0.30
JOF WASTE	**11**	**1**	**9.09%**	**0**	**0.00%**	**0.06**	**0.16**
JOF HYD	13	0	0.00%	**0**	**0.00%**	**0.05**	**-**
WS WASTE	**1768**	**208**	**11.76%**	40	2.26%	0.07	0.26
WS ORE	**456**	**53**	**11.62%**	2	0.44%	0.06	0.15
WS HYD	**1047**	**245**	**23.40%**	**38**	**3.63%**	**0.09**	**0.23**
DG WASTE	16278	231	1.42%	27	0.17%	0.02	0.20

DG ORE	13233	340	2.57%	14	0.11%	0.02	0.16
DG HYD	**9364**	**544**	**5.81%**	40	0.43%	0.04	0.17
FWZ WASTE	3426	68	1.98%	4	0.12%	0.02	0.17
FWZ ORE	**2327**	**111**	**4.77%**	1	0.04%	0.03	0.14
MCS WASTE (oxidised)	7833	183	2.34%	40	0.51%	0.03	0.29
MCS WASTE (black)	**408**	**153**	**37.50%**	**140**	**34.31%**	**2.39**	**6.35**
MTS WASTE	2602	37	1.42%	6	0.23%	0.02	0.26
WF WASTE	**5874**	**256**	**4.36%**	92	1.57%	0.03	0.37
ANG HYD	10	0	0.00%	0	0.00%	0.01	-
NEW WASTE	**4**	**1**	**25.00%**	0	0.00%	0.10	0.21

Total number of samples assayed for S	116575	
Total number of samples with S>0.1/0.3%	3206	470
Percentage of total with S>0.1/0.3%	2.75%	0.40%
Total number of waste samples assayed for S [a]	65485	
Total number of waste samples with S>0.1/0.3%	1490	371
Percentage of total waste samples with S>0.1/0.3%	2.28%	0.57%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Table 7 – Logged pyrite within BS2 drill holes.

Rock type	# times Pyrite logged
MCS WASTE	42

5.1.3 BS3/BS4 Project Area

A total of 131,860 samples were analysed for sulfur within the BS3/BS4 project area. Sulfur concentrations ranged from below the limit of detection (0.001%) to 11.8% S (drillhole GR16BS4B0014 within the MCS Formation). A total of 3,695 samples exceeded 0.1% sulfur (2.8% of total samples) with 419 of those exceeding 0.3% S (0.32% of total samples). A total of 2.06% of waste samples have sulfur values greater than 0.1% and approximately 0.37% have sulfur values greater than 0.3%.

Those rock types where more than 3% of samples have sulfur values greater than 0.1% warrant further investigation and include CLA, DET ORE, DOR, JOF HYD, WS WASTE, WS ORE, WS HYD, DG HYD, FWZ ORE, MCS WASTE (black), MAC WASTE and NAM WASTE. Further details regarding the sulfur concentrations within these rock groups are detailed below. It should be noted that this analysis is considered preliminary to the subsequent in-pit analysis; which considers the geometry of the proposed pit shells and those rock units like to be disturbed.

Pyrite (PYT) was logged in 43 samples from 14 drillholes. Concentrations of sulfur ranged from 1.0 – 20% S with an average of 5.12% S within the 14 drillholes that pyrite was observed. Utilising the pre-mining groundwater level for the Greater Brockman area, five of the drillholes identified pyrite AWT. Ten drillhole locations identified pyrite below water table (BWT) from within the FWZ WASTE, MCS WASTE and WF WASTE rock units. Sulfur concentrations within the BWT samples where pyrite was observed ranged from 0.02– 11.8% S with an average of 2.89% S.

A total of 6.25% of CLA samples (four in total) exceeded 0.1% S with one sample exceeding 0.3% S. The exceedances are spread across the entire BS3/BS4 area and not concentrated in any particular location. All the exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.32% S. Considering the average concentrations sulfur within the representative samples, **CLA is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of CLA related to the pit shells should be further investigated.*

A total of 6.15% of DET ORE samples (298 in total) exceeded 0.1% S with seven samples exceeding 0.3% S. The exceedances are spread across the entire BS3/BS4 area and not concentrated in any particular location. All the exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.15% S. Considering the average concentrations of sulfur within the representative samples, **DET ORE is likely to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of DET ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 5.6% of DOR samples exceeded 0.1% S (342 samples in total), with 1.51% exceeding 0.3% S (92 samples in total). The majority of samples (327) are situated AWT and the average concentration of samples exceeding 0.1% S is 0.31% S. ABA analysis has been performed on 18 DOR samples from across the Greater Brockman area and none were classified as PAF, although sulfur concentrations were significantly less than observed within the BS3/BS4 project area. Considering the average concentrations of sulfur within the representative samples, **DOR is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of DOR related to the pit shells should be further investigated.*

A total of 3.82% of JOF HYD samples exceeded 0.1% S (343 samples in total) with only 0.35% of samples (31 in total) exceeding 0.3% S. Locations of samples are situated within two clusters in the north east and south west of the BS3/BS4 project area and all are located AWT and therefore likely associated with sulfate minerals. ABA analysis was carried out on 41 Joffre member samples (five of which were classified as HYD) and all were classified as NAF (RGS, 2021). Considering the average concentration of the 343 samples exceeding 0.1% S is 0.2% S, **JOF HYD is considered to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore,**

this risk may change. ***The distribution of JOF HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 5.29% of WS WASTE samples exceeded 0.1% S (528 samples in total), with 0.49% exceeding 0.3% S (49 samples in total). Almost all samples (522) are situated AWT and located across both BS3 and BS4 project areas. The average concentration of samples exceeding the 0.1% S is 0.19% S. Considering the average concentrations sulfur within the representative samples, **WS WASTE is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of WS WASTE related to the pit shell should be further investigated.*

A total of 12.11% of WS ORE samples (345 in total) exceeded 0.1% S and 0.42% (12 in total) exceeding 0.3% S. Locations of samples are situated within the BS3 and BS4 project areas and all are located AWT and therefore likely associated with sulfate minerals. The average sulfur concentration of the nine samples exceeding 0.1% S is 0.16% S and hence, **WS ORE is considered to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 13.04% of WS HYD samples exceeded 0.1% S (248 samples in total) with only 1.68% of samples (32 in total) exceeding 0.3% S. Locations of samples are situated within the BS3 and BS4 project areas and all are located AWT and therefore likely associated with sulfate minerals. Considering the average concentration of the 248 samples exceeding 0.1% S is 0.22% S, **WS HYD is considered to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 3.64% of DG HYD samples exceeded 0.1% S (289 samples in total) with only 0.24% of samples (19 in total) exceeding 0.3% S. Locations of samples are situated within the BS3 and BS4 project areas and all are located AWT and therefore likely associated with sulfate minerals. Considering the average concentration of the 289 samples exceeding 0.1% S is 0.17% S, **DG HYD is considered to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of DG HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 4.06% of FWZ ORE samples (50 in total) exceeded 0.1% S with no samples exceeding 0.3% S. Locations of samples are situated within the BS3 and BS4 project areas and almost all samples (49 in total) are located AWT and therefore likely associated with sulfate minerals. The average sulfur concentration of the 50 samples exceeding 0.1% S is 0.13% S and hence, **FWZ ORE is considered to pose a low acid drainage risk, however as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of FWZ ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 27.71% of MCS WASTE (black) samples (64 in total) exceeded 0.1% S and 19.05% exceed 0.3% S (44 samples). Samples are concentrated within the BS4E and Endeavour prospects and 52 samples are located BWT. Given the average of samples exceeding 0.1% S is 3.02% S, **MCS WASTE (black) is likely to pose a high acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MCS WASTE (black) related to the pit shell should be further investigated.*

A total of 3.75% of MAC WASTE samples (12 in total) exceeded 0.1% S, with 0.94% (three samples in total) exceeding 0.3% S. Locations of samples are situated across the BS3 and BS4 area and 11 samples are located BWT. The average sulfur concentration of the 12 samples is however 0.27% S and hence, **MAC WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MAC WASTE related to the pit shell should be further investigated.*

A total of 24.69% of NAM WASTE samples (20 in total) exceeded 0.1% S, with 13.58% (11 samples in total) exceeding 0.3% S. Locations of samples are mainly situated across the BSMM and BS3 prospects and all samples are located BWT. The average sulfur concentration of the 20 samples is however 0.37% S and hence, **NAM WASTE is likely to pose a high acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of NAM WASTE related to the pit shell should be further investigated.*

Table 8 – Total sulfur analysis for BS3 and BS4 drill hole samples

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	**64**	**4**	**6.25%**	1	1.56%	0.04	0.32
CAL	269	2	0.74%	0	0.00%	0.02	0.13
DET WASTE	12253	121	0.99%	5	0.04%	0.02	0.15
DET ORE	**4847**	**298**	**6.15%**	7	0.14%	0.04	0.15
DOR	**6103**	**342**	**5.60%**	92	1.51%	0.03	0.31
WW WASTE	166	0	0.00%	0	0.00%	0.01	-
YAN WASTE	2277	7	0.31%	0	0.00%	0.01	0.12
YAN ORE	141	0	0.00%	0	0.00%	0.01	-
YAN HYD	1007	13	1.29%	0	0.00%	0.03	0.13
JOF WASTE	19819	202	1.02%	20	0.10%	0.01	0.18
JOF ORE	11053	216	1.95%	9	0.08%	0.02	0.16
JOF HYD	**8975**	**343**	**3.82%**	31	0.35%	0.04	0.20
WS WASTE	**9980**	**528**	**5.29%**	49	0.49%	0.03	0.19
WS ORE	**2850**	**345**	**12.11%**	12	0.42%	0.04	0.16
WS HYD	**1902**	**248**	**13.04%**	32	1.68%	0.05	0.21
DG WASTE	13023	99	0.76%	10	0.08%	0.01	0.19
DG ORE	12271	272	2.22%	18	0.15%	0.02	0.17
DG HYD	**7943**	**289**	**3.64%**	19	0.24%	0.04	0.17
FWZ WASTE	2265	39	1.72%	5	0.22%	0.02	0.24
FWZ ORE	**1232**	**50**	**4.06%**	0	0.00%	0.02	0.13

MCS WASTE (oxidised)	4111	93	2.26%	25	0.61%	0.03	0.59
MCS WASTE (black)	**231**	**64**	**27.71%**	**44**	**19.05%**	**0.86**	**3.02**
MTS WASTE	1030	21	2.04%	2	0.19%	0.02	0.15
MTS ORE	9	0	0.00%	0	0.00%	0.02	-
WF WASTE	5461	63	1.15%	24	0.44%	0.02	0.51
ANG ORE	74	1	1.35%	0	0.00%	0.01	0.12
NEW WASTE	944	1	0.11%	0	0.00%	0.01	0.12
NEW ORE	778	0	0.00%	0	0.00%	0.01	-
NEW HYD	373	2	0.54%	0	0.00%	0.03	0.13
MAC WASTE	**320**	**12**	**3.75%**	3	0.94%	0.02	0.27
MAC ORE	8	0	0.00%	0	0.00%	0.01	#DIV/0!
NAM WASTE	**81**	**20**	**24.69%**	**11**	**13.58%**	**0.10**	**0.37**

Total number of samples assayed for S	131860	
Total number of samples with S>0.1/0.3%	3695	419
Percentage of total with S>0.1/0.3%	2.80%	0.32%
Total number of waste samples assayed for S [a]	78397	
Total number of waste samples with S>0.1/0.3%	1618	291
Percentage of total waste samples with S>0.1/0.3%	2.06%	0.37%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Table 9 – Logged pyrite within BS3/BS4 drill holes.

Rock type	# times pyrite logged
DET ORE	1
JOF HYD	5
WS HYD	1
FWZ WASTE	1
MCS WASTE	19

WF WASTE	16

5.1.4 BS3X/Lens G Project Area

A total of 63,001 samples were analysed for sulfur within the BS3X/Lens G project areas. Sulfur concentrations ranged from below the limit of detection (0.001%) to 3.6% S (drillhole BS0304 within the MCS Formation). A total of 756 samples exceeded 0.1% sulfur (1.2% of total samples) with 95 of those exceeding 0.3% S (0.15% of total samples). Less than 1.06% of waste samples have sulfur values greater than 0.1% and approximately 0.15% have sulfur values greater than 0.3%.

Those rock types where more than 3% of samples have sulfur values greater than 0.1% warrant further investigation and include DET ORE, WS WASTE, WS ORE, WS HYD, DG ORE, DG HYD, MCS WASTE (oxidised), MTS WASTE, MAC WASTE, MAC ORE and NAM WASTE. Further details regarding the sulfur concentrations within these rock groups are detailed below. It should be noted that this analysis is considered preliminary to the subsequent in-pit analysis; which considers the geometry of the proposed pit shells and those rock units like to be disturbed.

Pyrite (PYT) was logged in eight samples from four drillholes. Concentrations ranged from 0.022 – 0.3% S with an average of 0.1% S within the four drillholes. Utilising the pre-mining groundwater level for the Greater Brockman area, one of the drillholes identified pyrite AWT. The remaining three drillhole locations identified pyrite below water table (BWT) within the NEW WASTE and MAC WASTE rock units. Sulfur concentrations within the BWT samples where pyrite was observed ranged from 0.05–0.3% S with an average of 1.14% S.

A total of 4.75% of DET ORE samples (75 in total) exceeded 0.1% S with no samples exceeding 0.3% S. The exceedances are spread across the entire BS3X/Lens G area and not concentrated in any particular area. All the exceedances are situated AWT and the average sulfur concentration of the exceedances is 0.14% S. Considering the average concentrations sulfur within the representative samples, **DET ORE is likely to pose a low acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of DET ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 7.61% of WS WASTE samples exceeded 0.1% S (27 samples in total), with 2.54% exceeding 0.3% S (nine samples in total). All of these samples are situated AWT and within the BS3X project area. The average concentration of samples exceeding the 0.1% S is 0.47% S. Considering the average concentrations sulfur within the representative samples, **WS WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of WS WASTE related to the pit shell should be further investigated.*

A total of 36% of WS ORE samples (nine in total) exceeded 0.1% S and 12% (three in total) exceeding 0.3% S. Locations of samples are situated within the BS3X project areas and all are located AWT and therefore likely associated with sulfate minerals. The average sulfur concentration of the nine samples exceeding 0.1% S is 0.27% S and hence, **WS ORE is considered to pose a moderate acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 15.15% of WS HYD samples exceeded 0.1% S (10 samples in total) with only 1.52% of samples (one in total) exceeding 0.3% S. Locations of samples are situated within the BS3X project areas and all are located AWT and therefore likely associated with sulfate minerals. Considering the average concentration of the 10 samples exceeding 0.1% S is 0.18% S, **WS HYD is considered to pose a moderate acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of WS HYD related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 4.62% of DG ORE samples (15 in total) exceeded 0.1% S, and none exceeded 0.3% S. Locations of samples are situated within BS3X project area and all are located AWT. The average sulfur concentration of the 15 samples is 0.14% and hence, **DG ORE is considered to pose a low acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of DG ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 4.35% of DG HYD samples (nine in total) exceeded 0.1% S, and none exceeded 0.3% S. Locations of samples are situated within BS3X project area and all are located AWT. The average sulfur concentration of the nine samples is 0.12% and hence, **DG HYD is considered to pose a low acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of DG ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 8.43% of MCS WASTE (oxidised) samples (15 in total) exceeded 0.1% S and 7.14% exceed 0.3% S. Samples are situated in the BS3X project area and all were AWT. Given the average sulfur concentration of all samples is 0.18% S and those exceeding 0.1% S is 1.9% S, **MCS WASTE (oxidised) is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MCS related to the pit shell should be further investigated.*

A total of 5.26% of MTS WASTE samples (three in total) exceeded 0.1% S and none exceeded 0.3% S. Locations of samples are from two drill holes within close proximity to each other. All samples are located AWT. The average sulfur concentration of the three samples is 0.14% S and hence, **MTS WASTE is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MTS WASTE related to the pit shell should be further investigated.*

A total of 4.58% of MAC WASTE samples (120 in total) exceeded 0.1% S, with 0.38% (10 samples in total) exceeding 0.3% S. Locations of samples are situated across the BS3X/Lens G area and 34 are located BWT. The average sulfur concentration of the 120 samples is however 0.17% S and hence, **MAC WASTE is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MAC WASTE related to the pit shell should be further investigated.*

A total of 22.16% of MAC ORE samples (39 in total) exceeded 0.1% S, and 3.98% (seven in total) exceeded 0.3% S. Locations of samples are situated within BS3X project area and all are located AWT. The average sulfur concentration of the 39 samples is 0.21% and hence, **MAC ORE is considered to pose a low acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.** ***The distribution of MAC ORE related to the pit shell and potential association of sulfur in the fines should be further investigated.***

A total of 4.66% of NAM WASTE samples (25 in total) exceeded 0.1% S, with 0.75% (four samples in total) exceeding 0.3% S. Locations of samples are situated across the BS3X/Lens G area and five are located BWT (from a single drillhole). The average sulfur concentration of the 25 samples is however 0.21% S and hence, **NAM WASTE is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of NAM WASTE related to the pit shell should be further investigated.*

Table 10 – Total sulfur analysis for BS3X/Lens G Deposits drillhole samples

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	109	0	0.00%	0	0.00%	0.01	-
CAL	1855	0	0.00%	0	0.00%	0.01	-
DET WASTE	21634	174	0.80%	25	0.12%	0.02	0.23
DET ORE	**1578**	**75**	**4.75%**	0	0.00%	0.03	0.14
DOR	331	2	0.60%	1	0.30%	0.02	0.27
JOF WASTE	27	0	0.00%	0	0.00%	0.01	-
WS WASTE	**355**	**27**	**7.61%**	9	2.54%	0.06	0.47
WS ORE	**25**	**9**	**36.00%**	**3**	**12.00%**	**0.12**	**0.27**
WS HYD	**66**	**10**	**15.15%**	1	1.52%	0.07	0.18
DG WASTE	1158	25	2.16%	0	0.00%	0.02	0.12
DG ORE	**325**	**15**	**4.62%**	0	0.00%	0.03	0.14
DG HYD	**207**	**9**	**4.35%**	0	0.00%	0.04	0.12
FWZ WASTE	148	3	2.03%	0	0.00%	0.02	0.12
MCS WASTE (oxidised)	**178**	**15**	**8.43%**	**13**	**7.30%**	**0.18**	**1.94**
MCS WASTE (black)	4	0	0.00%	0	0.00%	0.01	-
MTS WASTE	**57**	**3**	**5.26%**	0	0.00%	0.04	0.14
WF WASTE	9894	60	0.61%	4	0.04%	0.02	0.18
ANG ORE	851	0	0.00%	0	0.00%	0.01	-
ANG HYD	1058	6	0.57%	0	0.00%	0.03	0.13
NEW WASTE	9345	56	0.60%	8	0.09%	0.01	0.22
NEW ORE	7437	9	0.12%	1	0.01%	0.01	0.17
NEW HYD	3028	74	2.44%	9	0.30%	0.04	0.26

MAC WASTE	**2619**	**120**	**4.58%**	10	0.38%	0.03	0.17
MAC ORE	**176**	**39**	**22.16%**	**7**	**3.98%**	**0.07**	**0.21**
NAM WASTE	**536**	**25**	**4.66%**	4	0.75%	0.04	0.20

Total number of samples assayed for S	63001	
Total number of samples with S>0.1/0.3%	756	95
Percentage of total with S>0.1/0.3%	1.20%	0.15%
Total number of waste samples assayed for S [a]	48250	
Total number of waste samples with S>0.1/0.3%	510	74
Percentage of total waste samples with S>0.1/0.3%	1.06%	0.15%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Table 11 – Logged pyrite within BS3X/Lens G deposits drillholes.

Rock type	# times Pyrite logged
ANG HYD	3
NEW WASTE	3
MAC WASTE	2

5.1.5 BSMM Project Area

A total of 101,860 samples were analysed for sulfur within the BSMM deposits. Sulfur concentrations ranged from below the limit of detection (0.001%) to 19.4% S (drillhole RC16BS40079 within the WF WASTE rock unit). A total of 1,308 samples exceeded 0.1% sulfur (1.28% of total samples) with 418 exceeding 0.3% S (0.41% of total samples). A total of 1.64% of waste samples have sulfur values greater than 0.1% and 0.55% have sulfur values greater than 0.3%.

Those rock units where more than 3% of samples have sulfur values greater than 0.1% warrant further investigation and include DET WASTE, MAC WASTE and FOR WASTE. Further details regarding the sulfur concentrations within these rock groups are detailed below. It should be noted that this analysis is considered preliminary to the subsequent in-pit analysis; which considers the geometry of the proposed pit shells and those rock units like to be disturbed.

Pyrite (PYT) was logged in 40 samples from 15 drillholes. Concentrations ranged from 0.003 – 9.1% S with an average of 1.24% S within the 40 samples drillholes. Utilising the pre-mining groundwater level for the Greater Brockman area, 10 of the drillholes identified pyrite BWT from within the WF WASTE, NEW WASTE and FOR WASTE rock units.

A total of 4.46% of DET WASTE samples (353 in total) exceeded 0.1% S with 1.36% (108 samples) exceeding 0.3% S. The exceedances are spread across the entire BSMM area and not concentrated in any particular area. Of the 353 exceedances, only 21 were located BWT. The average concentration of samples exceeding 0.1% S is 0.36% S. Considering the average concentrations sulfur within the representative samples, **DET WASTE is likely to pose a low acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of DET WASTE related to the pit shell should be further investigated.*

A total of 3.4% of MAC WASTE samples exceeded 0.1% S (99 samples in total), with 0.96% exceeding 0.3% S (28 samples in total). Of these samples, 75 are situated BWT. The average concentration of samples exceeding the 0.1% S is 0.26% S. Considering the average concentrations sulfur within the representative samples, **MAC WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of MAC WASTE related to the pit shell should be further investigated.*

A total of 7.46% of FOR WASTE samples exceeded 0.1% S (53 samples in total), with 3.38% exceeding 0.3% S (24 samples in total). Of these 99 samples, 44 are situated BWT and likely associated with sulfide minerals. The average concentration of samples exceeding 0.1% S is 0.98% S. Considering the average concentrations sulfur within the representative samples, **FOR WASTE is likely to pose a moderate acid drainage risk, however, this risk may change depending on the spatial distribution of the material in comparison to the pit shell;** *the distribution of FOR WASTE related to the pit shell should be further investigated.*

Table 12 – Total sulfur analysis for BSMM Deposits drillhole samples

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	308	8	2.60%	5	1.62%	0.03	0.47
CAL	262	6	2.29%	3	1.15%	0.05	0.82
DET WASTE	**7920**	**353**	**4.46%**	108	1.36%	0.04	0.36
DET ORE	7406	46	0.62%	8	0.11%	0.02	0.20
DOR	2298	56	2.44%	11	0.48%	0.02	0.24
FWZ WASTE	22	0	0.00%	0	0.00%	0.02	-
MCS WASTE (oxidised)	36	0	0.00%	0	0.00%	0.02	-
MTS WASTE	81	0	0.00%	0	0.00%	0.01	-
WF WASTE	47770	560	1.17%	217	0.45%	0.02	0.65
ANG ORE	1404	5	0.36%	2	0.14%	0.01	0.29
ANG HYD	415	0	0.00%	0	0.00%	0.02	-
NEW WASTE	9822	48	0.49%	3	0.03%	0.01	0.15

NEW ORE	12115	5	0.04%	0	0.00%	0.01	0.13
NEW HYD	4877	36	0.74%	2	0.04%	0.03	0.16
MAC WASTE	**2909**	**99**	**3.40%**	28	0.96%	0.03	0.26
MAC ORE	483	0	0.00%	0	0.00%	0.01	-
NAM WASTE	2131	33	1.55%	7	0.33%	0.02	0.24
NAM ORE	891	0	0.00%	0	0.00%	0.01	-
FOR WASTE	**710**	**53**	**7.46%**	**24**	**3.38%**	**0.09**	**0.98**

Total number of samples assayed for S	101860	
Total number of samples with S>0.1/0.3%	1308	418
Percentage of total with S>0.1/0.3%	1.28%	0.41%
Total number of waste samples assayed for S [a]	74269	
Total number of waste samples with S>0.1/0.3%	1216	406
Percentage of total waste samples with S>0.1/0.3%	1.64%	0.55%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Table 13 – Logged pyrite within BSMM project area drillholes.

Rock type	# times Pyrite logged
DET WASTE	1
NEW WASTE	10
MAC WASTE	1
NAM WASTE	5
FOR WASTE	2
WF WASTE	21

5.2 Total Drillhole Sulfur Analysis Considering Proposed Final Pit Shells

The proposed final pit shells were used to further filter the drillhole dataset according to which drillhole intervals are located within the proposed pit within each project/prospect. Table 14 presents the pit shells used to undertake the filtering. Results of the statistical analysis are presented in the following sections.

Table 14: Pit shells utilised in the statistical analysis

Project Area	Pit Shells
BS1	BS1_Pit_All.00t
BS2	Pit shells incomplete
BS3/BS4	END_PFS_UF.00t
	N1_U.00T.00t, N2_U.00T.00t
	M1_U.00T.00t, M2_U.00T.00t
	bs3_vulcanpit_stage2_shrink_wrap_base.00t
BS3X/Lens G	BS3X_Southpits_Clipped.00t
	diesel_uf01.00t
	Monkey_pits_uncut.00t
	sandleford_pits.00t
	2020_pfs_lensg_stage1.00t
BS4MM	o1.00t, o2.00t, o3.00t, o4.00t
	o5_f1_revb_u.00t, o5_f2_revc_u.00t
	q_f123_revc_u.00t
	q4_uf15.00t
	r_uf12.00t

5.2.1 BS1 Project Area

A summary of the total sulfur analysis completed for those samples located within the final pit shells for the BS1 project area is provided in Table 18. A total of 34,156 samples with total sulfur analysis are situated within the proposed BS1 pits. Of these, 2.43% of samples returned values exceeded 0.1% S and 0.34% returned values of greater than 0.3% S (Figure 4). A total of 2.64% of waste samples exceeded 0.1% S and 0.72% of waste samples exceeded 0.3% S.

A comparison of the project wide total sulfur analysis (Table 4) to the in-pit sulfur analysis (Table 15) for rock types having sulfur concentrations with greater than 3% of samples exceeding 0.1%/0.3% S suggests the in-pit data is comparable to the project area. All rock units identified with elevated sulfur (Section 5.1.1) across the BS1 project area are represented by drillhole data within BS1 pit shells, with the exception of YAN WASTE, MCS HYD and MTS ORE which were absent (and were not identified as elevated AMD risk).

Of the rock units that were identified as elevated within the total sulfur analysis, two (MAC WASTE and NAM WASTE) were under-represented (less than 10 samples) by samples within the pit shells and hence, a risk rating based on project area total sulfur analysis will be adopted for the rock units until more site specific data is collected. The third rock unit (CAL) is represented within pit shells by 1,297 samples, however the concentration of these samples is below the threshold of greater than 3% of samples exceeding 0.1%/0.3% S. Those rock units with elevated concentrations of sulfur is discussed in the following sections.

The average concentration of all CLA samples from within the pit shell is 0.05% S with 7.55% of these samples exceeding 0.1% S. The average concentration of sulfur in the 7.55% of samples was 0.32% with the majority situated AWT. **CLA is likely to pose a low acid drainage risk.**

The average concentration of all DET WASTE samples from within the pit shell is 0.04% S with 5.98% of these samples exceeding 0.1% S. The average concentration of sulfur in the 5.98% of samples was 0.36% with only a single sample (out of a total of 62) situated BWT. Given the absence of lignite within the BS1 project area, and the Non-Acid Forming classification calculated for the majority of detrital samples (RGS 2021), **DET WASTE is likely to pose a low acid drainage risk.**

The average concentration of all WS WASTE samples from within the pit shell is 0.04% S with 5.88% of these samples exceeding 0.1% S. The average concentration of sulfur in the 5.88% of samples was 0.31% with all samples situated AWT. A total of 36 Whaleback Shale samples (although not all classified as "waste" samples) have been analysed for ABA parameters (RGS, 2021 and SRK, 2013) across the Greater Brockman area. Of these 36 samples, 35 were classified as Uncertain or NAF with only single sample classified as PAF. Although it is noted this sample is located in-pit within the BS1 project area. Pyrite was also identified in three of the samples also located in-pit. On this basis, **WS WASTE is likely to pose a moderate acid drainage risk.**

The average concentration of all WS ORE samples from within the pit shell is 0.04% S with 7.79% of these samples exceeding 0.1% S. The average concentration of sulfur in the 7.79% of samples was 0.2% with all samples situated AWT. Considering the ABA analysis undertaken on Whaleback Shale samples, **WS ORE is likely to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentration of all WS HYD samples from within the pit shell is 0.05% S with 6.06% of these samples exceeding 0.1% S. The average concentration of sulfur in the 6.06% of samples was 0.25% with all samples situated AWT. Considering the ABA analysis undertaken on Whaleback Shale samples, **WS HYD is likely to pose a low acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentration of all MCS WASTE (black) samples from within the pit shell is 0.1% S with 22.86% of these samples exceeding 0.1% S. The average concentration of sulfur in the 22.86% of samples was 0.3% with the majority of samples situated BWT. A total of 66 Mt McRae Shale samples were analysed for ABA parameters, two of which were classified as PAF one of which is located in-pit within BS1. On this basis, **MCS WASTE (black) is likely to pose a moderate acid drainage risk.**

MTS WASTE was also identified as elevated in the pit shells; however, this was based on only nine samples with one sample (11.11%) exceeding 0.1% S. The volume of samples is not considered sufficient to adequately characterise the sulfur risk within pit shells. In comparison to the risk assessment of sulfur concentrations across the entire BS1 project area, 845 samples were utilised with 0.59% exceeding 0.1% S. Acknowledgement of the slightly higher average sulfur concentration within the pit shells (0.05% S) compared to the greater BS1 area (0.02% S) results in an **MTS WASTE classification of low risk.**

Table 15: Summary of in-pit BS1 drill hole sulfur concentrations

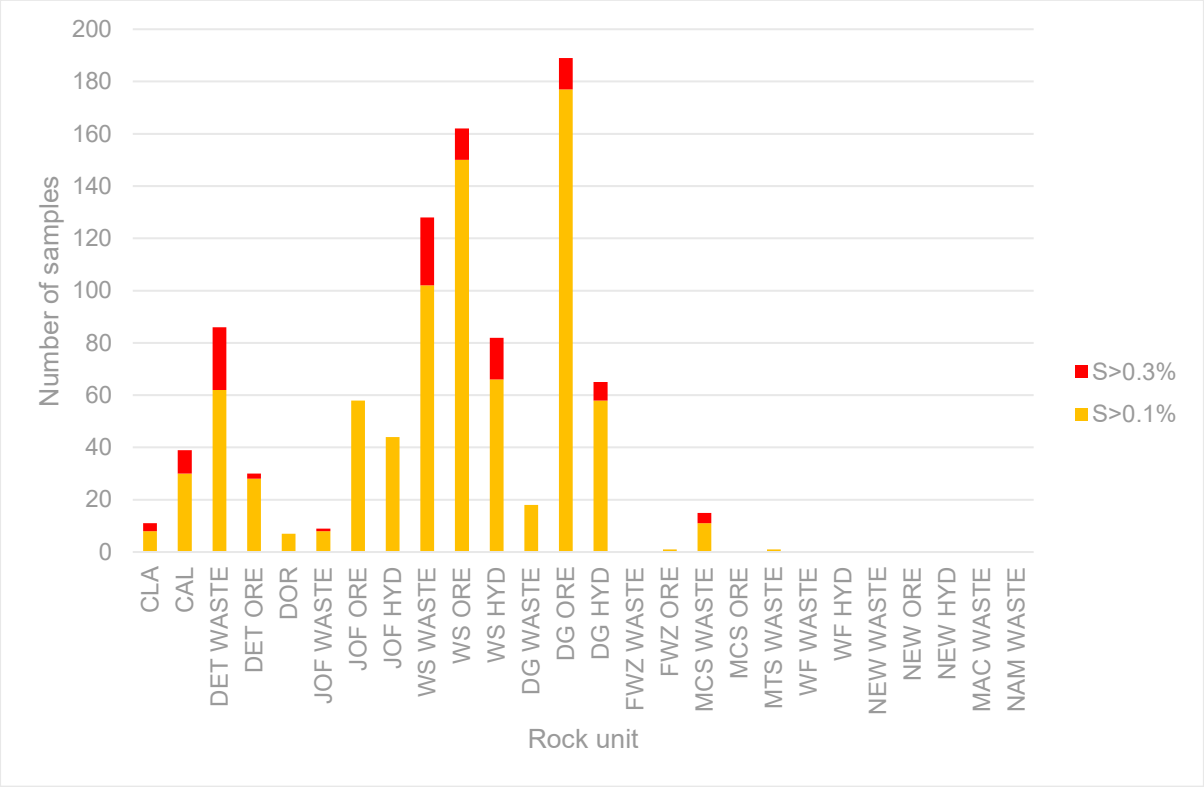
Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	**106**	**8**	**7.55%**	3	2.83%	0.05	0.32
CAL	1297	30	2.31%	9	0.69%	0.03	0.40
DET WASTE	**1036**	**62**	**5.98%**	24	2.32%	0.04	0.36
DET ORE	1082	28	2.59%	2	0.18%	0.03	0.16
DOR	348	7	2.01%	0	0.00%	0.02	0.17
JOF WASTE	1122	8	0.71%	1	0.09%	0.02	0.19
JOF ORE	3806	58	1.52%	0	0.00%	0.02	0.13
JOF HYD	1899	44	2.32%	0	0.00%	0.04	0.12
WS WASTE	**1734**	**102**	**5.88%**	26	1.50%	0.04	0.31
WS ORE	**1926**	**150**	**7.79%**	12	0.62%	0.04	0.20
WS HYD	**1089**	**66**	**6.06%**	16	1.47%	0.05	0.25
DG WASTE	3082	18	0.58%	0	0.00%	0.02	0.13
DG ORE	11182	177	1.58%	12	0.11%	0.02	0.16
DG HYD	3128	58	1.85%	7	0.22%	0.04	0.25
FWZ WASTE	209	0	0.00%	0	0.00%	0.01	-
FWZ ORE	612	1	0.16%	0	0.00%	0.01	0.13
MCS WASTE (black)	**35**	**8**	**22.86%**	**3**	**8.57%**	**0.10**	**0.30**
MCS ORE	8	0	0.00%	0	0.00%	0.02	-
MTS WASTE	**9**	**1**	**11.11%**	0	0.00%	0.05	0.10
WF WASTE	176	0	0.00%	0	0.00%	0.02	-
ANG HYD	4	0	0.00%	0	0.00%	0.01	-
NEW WASTE	17	0	0.00%	0	0.00%	0.00	-
NEW ORE	59	0	0.00%	0	0.00%	0.01	-
NEW HYD	9	0	0.00%	0	0.00%	0.02	-
MAC WASTE	3	0	0.00%	0	0.00%	0.03	-
NAM WASTE	8	0	0.00%	0	0.00%	0.04	-
Total number of samples assayed for S		34156					

Total number of samples with S>0.1/0.3%	829	116
Percentage of total with S>0.1/0.3%	2.43%	0.34%
Total number of waste samples assayed for S [a]	9352	
Total number of waste samples with S>0.1/0.3%	247	67
Percentage of total waste samples with S>0.1/0.3%	2.64%	0.72%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Figure 4 – Distribution of rock type and elevated sulfur samples with the final pit shell of the BS1 project area



5.2.2 BS2 Project Area

At the time of reporting, draft pit shells for the BS2 project area had not been completed. As a result, the risk assessment detailed in Section 5.1.2 will be utilised until pit shells are available for a more detailed assessment.

5.2.3 BS3/BS4 Project Area

A summary of the total sulfur analysis completed for those samples located within the final pit shell for the BS3 and BS4 project areas is provided in

Table 16 . A total of 20,467 samples with total sulfur analysis are situated within the proposed BS3 and BS4 pits. Of these, 5.35% of samples returned values exceeding 0.1% S and 0.6% returned values of greater than 0.3% S (Figure 5). A total of 3.45% of waste samples exceeded 0.1% S and 0.67% of waste samples exceeded 0.3% S.

A comparison of the BS3/BS4 project area total sulfur analysis (Table 8) to the in-pit sulfur analysis (Table 16) for rock types having sulfur concentrations with greater than 3% of samples exceeding 0.1%/0.3% S suggests the in-pit data is broadly comparable to the greater project area. It is noted that JOF ORE and JOF WASTE rock units within the pits appear to have higher concentrations of sulfur when compared to the BS3/BS4 project area.

All rock types identified with elevated sulfur (Section 5.1.3) across the BS3/BS4 project areas were represented by in-pit drillhole data with the exception of NAM WASTE. Other rock units (WW WASTE, YAN WASTE, YAN ORE, YAN HYD and MAC ORE) identified across the BS3/BS4 project areas that were not elevated and are absent from the BS3 and BS4 pits. Three rock units (CLA, MTS WASTE and MAC WASTE) were represented by less than 10 samples in-pit, typically an insufficient amount of samples to adequately quantity the risk. It is noted that waste rock from these units is predicted to total 0.25% of total waste (1.6 Mt) and therefore not sufficient volume to result in an elevated risk of AMD. Considering the project level risk of each rock unit at the project level (CLA low risk, MAC WASTE moderate and MTS WASTE not requiring assessment as low sulfur concentrations), the three rock units are considered a low risk of AMD.

and therefore the risk classification of the total sulfur analysis for the project area will be adopted for these units until additional site specific data is collected.

The average concentrations of all DET ORE samples from within the pit shell is 0.04% with 7.57% of these samples exceeding 0.1% S. The average value of sulfur in the 7.57% of samples was 0.17% and all were AWT, suggesting the sulfur is present as sulfates and not sulfides. **DET ORE is likely to pose a low acid drainage risk, however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all DOR samples from within the pit shell is 0.08% with 10.31% of these samples exceeding 0.1% S. The average value of sulfur in the 10.31% of samples was 0.56% and the majority are AWT. ABA analysis has been performed on 18 DOR samples from across the Greater Brockman area and none were classified as PAF, although sulfur concentrations were significantly less than observed within the BS3/BS4 project area. **DOR is considered to pose a low acid drainage risk.**

The average concentrations of all JOF WASTE samples from within the pit shell is 0.04% with 5.71% of these samples exceeding 0.1% S. The average value of sulfur in the 5.71% of samples was 0.2% and the majority are AWT. It is noted that JOF WASTE was not identified as elevated across greater BS3 and BS4 project area. In addition, ABA analysis was carried out on 41 Joffre member samples and all were classified as NAF (RGS, 2021). **JOF WASTE is considered to pose a low acid drainage risk.**

The average concentrations of all JOF ORE samples from within the pit shell is 0.04% with 4.9% of these samples exceeding 0.1% S. The average value of sulfur in the 4.9% of samples was 0.16% and the majority are AWT. It is noted that JOF ORE was not identified as elevated across greater BS3 and

BS4 project area. **JOF ORE is considered to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all JOF HYD samples from within the pit shell is 0.06% with 10.37% of these samples exceeding 0.1% S. The average value of sulfur in the 10.37% of samples was 0.22% and the majority are AWT. Considering the ABA analysis carried out on 41 Joffre member samples identifying all 41 samples as NAF (RGS, 2021), **JOF HYD is considered to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all WS WASTE samples from within the pit shell is 0.05% with 9.9% of these samples exceeding 0.1% S. The average value of sulfur in the 9.9 % of samples was 0.25% and the majority are AWT. A total of 36 Whaleback Shale samples (although not all classified as "waste" samples) have been analysed for ABA parameters (RGS, 2021 and SRK, 2013) across the Greater Brockman area. Of these 36 samples, 35 were classified as Uncertain or NAF with only single sample, classified as PAF. Considering this additional analysis, **WS WASTE is considered to pose a low acid drainage risk.**

The average concentrations of all WS ORE samples from within the pit shell is 0.05% with 17.09% of these samples exceeding 0.1% S. The average value of sulfur in the 17.09% of samples was 0.17% and the majority are AWT. Considering the ABA analysis undertaken on WS samples (detailed above), **WS ORE is considered to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all WS HYD samples from within the pit shell is 0.06% with 17.48% of these samples exceeding 0.1% S. The average value of sulfur in the 17.48% of samples was 0.19% and all samples are AWT. Considering the ABA analysis undertaken on WS samples (detailed above), **WS HYD is considered to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all DG HYD samples from within the pit shell is 0.04% with 6.03% of these samples exceeding 0.1% S. The average value of sulfur in the 6.03% of samples was 0.18% and all samples are AWT. **DG HYD is considered to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all FWZ ORE samples from within the pit shell is 0.03% with 4.21% of these samples exceeding 0.1% S. The average value of sulfur in the 4.21% of samples was 0.13% and 160 from a total of 190 samples are AWT. **FWZ ORE is considered to pose a low acid drainage risk.**

The average concentrations of all MCS WASTE (oxidised) samples from within the pit shell is 2.25% with 3.03% of these samples exceeding 0.1% S. The average value of sulfur in the 3.03% of samples was 12.95% and 65 from a total of 66 samples were AWT. **MCS WASTE (oxidised) considered to pose a moderate acid drainage risk.**

Table 16: Summary of in-pit BS3 and BS4 drill hole sulfur concentrations

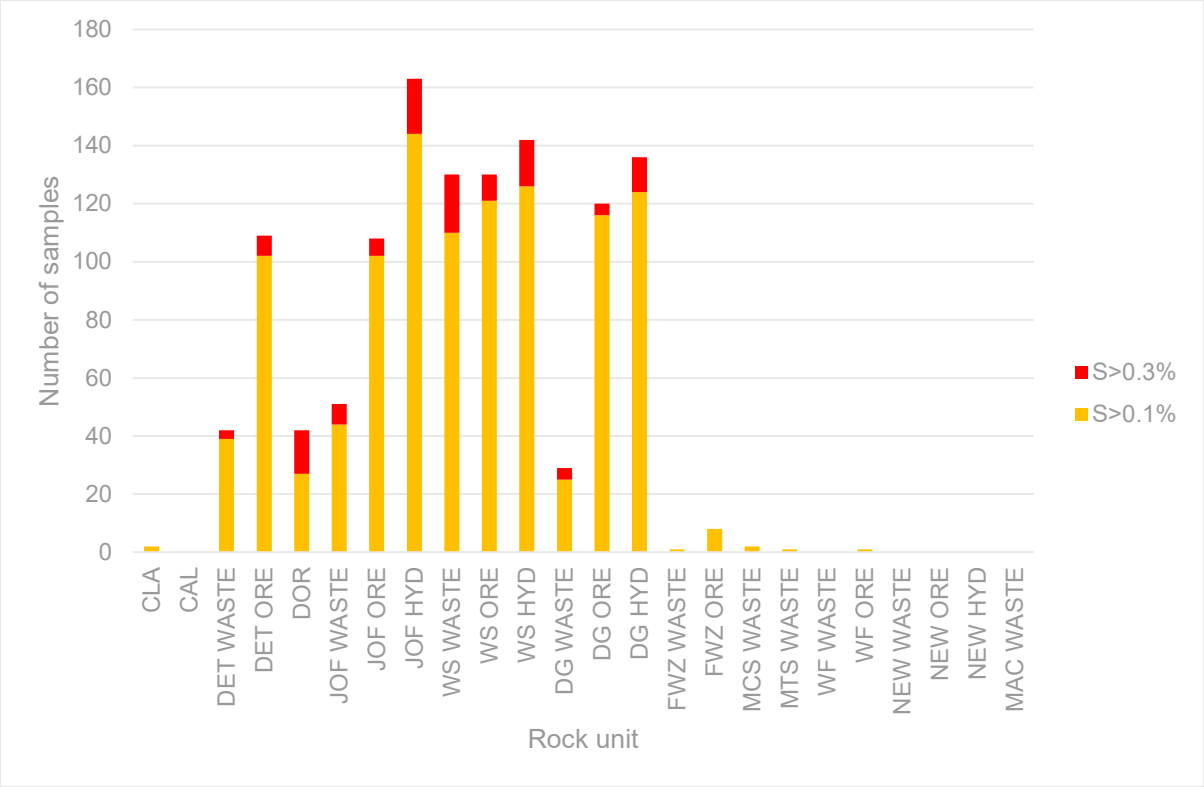
Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	**4**	**2**	**50.00%**	0	0.00%	0.10	0.17
CAL	14	0	0.00%	0	0.00%	0.02	-
DET WASTE	3053	39	1.28%	3	0.10%	0.02	0.16
DET ORE	**1348**	**102**	**7.57%**	7	0.52%	0.04	0.17
DOR	**262**	**27**	**10.31%**	**15**	**5.73%**	**0.08**	**0.56**
JOF WASTE	**771**	**44**	**5.71%**	7	0.91%	0.04	0.20
JOF ORE	**2080**	**102**	**4.90%**	6	0.29%	0.04	0.16
JOF HYD	**1389**	**144**	**10.37%**	19	1.37%	0.06	0.22
WS WASTE	**1111**	**110**	**9.90%**	20	1.80%	0.05	0.25
WS ORE	**708**	**121**	**17.09%**	9	1.27%	0.05	0.17
WS HYD	**721**	**126**	**17.48%**	16	2.22%	0.06	0.19
DG WASTE	1302	25	1.92%	4	0.31%	0.02	0.28
DG ORE	4173	116	2.78%	4	0.10%	0.02	0.14
DG HYD	**2055**	**124**	**6.03%**	12	0.58%	0.04	0.18
FWZ WASTE	89	1	1.12%	0	0.00%	0.02	0.10
FWZ ORE	**190**	**8**	**4.21%**	0	0.00%	0.03	0.13
MCS WASTE (oxidised)	**66**	**2**	**3.03%**	0	0.00%	2.25%	12.95%
MTS WASTE	**4**	**1**	**25.00%**	0	0.00%	0.07	0.10
WF WASTE	542	0	0.00%	0	0.00%	0.02	-
ANG ORE	40	1	2.50%	0	0.00%	0.02	0.12
NEW WASTE	47	0	0.00%	0	0.00%	0.01	-
NEW ORE	314	0	0.00%	0	0.00%	0.01	-
NEW HYD	181	0	0.00%	0	0.00%	0.03	-
MAC WASTE	3	0	0.00%	0	0.00%	0.04	-
Total number of samples assayed for S		20467					
Total number of samples with S>0.1/0.3%		1095		122			

Percentage of total with S>0.1/0.3%	5.35%	0.60%
Total number of waste samples assayed for S [a]	7268	
Total number of waste samples with S>0.1/0.3%	251	49
Percentage of total waste samples with S>0.1/0.3%	3.45%	0.67%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

a waste samples do not include ORE, HYD, DMP or OTHER samples.

Figure 5 – Distribution of rock type and elevated sulfur samples with the final pit shell of the BS3 and BS4 project area



5.2.4 BS3X/Lens G Project Area

A summary of the total sulfur analysis completed for those samples located within the final pit shell for the BS3X/Lens G project area is provided in Table 18. A total of 13,465 samples with total sulfur analysis are situated within the proposed BS3X and Lens G pits. Of these, 1.05% of samples returned values exceeded 0.1% S and 0.17% returned values of greater than 0.3% S (Figure 6). A total of 0.89% of waste samples exceeded 0.1% S and 0.18% of waste samples exceeded 0.3% S.

A comparison of the project area total sulfur analysis to the in-pit sulfur analysis for rock types having sulfur concentrations with greater than 3% of samples exceeding 0.1%/0.3% S suggests the in-pit data is comparable to the greater BS3X/Lens G project areas. All rock types identified with elevated sulfur (Section 5.1.4) across the BS3X and Lens G project areas were also identified within the in-pit analysis,

with the exception of DG ORE, MCS WASTE (oxidised), MCS WASTE (black), MTS WASTE and NAM WASTE. Both DG ORE and NAM WASTE are represented by in-pit samples, however concentrations are below the threshold of greater than 3% of samples exceeding 0.1%/0.3% S. MCS WASTE (oxidised) and MTS WASTE were not sampled within any in-pit drillhole. A review of logging data suggests these units (and overlying sequences) are absent from the pits within the BS3X and Lens G deposits.

The average concentrations of all DET ORE samples from within the pit shell is 0.03% with 4.75% of these samples exceeding 0.1% S. The average value of sulfur in the 4.75% of samples was 0.14% and all were AWT, suggesting the sulfur is present as sulfates and not sulfides. **DET ORE is likely to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

Sulfur concentrations within the DOR rock unit were not identified as elevated within the greater BS3X/Lens G project areas with only 2 samples exceeding 0.1% S within the entire BS3X/Lens G project area. One of these exceedances is located within a pit shell, hence it has been identified as exceeding the criteria of having sulfur concentrations with greater than 3% of samples exceeding 0.1%/0.3% S. The single sample (from a total of 23) is located AWT. The average S concentration of all sulfur is 0.05% S. Given this average concentration, **DOR is likely to pose a low acid drainage risk.**

The average concentrations of all WS WASTE samples from within the pit shell is 0.39% S with 45.16% of these samples exceeding 0.1% S. The average value of sulfur in the 45.16% of samples was 0.79% and all were situated BWT. A total of 36 Whaleback Shale samples (although not all classified as “waste” samples) have been analysed for ABA parameters (RGS, 2021 and SRK, 2013) across the Greater Brockman area. Of these 36 samples, 35 were classified as Uncertain or NAF with only single sample classified as PAF. **WS WASTE is likely to pose a moderate acid drainage risk.**

The average concentrations of all WS ORE samples from within the pit shell is 0.25% S with 90% of these samples exceeding 0.1% S. The average value of sulfur in the 90% of samples was 0.27% and all were situated BWT. Given the ABA analysis undertaken across Greater Brockman (detailed above), **WS ORE is likely to pose a moderate acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all WS HYD samples from within the pit shell is 0.08% S with 20.51% of these samples exceeding 0.1% S. The average value of sulfur in the 20.51% of samples was 0.19% and all were situated BWT. Given the ABA analysis undertaken across Greater Brockman (detailed above), **WS HYD is likely to pose a moderate acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all DG WASTE samples from within the pit shell is 0.04% S with 7.89% of these samples exceeding 0.1% S. The average value of sulfur in the 7.89% of samples was 0.14% and all were situated BWT. **DG WASTE is likely to pose a low acid drainage risk.**

The average concentrations of all DG HYD samples from within the pit shell is 0.05% S with 6.3% of these samples exceeding 0.1% S. The average value of sulfur in the 6.3% of samples was 0.13% and

all were situated BWT. **DG HYD is likely to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

The average concentrations of all MAC WASTE samples from within the pit shell is 0.05% S with 9.62% of these samples exceeding 0.1% S. The average value of sulfur in the 9.62% of samples was 0.15% and all were situated BWT. **MAC WASTE is likely to pose a moderate acid drainage risk.**

The average concentrations of all MAC ORE samples from within the pit shell is 0.04% S with 3.13% of these samples exceeding 0.1% S. The average value of sulfur in the 3.13% of samples was 0.11% and all were situated BWT. **MAC ORE is likely to pose a low acid drainage risk however, as this ore is likely to be mined and removed from site, it poses little risk from an AMD perspective. If this material is disturbed and not removed as ore, this risk may change.**

Table 17: Summary of sulfur analysis for in-pit drill holes within BS3x and Lens G areas

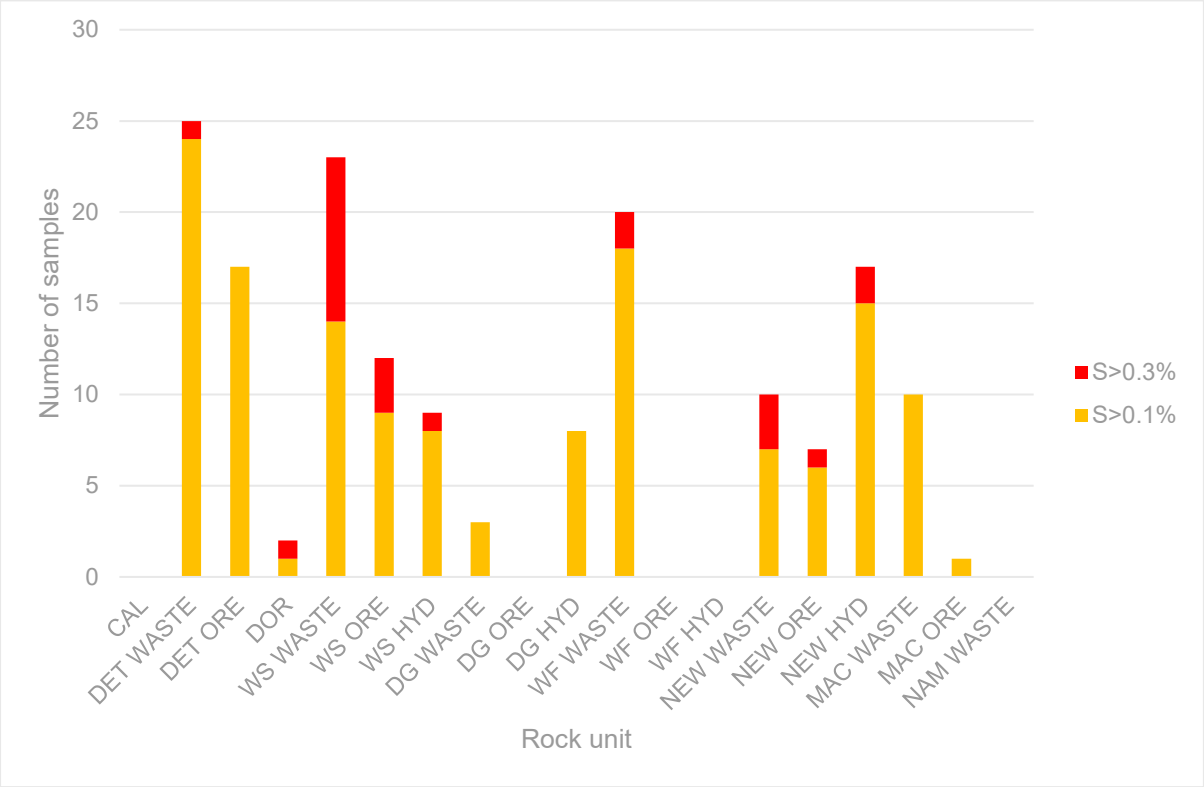
Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CAL	74	0	0.00%	0	0.00%	0.02	-
DET WASTE	6023	24	0.40%	1	0.02%	0.02	0.15
DET ORE	**358**	**17**	**4.75%**	**0**	**0.00%**	**0.03**	**0.14**
DOR	**23**	**1**	**4.35%**	**1**	**4.35%**	**0.05**	**0.38**
WS WASTE	**31**	**14**	**45.16%**	**9**	**29.03%**	**0.39**	**0.79**
WS ORE	**10**	**9**	**90.00%**	**3**	**30.00%**	**0.25**	**0.27**
WS HYD	**39**	**8**	**20.51%**	**1**	**2.56%**	**0.08**	**0.19**
DG WASTE	**38**	**3**	**7.89%**	**0**	**0.00%**	**0.04**	**0.14**
DG ORE	194	0	0.00%	0	0.00%	0.02	-
DG HYD	**127**	**8**	**6.30%**	**0**	**0.00%**	**0.05**	**0.13**
WF WASTE	1791	18	1.01%	2	0.11%	0.02	0.20
ANG ORE	157	0	0.00%	0	0.00%	0.02	-
ANG HYD	187	0	0.00%	0	0.00%	0.03	-
NEW WASTE	600	7	1.17%	3	0.50%	0.02	0.46
NEW ORE	2705	6	0.22%	1	0.04%	0.01	0.20
NEW HYD	956	15	1.57%	2	0.21%	0.03	0.35
MAC WASTE	**104**	**10**	**9.62%**	**0**	**0.00%**	**0.05**	**0.15**
MAC ORE	**32**	**1**	**3.13%**	**0**	**0.00%**	**0.04**	**0.11**
NAM WASTE	16	0	0.00%	0	0.00%	0.02	-

Total number of samples assayed for S	13465	
Total number of samples with S>0.1/0.3%	141	23
Percentage of total with S>0.1/0.3%	1.05%	0.17%
Total number of waste samples assayed for S [a]	8700	
Total number of waste samples with S>0.1/0.3%	77	16
Percentage of total waste samples with S>0.1/0.3%	0.89%	0.18%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Figure 6 – Distribution of rock type and elevated sulfur samples with the final pit shells of the BS3x and Lens G project area



5.2.5 BSMM Project Area

A summary of the total sulfur analysis completed for those samples located within the final pit shell for the BSMO, BSMQ and BSMR prospects is provided in Table 18. A total of 38,167 samples with total sulfur analysis are situated within the proposed BSMO, BSMQ and BSMR pits. Of these, 1.32% of

samples returned values exceeded 0.1% S and 0.46% returned values of greater than 0.3% (Figure 7) total of 1.95% of waste samples exceeded 0.1% S and 0.71% of waste samples exceeded 0.3% S.

A comparison of the project area total sulfur analysis (Table 12) to the in-pit sulfur analysis (Table 18) for rock types having sulfur concentrations with greater than 3% of samples exceeding 0.1%/0.3% S suggests the in-pit data is comparable to the greater project area. All rock types identified with elevated sulfur (Section 5.1.5) across the BSMO, BSMQ and BSMR prospect areas were also identified within the in-pit analysis. Specific rock units are discussed below.

The CLA unit was not identified as elevated in the project area total sulfur analysis, with only eight samples exceeding 0.1% S across the BSMO, BSMQ and BSMR prospects. Four of these samples are situated within the proposed pit shells, resulting in 3.05% of CLA samples within pit shells exceeding 0.1% S. The average sulfur concentration of all samples within the pit shells is 0.03% S. All exceedances of 0.1% S were located AWT. Given the average concentration of sulfur within CLA samples and the source of elevated sulfur originating from AWT samples, **CLA is likely to pose a low acid drainage risk.**

The average concentration of all DET WASTE samples from within the pit shell is 0.04% S with 3.74% of these samples exceeding 0.1% S. The average concentration of sulfur in the 3.74% of samples was 0.34% and 14 samples (out of a total of 158) were situated BWT. Given the absence of lignite within the BSMM project area, and the NAF classification calculated for the majority of detrital samples (RGS 2021), **DET WASTE is likely to pose a low acid drainage risk.**

The FOR WASTE rock unit was identified as 'moderate risk' from the project area total sulfur analysis. Only three FOR WASTE samples were situated within the pit shells and this is not considered sufficient data to adequately quantify the risk. As a result, the risk category based on the total sulfur analysis for this unit will remain until additional site specific data is collected.

Table 18: Summary of sulfur analysis for in-pit drill holes within BSMM areas

Rock type	Total samples assayed for S	Number of samples with S>0.1%	Percentage of total samples with S>0.1%	Number of samples with S>0.3%	Percentage of samples with S>0.3%	Average S value for all samples	Average S value for samples with S>0.1%
CLA	**131**	**4**	**3.05%**	**4**	**3.05%**	**0.03**	**0.60**
CAL	20	0	0.00%	0	0.00%	0.04	-
DET WASTE	**4220**	**158**	**3.74%**	**49**	**1.16%**	**0.04**	**0.34**
DET ORE	4291	32	0.75%	5	0.12%	0.02	0.21
DOR	745	11	1.48%	7	0.94%	0.02	0.55
FWZ WASTE	6	0	0.00%	0	0.00%	0.04	-
MCS WASTE	9	0	0.00%	0	0.00%	0.03	-
MTS WASTE	11	0	0.00%	0	0.00%	0.01	-
WF WASTE	14828	262	1.77%	107	0.72%	0.03	0.73

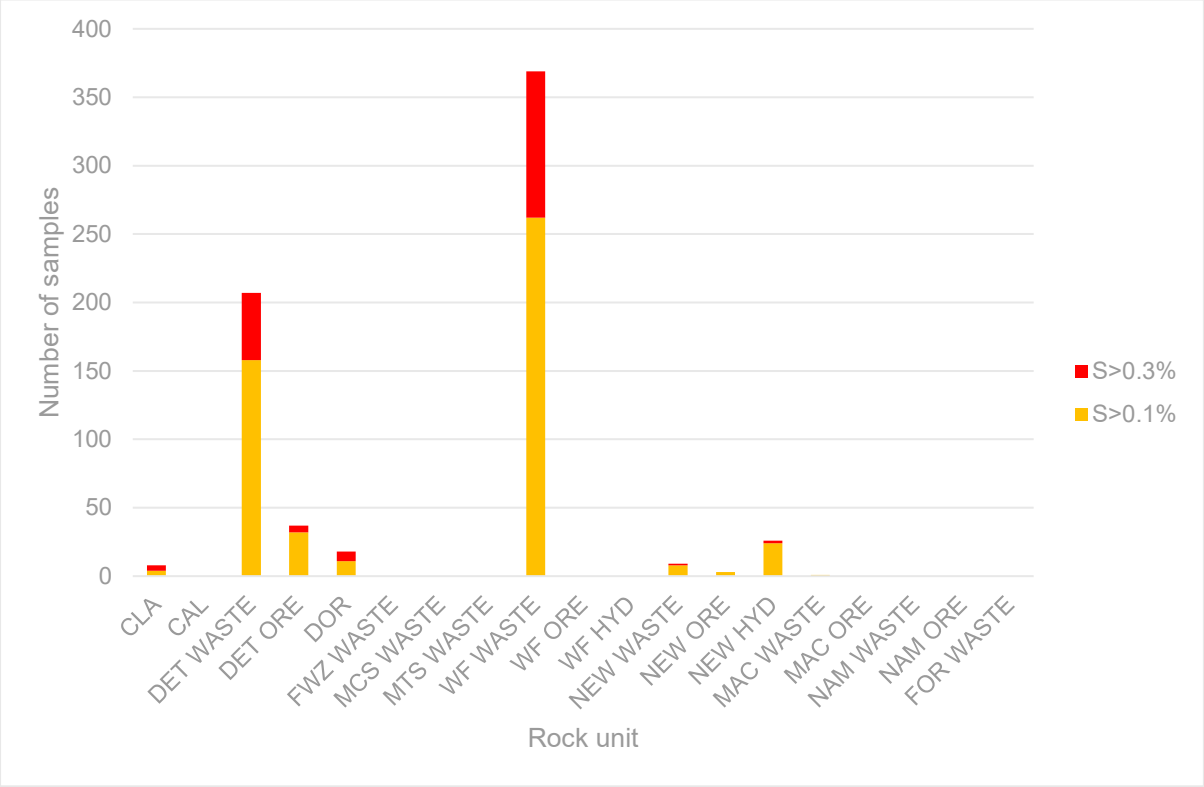
ANG ORE	647	0	0.00%	0	0.00%	0.01	-
ANG HYD	341	0	0.00%	0	0.00%	0.02	-
NEW WASTE	2328	8	0.34%	1	0.04%	0.01	0.20
NEW ORE	6756	3	0.04%	0	0.00%	0.01	0.12
NEW HYD	2960	24	0.81%	2	0.07%	0.03	0.18
MAC WASTE	443	1	0.23%	0	0.00%	0.03	0.19
MAC ORE	139	0	0.00%	0	0.00%	0.02	-
NAM WASTE	49	0	0.00%	0	0.00%	0.03	-
NAM ORE	240	0	0.00%	0	0.00%	0.01	-
FOR WASTE	3	0	0.00%	0	0.00%	0.01	-

Total number of samples assayed for S	38167	
Total number of samples with S>0.1/0.3%	503	175
Percentage of total with S>0.1/0.3%	1.32%	0.46%
Total number of waste samples assayed for S [a]	22793	
Total number of waste samples with S>0.1/0.3%	444	161
Percentage of total waste samples with S>0.1/0.3%	1.95%	0.71%

* those waste rock types with greater than 3% of samples having sulfur values exceeding 0.1%/0.3% have been highlighted in red

[a] waste samples do not include ORE, HYD, DMP or OTHER samples.

Figure 7 – Distribution of rock type and elevated sulfur samples with the final pit shell of the BSMM project area



5.3 Summary of Risk Profiles

A summary of the risk profiles of each rock unit based on project and inpit sulfur concentrations are detailed in Section 5.1 and 5.2 is presented in Table 19.

Table 19 – Summary of risk profiles for each site based on project and in pit sulfur concentration.

Rock units	BS1		BS2		BS3/BS4		BS3X/Lens G		BSMM	
	Project risk	In-pit risk	Project risk	In-pit risk	Project risk	In-pit risk	Project risk	In-pit risk	Project risk	In-pit risk
CLA				1		1				
CAL				1						
DET WASTE				1						
DET ORE				1						
DOR				1						
WW WASTE										
YAN WASTE										
YAN ORE										
YAN HYD										
JOF WASTE				1						
JOF ORE										
JOF HYD				1						
WS WASTE				1						
WS ORE				1						

WS HYD				1						
DG WASTE				1						
DG ORE				1						
DG HYD				1						
FWZ WASTE				1						
FWZ ORE				1						
MCS WASTE (oxidised)				1						
MCS WASTE (black)				1						
MCS ORE										
MCS HYD										
MTS WASTE				1		1				
MTS ORE										
WF WASTE				1						
ANG ORE										
ANG HYD										
NEW WASTE				1						
NEW ORE										
NEW HYD										
MAC WASTE		1				1				
MAC ORE										
NAM WASTE		1								
NAM ORE										
FOR WASTE										1

	High
	Moderate
	Low
	Below >3% of samples having concentration >0.1%
	Rock unit absent / not assessed
1	Insufficient samples, adopted project area classification

6. Sulfur Exposures and Sulfur Risk

A review of the current mine models for the Greater Brockman area was undertaken in order to determine pit exposures and tonnages of material that has been classified as sulfur risk 1 (low risk), 2 (moderate risk) or 3 (high risk). The classification of risk is based on Table 3 (RTIO, 2020).

6.1 Sulfur Risk in the Mining Model

As detailed in Table 20, BS1 will excavate the largest quantity of Risk 2 (22.2 Mt) and Risk 3 (0.18 Mt) material, although as a proportion of total mined waste (276 Mt) this is relatively small. It is noted that BS2 waste could not yet be calculated due to an absence of pit shells that have been created for this resource. Both BS3/BS4 and BSMM will excavate minor quantities, while BS3X/Lens G will not excavate any Risk 2 or 3 material.

Table 20 – Mine model tonnages of waste classified as sulfur risk 1, 2 or 3.

Waste Type	Total tonnages (Mt)				
	BS1	BS2	BS3/BS4	BS3X/Lens G	BSMM
Sulfur risk 1 (Low Risk BS-Oxide)	55.7	No data available	100.6	49.6	129.3
Sulfur risk 2 (Moderate Risk BS-Cold)	22.2		5.1	-	1.0
Sulfur risk 3 (High Risk BS-Hot)	0.18		0.96	-	0.12
Total waste (Risk 2 and Risk 3)	**22.4**		**6.06**	**-**	**1.2**
Total waste (Risk 0-4)	**276**		**698**	**296**	**295**

6.2 Sulfur Exposures on Final Pit Shells

A review was undertaken of the proposed mine pit designs to the mine model to determine if any sulfide_risk 2 or sulfide_risk 3 material will be exposed in the final pit walls. Results are presented in Table 21 and Figure 8 - Figure 18. The current pit shells for BS1, BS3/4 and BSMM project areas are predicted to result in exposed sulfide_risk 2 and sulfide_risk 3 material. BS2 could not be calculated due to an absence of pit shells for this project. BS3X/Lens G is not expected to result in any sulfide_risk 2 or 3 material in the final pit walls.

BS1 presents the largest risk in terms of exposures of sulfide_risk 2 and sulfide_risk 3 with 7.27% (698,550 m^2) of sulfide_risk 2 and 0.16% (15,038 m^2) of sulfide_risk 3 present in the final pit walls. The BS3/BS4 area is significantly lower with 0.94% (44,009 m^2) of the final pit shells exposing sulfide_risk 2 material and 0.02% (1,009 m^2) of the final pit shells exposing sulfide_risk 3 material. The BSMM pit shells is likely to result in a 0.16% (12,212 m^2) sulfide_risk 2 exposure and 0.05% (3,422 m^2) sulfide_risk 3 exposure.

It is noted that a large proportion of the Risk 2 and 3 exposures are situated at shallow depths and situated AWT. These elevated sulfur concentrations are likely associated with sulfate minerals and present a lower risk of AMD than sulfide minerals (e.g. pyrite). Additional characterisation work of predicted exposures and risk ranking within the mine model will need to be carried out to ensure proper characterisation of material.

Table 21 – Pit exposures of sulfide risk category 2 and 3 across the Greater Brockman area.

Project	Pit	Total Area (m^2)	Risk 2 area (m^2)	Risk 3 area (m^2)	Risk 2 % of pit	Risk 3 % of pit
BS1	East 1	1,956,000	116,935	8,842	5.98%	0.45%
	East 2	2,337,000	30,501	-	1.31%	-
	East 3	826,294	4,935	-	0.60%	-
	West 1	1,968,000	119,270	5	6.06%	0.00%
	West 2	2,522,000	426,909	6,192	16.93%	0.25%
	Total	**9,609,294**	**698,550**	**15,038**	**7.27%**	**0.16%**
BS3/BS4	BS3	2,137,000	5,974	1,009	0.28%	0.05%
	END Pit 1	2,290,000	28,351	-	1.24%	-
	END Pit 2	164,681	4,628	-	2.81%	-
	END Pit 3	72,970	5,056	-	6.93%	-
	Total	**4,664,651**	**44,009**	**1,009**	**0.94%**	**0.02%**
BSMM	Pit Q	4,684,000	725	-	0.02%	-
	Pit R	2,744,000	11,487	3,422	0.42%	0.12%
	Total	**7,428,000**	**12,212**	**3,422**	**0.16%**	**0.05%**

Figure 8 – BS1 west 1 pit sulfide risk exposures.

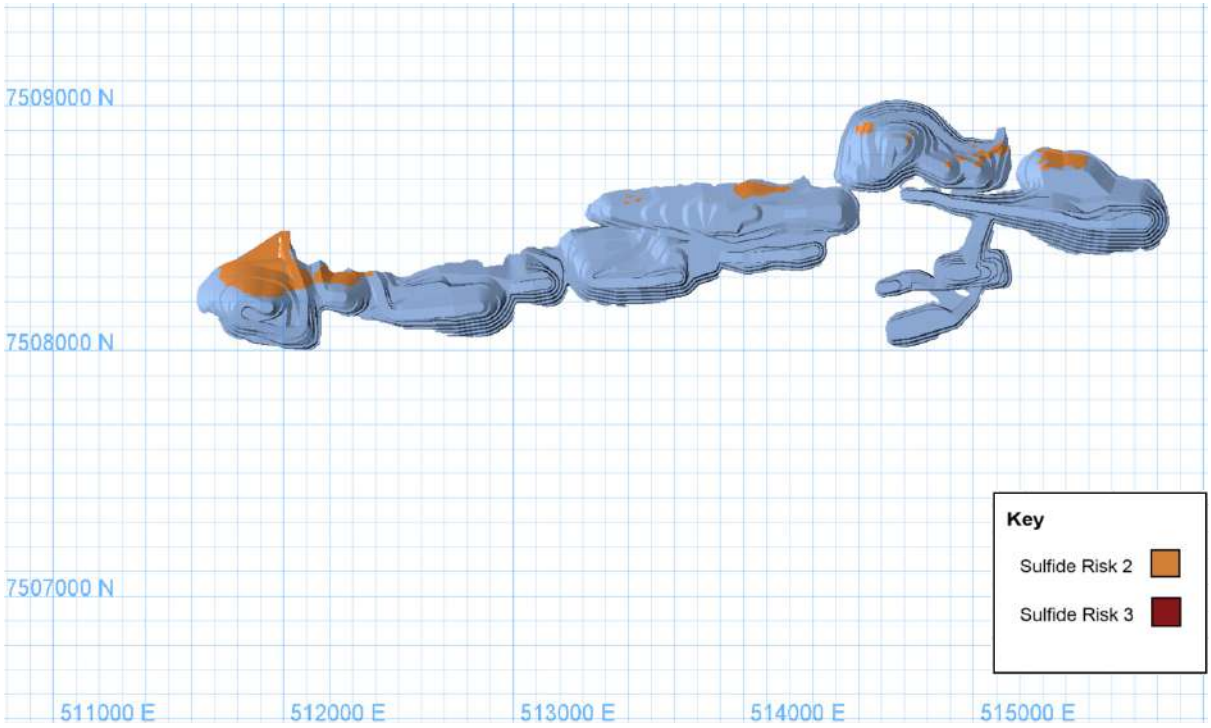


Figure 9 – BS1 west 2 pit sulfide risk exposures.

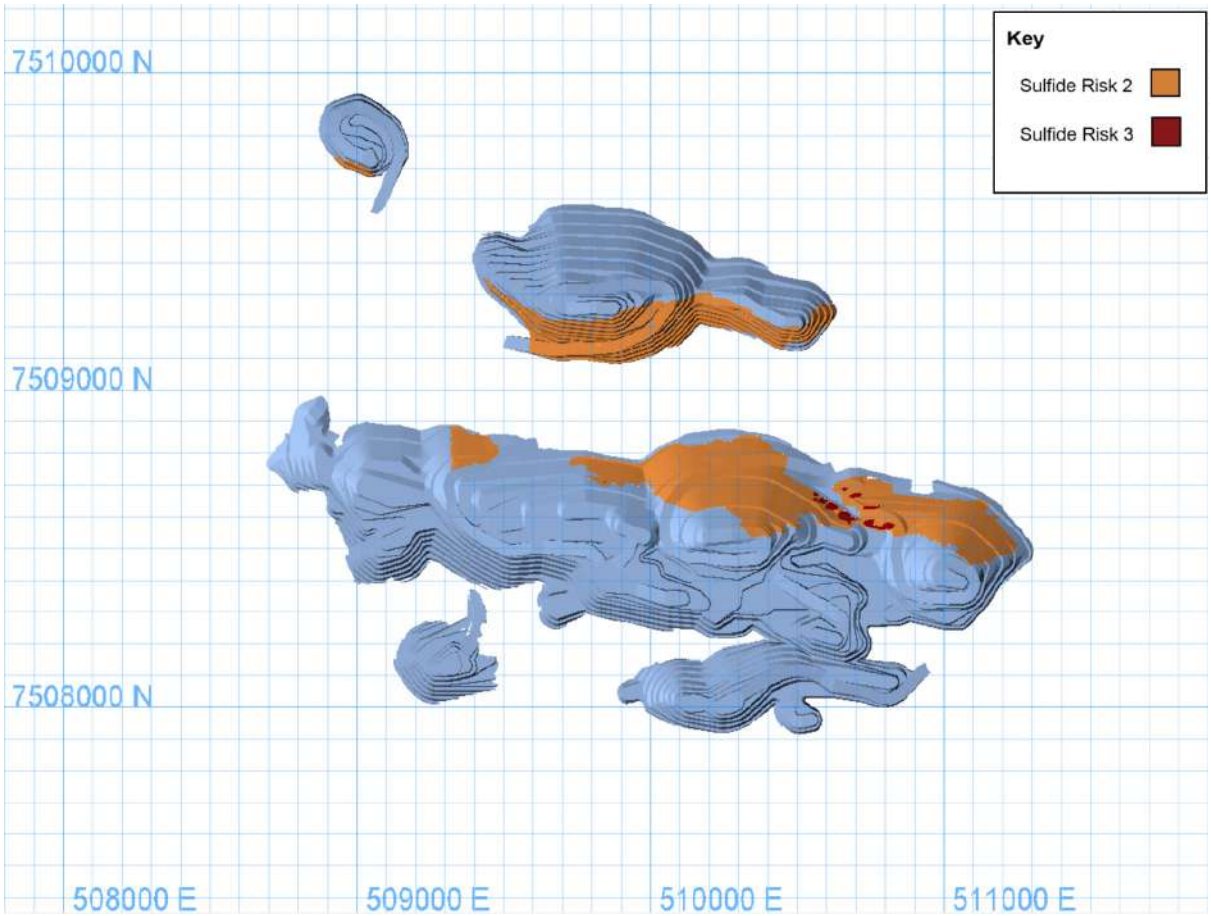


Figure 10 – BS1 east 1 pit sulfide risk exposures.

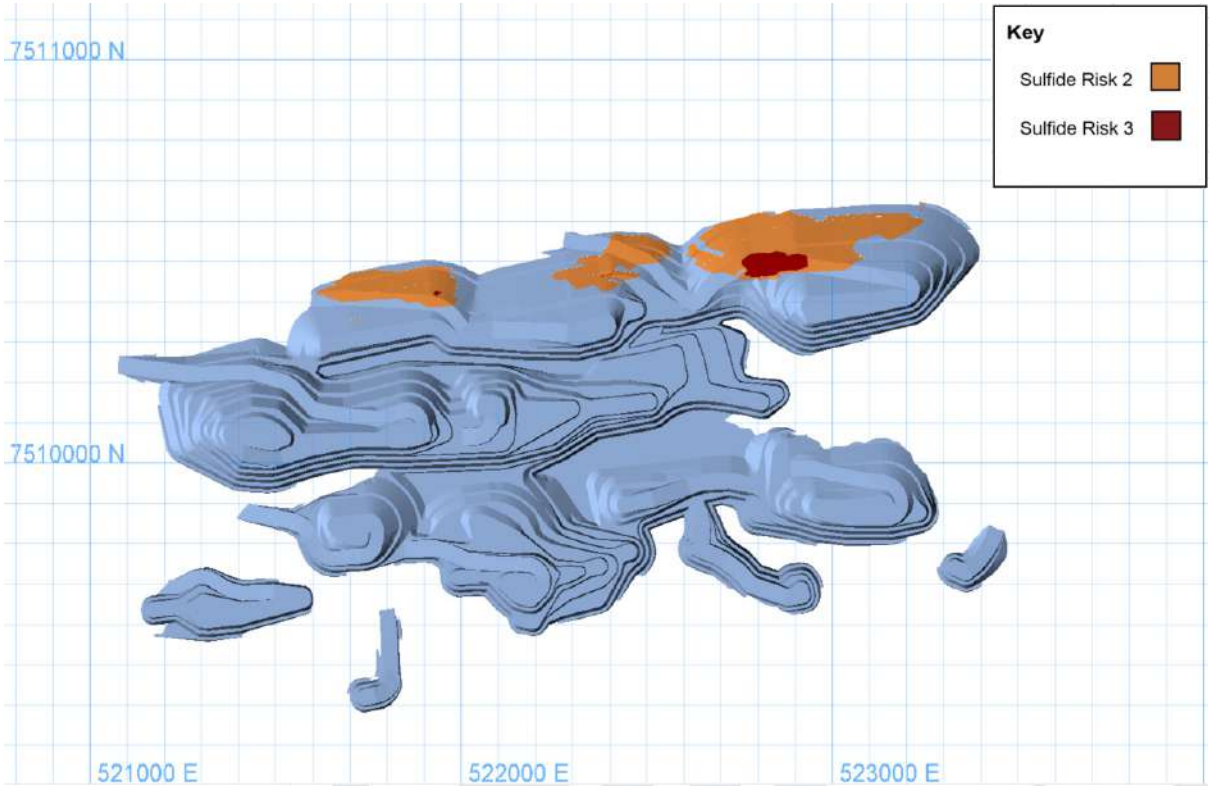


Figure 11 – BS1 east 2 pit sulfide risk exposures.

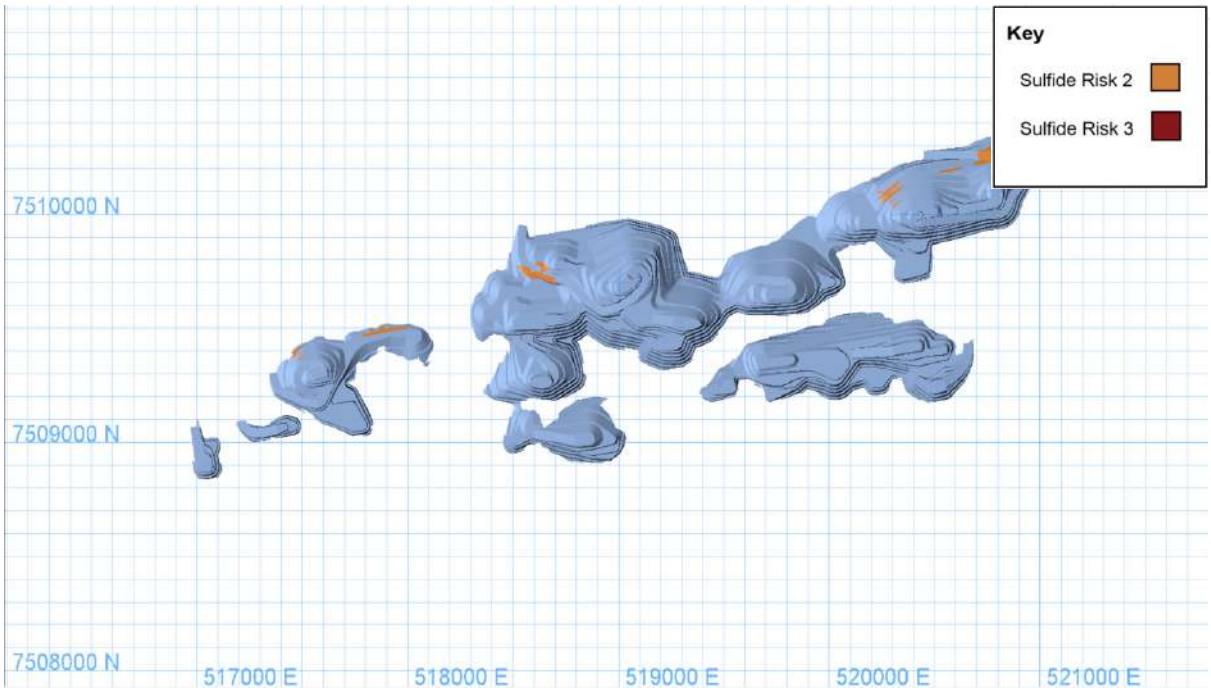


Figure 12 – BS1 east 3 pit sulfide risk exposures.

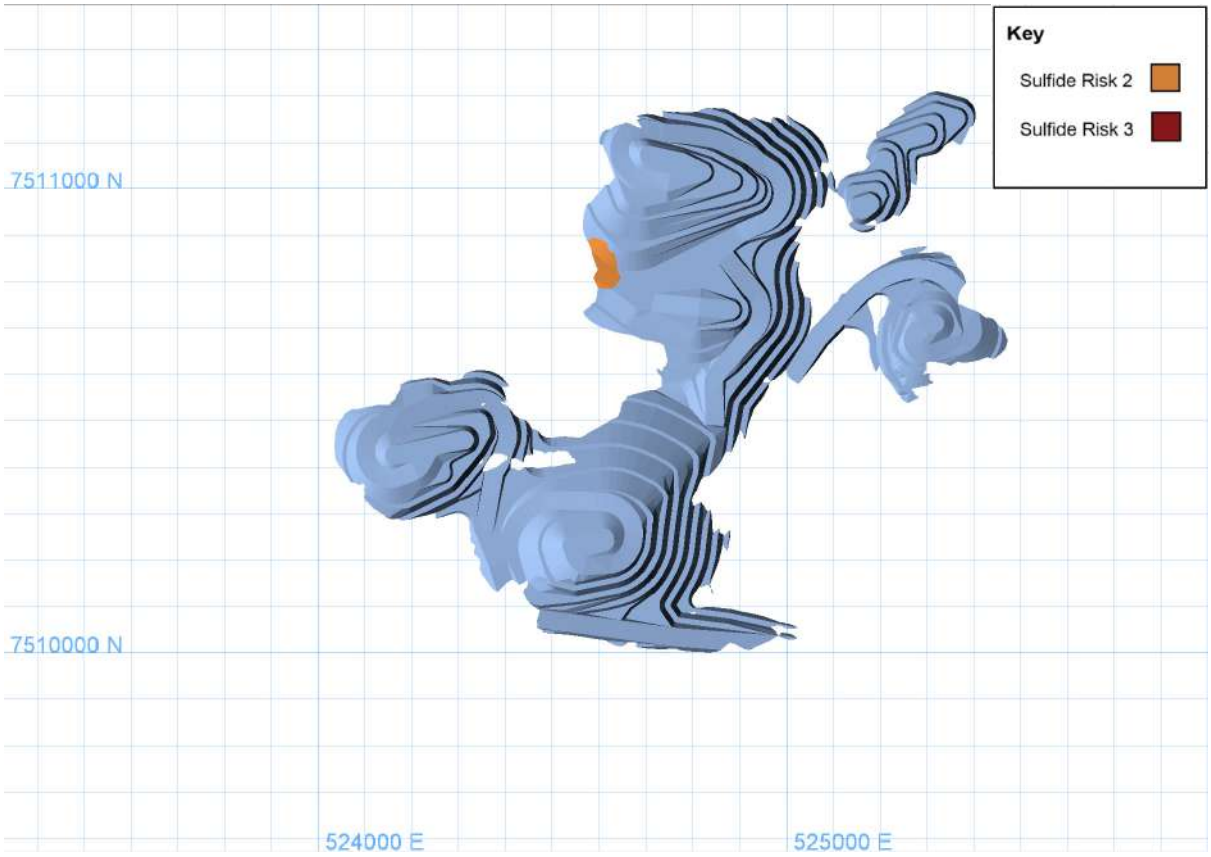


Figure 13 – BS3 pit sulfide risk exposures.

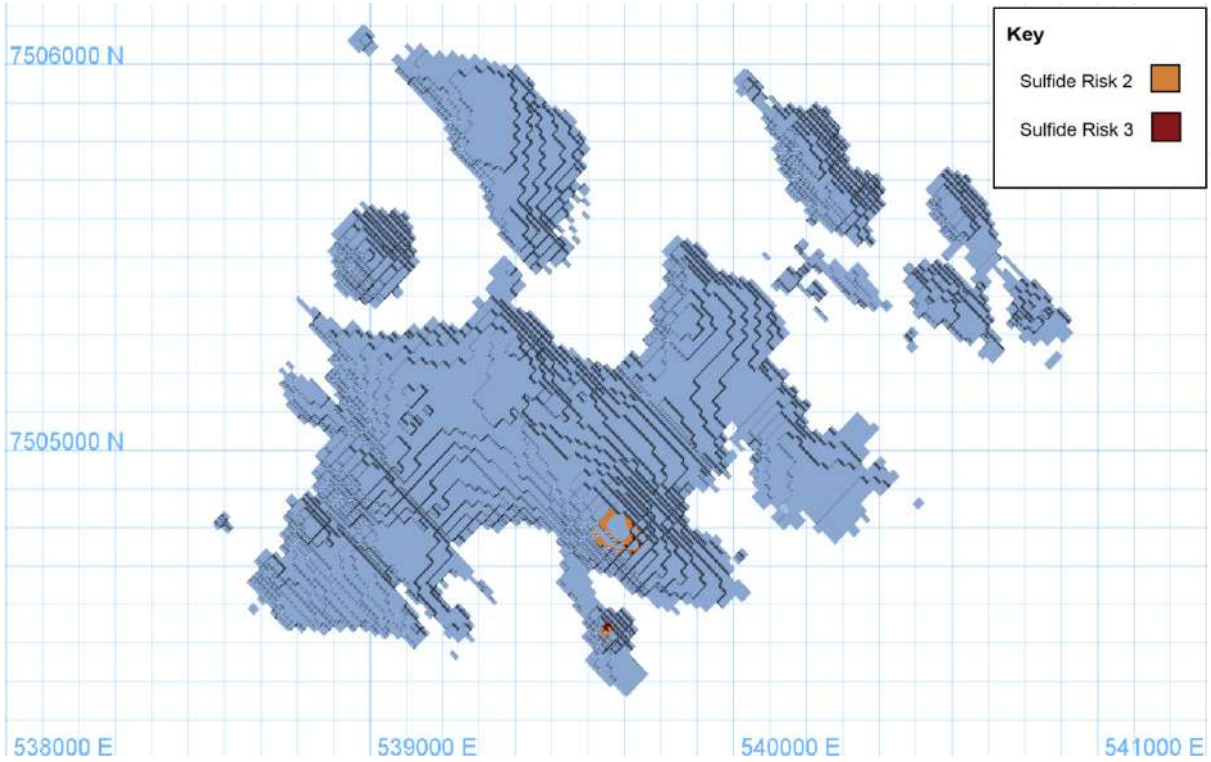


Figure 14 – Endeavour Pit 1 sulfide risk exposures.

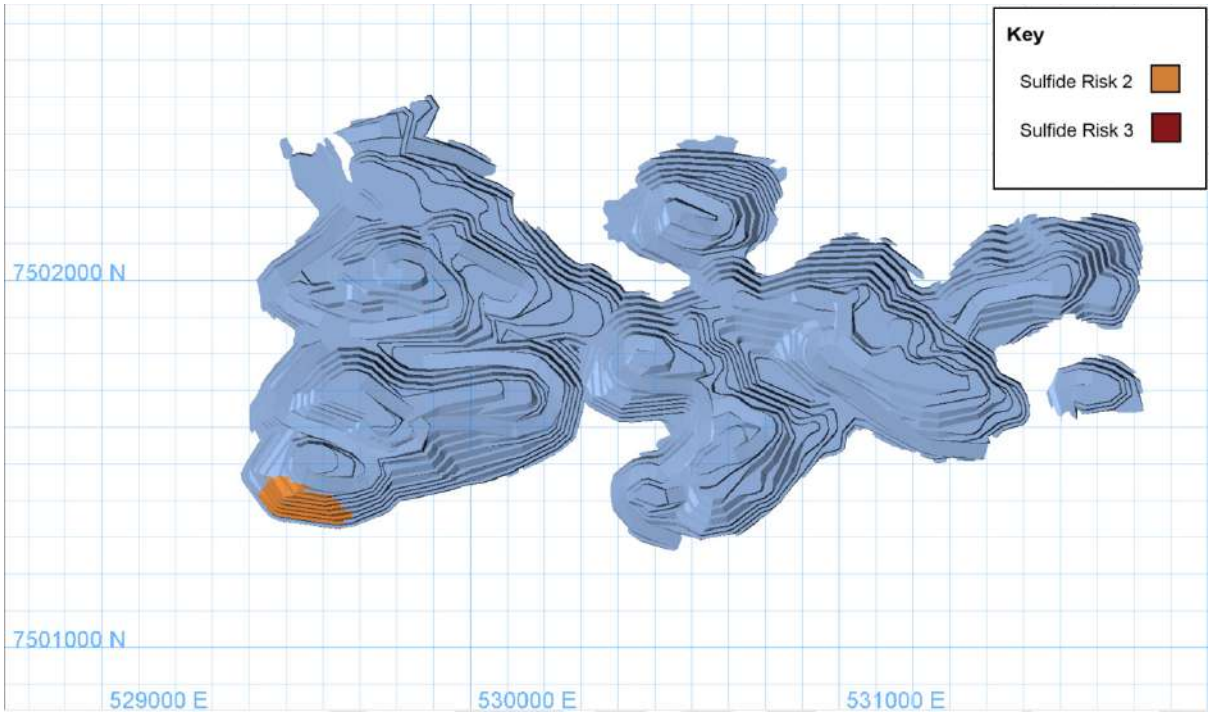


Figure 15 – Endeavour Pit 2 sulfide risk exposures.

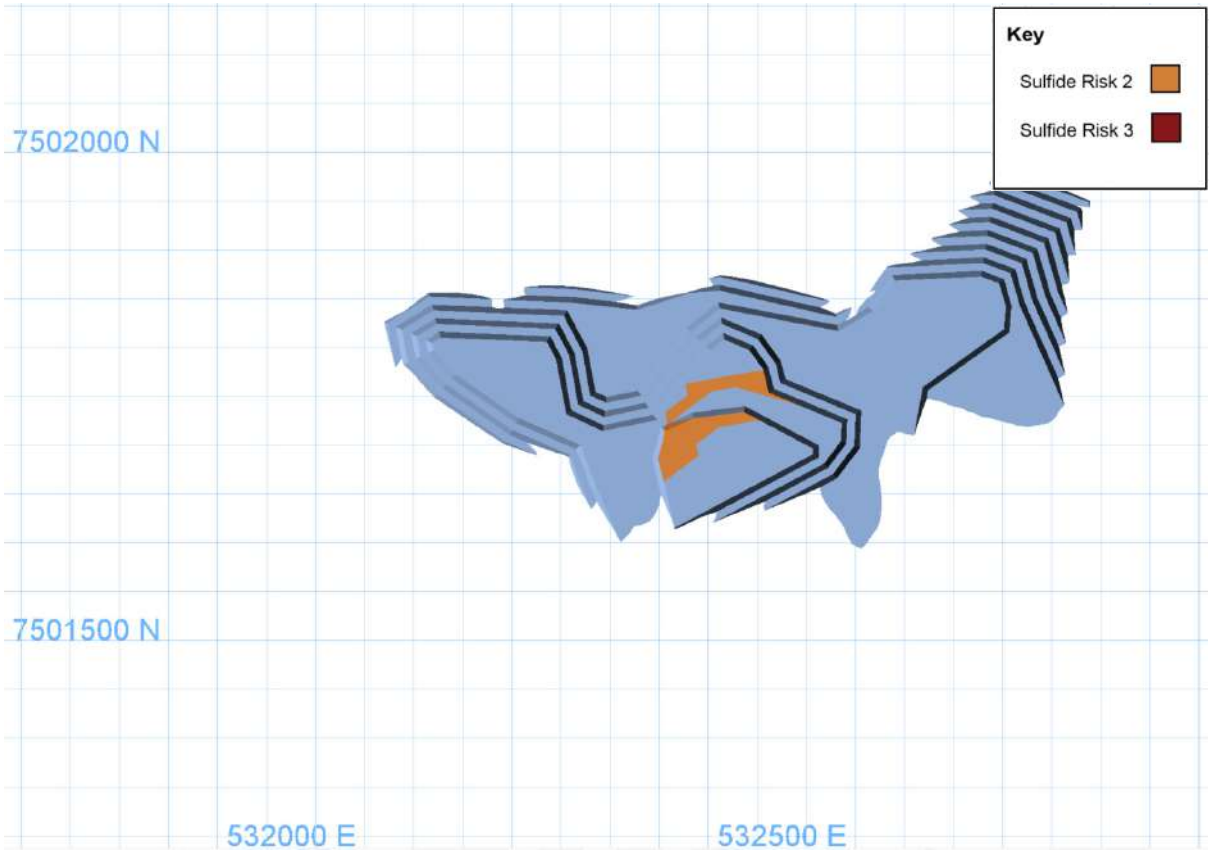


Figure 16 – Endeavour Pit 3 sulfide risk exposures.

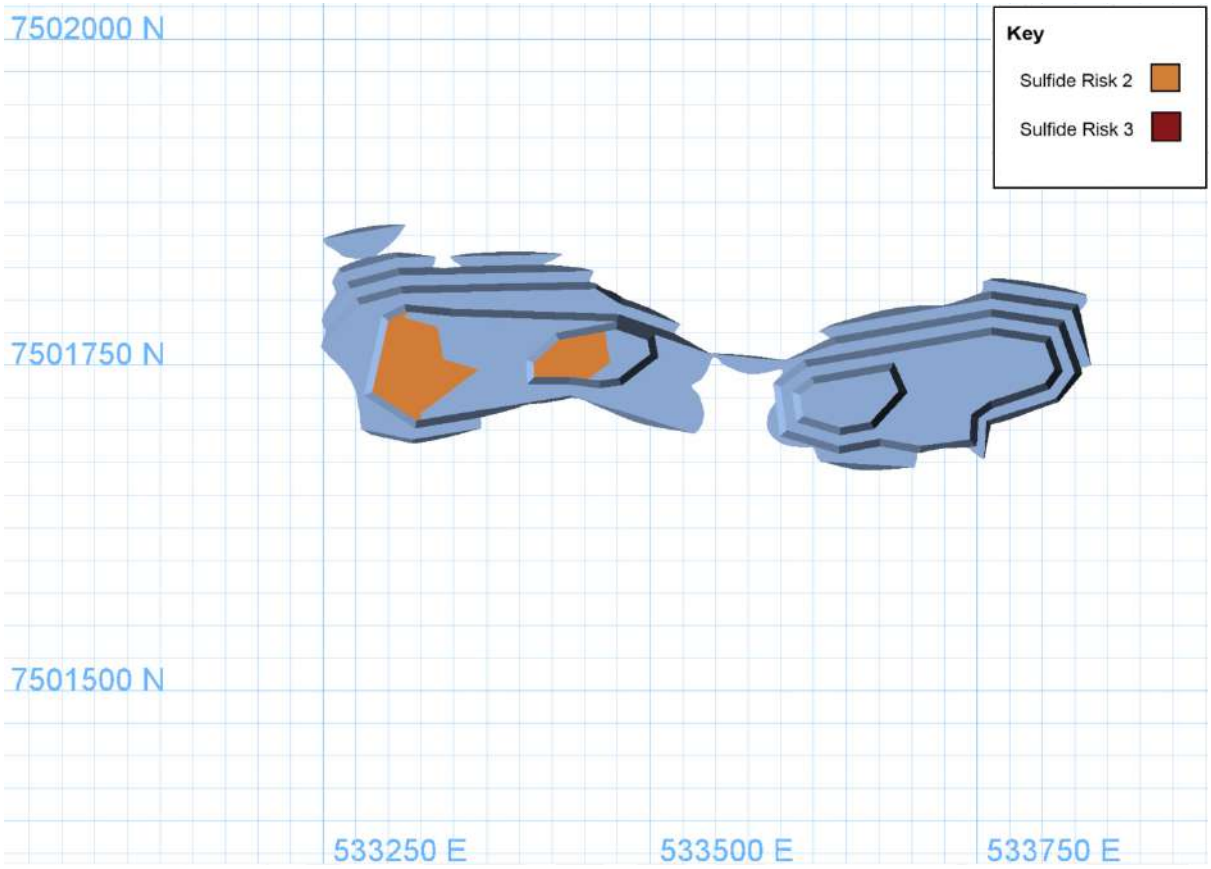


Figure 17 – BSMM Pit R sulfide risk exposures.

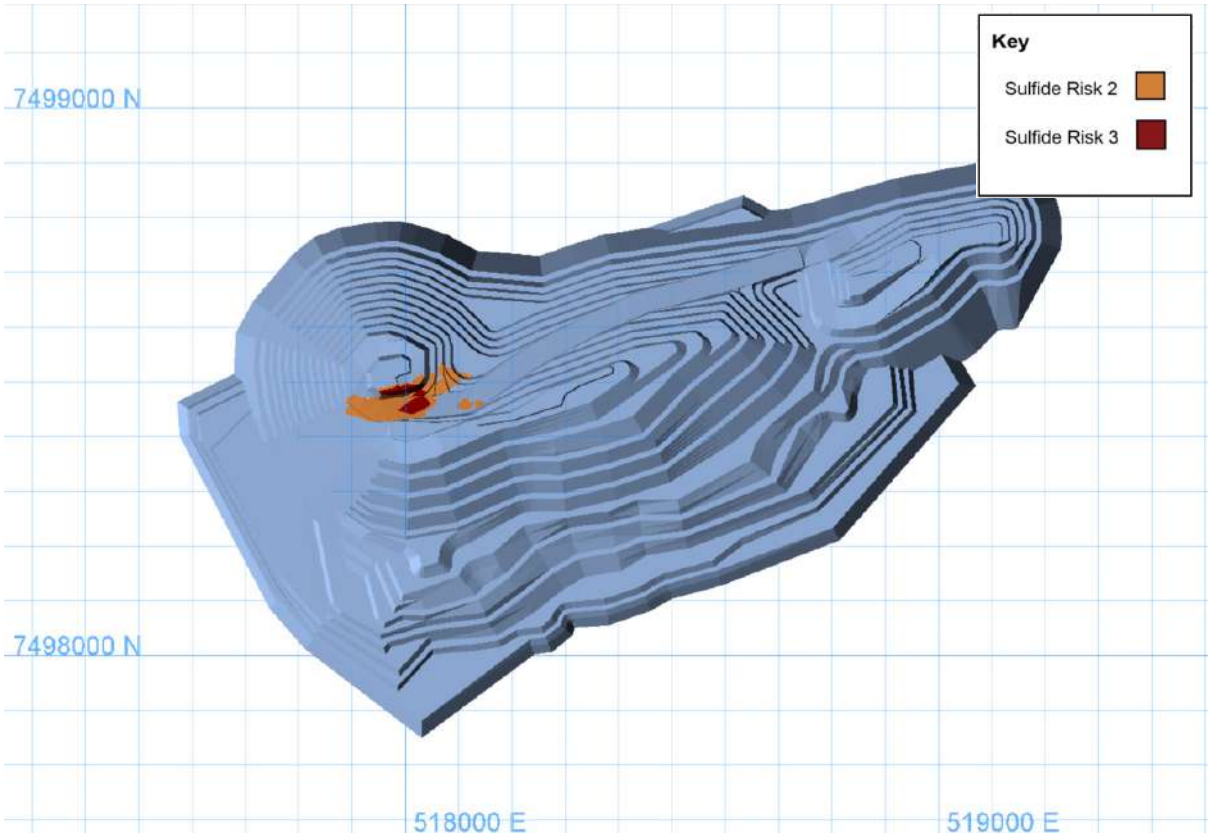
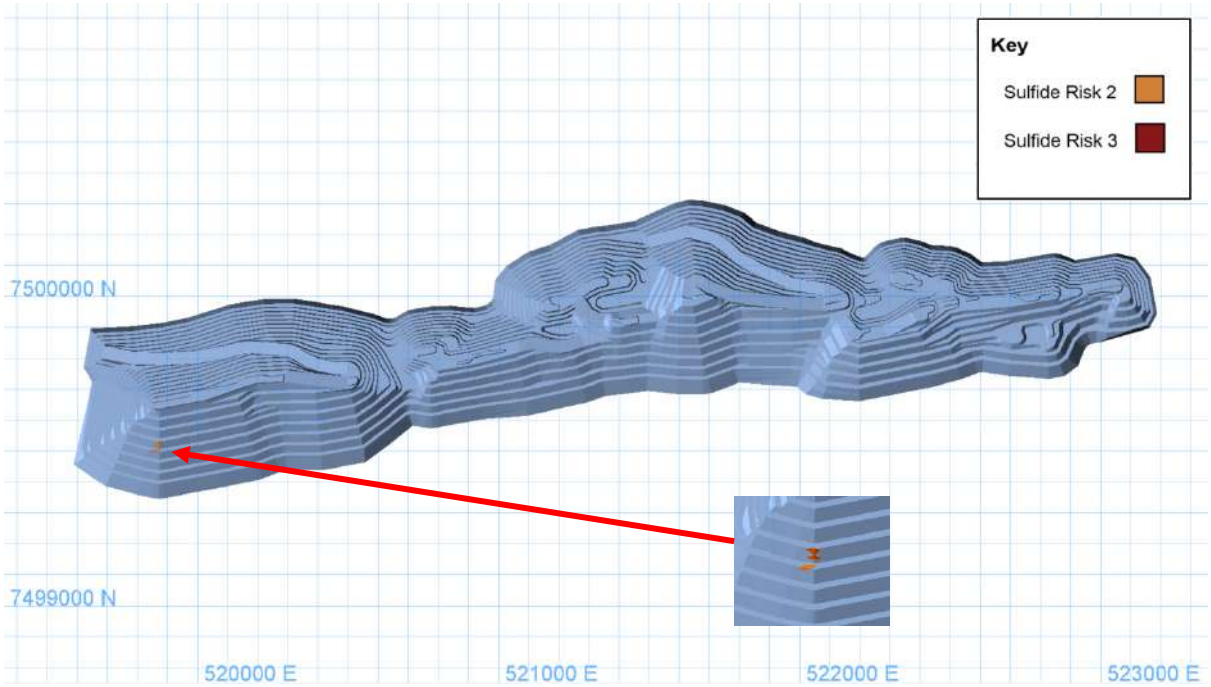


Figure 18 – BSMM Pit Q sulfide risk exposures.



6.3 Sulfidic Material management Strategies

Any PAF material encountered in the pits will be managed as per the Rio Tinto Spontaneous Combustion and acid rock drainage (SCARD) management plan (Rio Tinto, 2019).

7. Chemical Enrichment

Understanding the geochemistry of waste materials can assist with more environmentally sound waste management. Drillholes are regularly analysed for the main chemical element suite of Al, Ca, Fe, Mg, Mn, P, S, Si and Ti as well as As, Ba, Cl, Co, Cr, Cu, Pb, Ni, K, Na, Sr, Sn, V, Zn and Zr. In addition to the full chemical suite, additional elemental abundances in solids are determined for Ag, B, Be, Cd, F, Hg, Mo, Sb, Se, Th and U by either inductively coupled plasma mass spectrometry/atomic emission spectroscopy (ICP-MS/ICP-AES), trace XRF, or by specific ion electrode methods. This test work is completed on a suite of ore and waste samples which are representative of the main lithologies expected to be mined.

The extent of enrichment of a drillhole sample can be reported as the Geochemical Abundance Index (GAI), which relates the actual concentration with average crustal abundance on an adjusted log 2 scale (Bowen, 1979). The GAI is typically expressed in integer increments where a GAI of zero indicates the element is present at a concentration similar to, or less than, the average crustal abundance. A GAI of 6 indicates approximately a 100-fold enrichment above the average crustal abundance. The main purpose of the GAI is to provide an indication of elemental enrichment that may be of environmental importance. As a general rule, a GAI of 3 or greater signifies enrichment that warrants further examination, while a GAI of 1 or 2 indicates the element may be elevated.

The GAI values from the drillhole samples were also compared to Ecological Investigation Levels (EILs) and Health Investigation Levels (HILs) provided in the Contaminated Sites Management Series Assessment Levels for Soil, Sediment and Water (DEC, 2014), as well as US EPA Ecological Soil Screening Levels (Eco-SSLs) (USEPA, 2005). These various screening levels provide a basis for identifying contaminants of potential concern in soils and sediments, which can then be evaluated through site specific assessments. The comparison of the crustal abundance (GAI) trigger concentrations which are used in this assessment against the EILs, HILs and Eco-SSLs is summarised in Green, 2011. In summary, the GAI trigger is lower than the EILs, HILs, and Eco-SSL values with the exception of Ba, Cd, Co, Cr, Cu, Mn, Ni, P, Pb, S, Sb, V, and Zn. The GAI trigger is generally higher than Eco-SSLs (US EPA, 2005) with the exception of As and Se, for which the crustal abundance trigger is lower than the most conservative Eco-SSL value.

The most conservative Eco-SSLs were considered for the purpose of this comparison; however these values may not be the most appropriate for Pilbara-specific receptors. It should be noted that material from RTIO mine sites is mostly rock and not soil, and therefore whilst the EILs, HILs and Eco-SSLs discussed above are useful for screening purposes, they may not be appropriate to use as management triggers. Furthermore, whilst concentrations of some trace elements of environmental concern (e.g. As and Sn) may be enriched in some of the sampled waste and ore materials, these elements will not necessarily mobilise into groundwater. Arsenic in particular is commonly enriched in ore and waste for many Hamersley Group deposits. Iron oxy-hydroxides such as hematite and magnetite have high sorption capacities for As and consequently these materials have been used around the world for treating water enriched in arsenic.

The multi-element analysis of all drillhole assay data (derived from the full chemical suite) for the Brockman and Marra Mamba deposits and the corresponding GAI values are presented in Appendix 2. A summary of the mean GAI values is shown in Table 22,Table 24,Table 26,Table 28 and Table 30.

GAI triggers for the standard element suite including Ba, Co, Cr, Cu, Mn, Ni, P, Pb, S, V, and Zn, are higher than the DEC/EPA EILs, HILs, and Eco-SSL trigger for both the Brockman and Marra Mamba deposit rock types. An analysis comparing the lower triggers against the average concentration of those

elements are shown in Table 23,Table 25,Table 27,Table 29 and Table 31 are summarised in the following sections.

7.1 BS1 Project Area

Table 22 presents a summary of the geochemical enrichment review of BS1 drillholes. Results are also summarised below.

- Rocks are either enriched or elevated in Fe (associated with the iron mineralisation).
- The majority rock types are enriched in arsenic.
- Tin is elevated in all rock types.
- MCS WASTE is enriched or elevated in S, As, Fe, Pb, Sn.

Table 22: Geochemical enrichment summary for BS1 drillhole samples.

BS1 Rock Type	Enriched (GAI >3)				Elevated
	Fe	As	S	Mn	(GAI = 1 or 2)
CLA		6			Fe, CaO, MgO, Cl, Sn
CAL		4			Fe, Cl, Sn
DET ORE	3	3			Sn
DET WASTE	3	4			Sn
DOR					Fe, As, Cl, Cu, Sn, V
YAN HYD	3	3			Sn
YAN WASTE		3			Fe, Sn
JOF HYD	3				As, Sn
JOF ORE	3				As, Sn
JOF WASTE	3				As, Sn
WS HYD	3	3			Sn
WS ORE	3	3			Mn, Sn
WS WASTE	3	3			Mn, Sn
DG HYD	3	3			Sn
DG ORE	3	3			Sn
DG WASTE	3	3			Sn
FWZ ORE	3	5			Sn
FWZ WASTE	3	5			Sn
MCS ORE	3	5			Sn
MCS WASTE		6	3		Fe, Pb, Sn
MTS ORE	3	5			Sn
MTS WASTE		5			Fe, Pb, Sn
ANG ORE	3	4			Mn, Cl, Pb, Sn, Zn
WF WASTE		4		3	Fe, Cl, Pb, Sn, Zn
NEW HYD	3	3			Sn
NEW ORE	3	3			Sn
NEW WASTE					Fe, As, Sn
MAC WASTE		3			Fe, Sn
NAM WASTE					Fe, As, Sn

Table 23: Analysis of BS1 mean concentrations compared to the lowest DEC/EPA trigger values*.

	Ba (ppm)	*Co (ppm)*	*Cr (ppm)*	*Cu (ppm)*	*Mn (%)*	*Ni (ppm)*	*P (%)*	*Pb (ppm)*	*S (%)*	*V (ppm)*	*Zn (ppm)*
GAI trigger	6000	240	1200	600	1.14	960	1.2	168	0.31	1920	900
DEC/EPA trigger	330	13	26	28	0.022	38	0.2	11	0.06	7.8	46
CLA	81.92	24.82	79.20	20.85	0.05	59.96	0.04	15.18	0.05	139.60	106.83
CAL	66.52	12.57	39.43	17.44	0.03	23.74	0.02	14.80	0.03	59.61	28.44
DET ORE	45.68	10.18	50.31	12.47	0.06	22.76	0.06	12.18	0.03	84.38	16.94
DET WASTE	80.13	13.48	89.98	24.65	0.06	35.55	0.05	17.66	0.04	130.44	42.00
DOR	143.95	30.67	107.83	149.77	0.12	63.33	0.07	17.96	0.02	387.26	99.44
YAN HYD	39.17	13.33	48.33	26.67	0.02	18.33	0.17	5.00	0.02	55.00	23.33
YAN WASTE	36.74	8.70	33.91	15.43	0.02	22.61	0.06	16.74	0.02	40.87	16.30
JOF HYD	55.66	8.49	17.28	13.08	0.03	13.38	0.10	8.03	0.04	39.30	12.43
JOF ORE	51.70	8.85	11.99	11.78	0.04	14.16	0.14	8.93	0.02	14.56	13.44
JOF WASTE	55.86	7.97	11.72	13.27	0.05	14.01	0.09	15.14	0.01	16.87	14.64
WS HYD	156.52	9.96	20.19	12.46	0.20	15.81	0.12	10.15	0.05	29.26	21.75
WS ORE	105.19	10.61	15.92	11.99	0.21	16.14	0.17	9.38	0.04	19.22	23.99
WS WASTE	179.51	10.75	30.73	21.38	0.27	21.54	0.12	18.78	0.02	42.60	36.79
DG HYD	50.20	9.06	19.24	11.53	0.04	16.96	0.10	8.76	0.03	32.29	24.32
DG ORE	58.07	9.70	11.00	12.32	0.06	16.25	0.14	9.90	0.02	13.86	26.01
DG WASTE	51.46	7.64	12.10	13.34	0.06	15.11	0.10	16.39	0.01	15.31	23.66
FWZ ORE	35.23	10.13	20.16	13.77	0.06	21.73	0.15	7.98	0.02	22.25	53.98
FWZ WASTE	82.08	10.32	26.18	19.32	0.10	22.70	0.10	17.36	0.01	34.85	56.56
MCS ORE	21.82	10.00	46.06	27.12	0.03	31.67	0.07	10.61	0.03	42.42	77.88
MCS WASTE	103.28	16.44	103.27	47.28	0.04	57.53	0.04	60.66	0.34	101.40	155.86
MTS ORE	20.45	5.45	64.55	21.82	0.07	12.27	0.03	12.27	0.02	95.91	38.18
MTS WASTE	83.34	14.57	92.48	35.95	0.05	41.61	0.04	37.13	0.02	87.88	98.56
ANG ORE	194.55	38.18	90.91	58.64	0.31	98.18	0.07	55.91	0.04	104.55	250.91
WF WASTE	293.90	26.70	152.22	55.71	1.60	116.05	0.05	47.17	0.03	121.14	181.57
NEW HYD	63.10	11.83	52.86	32.54	0.08	34.68	0.06	7.06	0.02	42.46	50.63
NEW ORE	55.82	10.24	18.52	9.14	0.20	26.00	0.08	9.89	0.01	10.33	45.80
NEW WASTE	43.46	7.27	16.88	13.60	0.09	22.88	0.05	23.67	0.01	13.70	46.21
MAC WASTE	42.28	9.17	45.87	21.70	0.07	37.28	0.04	14.38	0.03	38.04	57.97
NAM WASTE	34.84	17.10	36.21	37.02	0.03	40.97	0.04	13.47	0.04	34.84	53.95

* green (< trigger + 20%); yellow (> trigger + 20% and < trigger + 40%); red (> trigger + 40%)

Table 23 presents a summary of BS1 drillhole data in comparison to EILs, HILs and Eco-SSLs triggers. Results are also summarised below.

- Mean elemental values are less than the DEC/EPA triggers for Ba and P for all rock types.
- Mean concentrations of Mn were higher for all rock types when compared to the Eco-SSL trigger of 220 mg/kg.
- All rock types have higher mean concentrations of V, with concentrations typically exceeding the triggers by 40% in most rocks (using the Eco-SSL trigger of 7.8 mg/kg compared with the GAI trigger of 160mg/kg).
- The majority of rock types exceeded the Pb Eco-SSL trigger of 11 mg/kg.

- The mean Cr concentration exceeded the DEC/EPA triggers in detrital, dolerite, Yandicoogina, WS WASTE, McRae Shale, Mt Sylvia, Wittenoom Formation, NEW HYD, MAC WASTE and NAM WASTE rock units.
- The mean concentration of Cu is below the Eco-SSL trigger of 28 mg/kg for the majority of rock units. Exceedances were observed for 7 out of 29 rock units.
- Exceedances for Ni were observed in 7 out of 29 rock units.
- Exceedances of Ni were observed in 13 out of 29 rock units.

  Mean concentrations of sulfur were below trigger values with the exception of MCS WASTE, which recorded a concentration of 40% higher than the Eco-SSL trigger.

7.2 BS2 Project Area

Table 24 presents a summary of the geochemical enrichment review of BS2 drillholes. Results are also summarised below.

- BS2 rock types are either enriched or elevated in Fe (associated with the iron mineralisation).
- The majority rock types are enriched in or have elevated arsenic.
- Tin is elevated in all rock types.
- Sulfur is elevated in 7 out of 21 rock types.
- DOR is elevated in Cu and V.
- MCS WASTE, MTS WASTE and WF WASTE are all elevated in Pb
- FWZ WASTE, ANG ORE and WF WASTE all have elevated Mn

Table 25 presents a summary of BS2 drillhole data in comparison to EILs, HILs and Eco-SSLs triggers. Results are also summarised below.

- All rock types have mean elemental values less than the lower DEC/EPA triggers for Ba and P.
- The mean Cr concentration exceeded the DEC/EPA triggers in all the detrital rock units in addition to DOR, WS WASTE, MCS WASTE, MTS ORE, MTS WASTE, ANG ORE and WF WASTE rock units.
- The mean concentration of Cu exceeded the Eco-SSL trigger in DOR, MCS WASTE, MTS ORE, MTS WASTE and WF WASTE.
- Mean concentrations of Mn exceeded the trigger value in all rock types except MTS ORE.
- The Ni Eco-SSL trigger was exceeded in DOR, MCS WASTE, MTS WASTE, ANG ORE and WF WASTE.
- The higher mean concentrations of Pb exceeded the Eco-SSL trigger value in the majority of rock units.
- The mean concentrations of S exceeded the Eco-SSL trigger in WS HYD, WS WASTE, MCS WASTE and NEW WASTE.
- Mean concentrations of vanadium exceeded the Eco-SSL trigger in all rock types with the exception of NEW WASTE.
- The mean concentrations of Zn exceed the DEC/EPA trigger in DOR, FWS ORE, FWZ WASTE, MCS WASTE, MTS WASTE, ANG ORE and WF WASTE.

Table 24: Geochemical enrichment summary for BS2 drillhole samples.

BS2 Rock Type	Enriched (GAI >3)		Elevated
	Fe	As	(GAI = 1 or 2)
CLA	3	6	Sn
CAL		4	Sn
DET ORE	3	4	Sn
DET WASTE	3	4	Sn
DOR		6	Fe, S, Cu, Sn, V
JOF HYD	3		As, Sn
JOF WASTE	3	3	S, Sn
WS HYD	3	3	S, Sn
WS ORE	3	4	S, Sn
WS WASTE	3	4	S, Sn
DG HYD	3	4	Sn
DG ORE	3	3	Sn
DG WASTE	3	3	Sn
FWZ ORE	3	5	Sn
FWZ WASTE	3	5	Mn, Sn
MCS WASTE		7	Fe, S, Pb, Sn
MTS ORE	3	5	Sn
MTS WASTE		6	Fe, Pb, Sn
ANG ORE	3	4	Mn, Sn
WF WASTE		5	Fe, Mn, Pb, Sn
NEW WASTE			Fe, S, As, Sn

Table 25: Analysis of BS2 mean concentrations compared to the lowest DEC/EPA trigger values*.

	Ba (ppm)	*Co (ppm)*	*Cr (ppm)*	*Cu (ppm)*	*Mn (%)*	*Ni (ppm)*	*P (%)*	*Pb (ppm)*	*S (%)*	*V (ppm)*	*Zn (ppm)*
GAI trigger	6000	240	1200	600	1.14	960	1.2	168	0.31	1920	900
DEC/EPA trigger	330	13	26	28	0.022	38	0.2	11	0.06	7.8	46
CLA	63.79	12.04	98.39	19.08	0.06	36.80	0.06	28.27	0.02	115.57	44.93
CAL	82.94	13.37	35.24	9.67	0.07	23.62	0.02	11.38	0.01	32.57	43.04
DET ORE	41.25	12.92	46.32	11.38	0.04	21.54	0.06	16.82	0.03	59.13	21.17
DET WASTE	84.24	10.63	69.81	19.16	0.06	27.34	0.07	18.24	0.02	75.89	35.47
DOR	78.22	12.28	150.13	113.63	0.08	63.43	0.12	20.90	0.06	362.89	68.56
JOF HYD	30.00	22.31	22.00	11.54	0.03	17.31	0.10	5.38	0.05	27.69	15.00
JOF WASTE	79.55	10.45	18.18	17.27	0.02	23.64	0.07	15.00	0.06	21.82	20.00
WS HYD	141.22	12.14	24.55	15.47	0.14	19.50	0.15	19.61	0.09	27.47	25.65
WS ORE	53.83	13.83	24.26	15.41	0.12	26.95	0.17	21.41	0.06	18.29	25.63
WS WASTE	155.62	9.35	42.21	20.86	0.17	27.33	0.12	19.04	0.07	55.65	44.95
DG HYD	103.52	11.16	18.40	10.90	0.09	17.09	0.11	12.10	0.04	22.68	24.94
DG ORE	83.92	12.90	13.22	10.74	0.09	17.30	0.15	14.51	0.02	12.98	27.88
DG WASTE	96.99	10.34	12.99	11.59	0.11	18.15	0.11	17.46	0.02	11.32	25.84
FWZ ORE	78.30	13.62	23.16	13.89	0.10	22.76	0.16	10.14	0.03	25.00	55.70
FWZ WASTE	240.07	14.02	24.92	16.49	0.26	24.56	0.12	14.45	0.02	23.84	55.25
MCS WASTE	162.47	15.18	110.97	51.79	0.06	60.37	0.04	74.06	0.14	107.68	121.59
MTS ORE	5.00	7.14	29.29	40.00	0.01	10.71	0.06	12.14	0.02	62.86	12.14
MTS WASTE	66.47	11.00	88.75	35.29	0.06	40.08	0.04	32.63	0.02	75.70	88.91
ANG ORE	29.50	17.50	95.00	18.50	0.65	57.00	0.07	5.00	0.01	46.00	98.00
WF WASTE	122.22	15.06	189.68	44.34	0.26	66.57	0.04	30.10	0.03	117.40	112.01
NEW WASTE	5.00	5.00	5.00	5.00	0.18	5.00	0.01	8.75	0.10	5.00	22.50

7.3 BS3/BS4 Project Area

Table 26 presents a summary of the geochemical enrichment review of BS3/BS4 drillholes. Results are also summarised below.

- All rock types are either enriched or elevated in Fe (associated with the iron mineralisation).
- The majority rock types are enriched in arsenic.
- Tin is enriched or elevated in all rock types.
- MCS WASTE and NAM WASTE rock units have elevated sulfur.

Table 27 presents a summary of BS3/BS4 drillhole data in comparison to EILs, HILs and Eco-SSLs triggers. Results are also summarised below.

- All rock types have mean elemental values less than the lower DEC/EPA triggers for phosphorus.
- The majority of rock types exceed trigger values for Cr, Mn and V.
- The mean concentration of Cu exceeds the Eco-SSL trigger in CLA, CAL, DOR, MCS WASTE, MTS WASTE and WF WASTE.
- Nickel exceeds the Eco-SSL trigger in CLA, CAL, DOR, YAN ORE, MCS WASTE, MTS WASTE, ANG ORE and WF WASTE.
- Mean concentrations of Pb exceeded Eco-SSL trigger in 20 out of 29 rock units.
- The mean concentrations of sulfur exceeded the Eco-SSL trigger in MCS WASTE and NAM WASTE.

- The mean concentrations of Zn exceed the DEC/EPA trigger in CLA, DOR, MCS WASTE, MTS ORE, MTS WASTE, ANG ORE and WF WASTE.

Table 26: Geochemical enrichment summary for BS3/BS4 drillhole samples.

BS3 and BS4 Rock Types	Enriched (GAI >3)				Elevated
	Fe	As	Sn	Mn	(GAI = 1 or 2)
CLA		3			Fe, Cl, Cr, Sn
CAL		3	3		Fe
DET ORE	3	4			Sn
DET WASTE	3	3			Sn
DOR			3		Fe, As, Cl, Cu, V
YAN WASTE	3	3			Sn
YAN HYD	3	3			Sn
YAN ORE	3	3			Sn
JOF HYD	3				As, Sn
JOF ORE	3				As, Sn
JOF WASTE	3				Sn
WS HYD	3	3			Cl, Sn
WS ORE	3	3			Sn
WS WASTE	3	3			Pb, Sn
DG HYD	3	3			Sn
DG ORE	3	3			Sn
DG WASTE	3	3			Sn
FWZ ORE	3	4			Sn
FWZ WASTE	3	4			Sn
MCS WASTE		6			Fe, S, Pb, Sn
MTS ORE	3	5			Mn, Sn
MTS WASTE		5			Fe, Pb, Sn
ANG ORE	3	4		4	Sn
WF WASTE		5		3	Fe, Sn
NEW HYD	3	3			Sn
NEW ORE	3	3			Sn
NEW WASTE					Fe, Sn
MAC WASTE		3			Fe, Sn
NAM WASTE					Fe, S, As, Sn

Table 27: Analysis of BS3/BS4 mean concentrations compared to DEC/EPA trigger values*.

	Ba (ppm)	*Co (ppm)*	*Cr (ppm)*	*Cu (ppm)*	*Mn (%)*	*Ni (ppm)*	*P (%)*	*Pb (ppm)*	*S (%)*	*V (ppm)*	*Zn (ppm)*
GAI trigger	6000	240	1200	600	1.14	960	1.2	168	0.31	1920	900
DEC/EPA trigger	330	13	26	28	0.022	38	0.2	11	0.06	7.8	46
CLA	64.05	27.84	213.51	76.22	0.06	76.62	0.03	10.00	0.04	172.97	92.16
CAL	168.10	14.51	94.58	38.92	0.28	43.94	0.02	10.76	0.02	94.16	41.24
DET ORE	42.33	11.25	42.28	13.14	0.07	24.04	0.06	18.02	0.04	88.70	21.08
DET WASTE	95.57	12.16	94.13	26.96	0.07	36.82	0.04	18.55	0.02	183.04	28.67
DOR	212.82	37.80	91.24	165.20	0.14	61.63	0.06	27.05	0.03	409.19	110.71
YAN WASTE	53.12	11.45	36.86	15.36	0.02	24.15	0.06	23.79	0.01	80.79	24.66
YAN HYD	34.85	10.38	31.33	15.08	0.02	21.92	0.11	29.67	0.03	53.58	18.72
YAN ORE	25.36	8.08	50.40	16.35	0.02	53.90	0.16	41.93	0.01	38.48	19.33
JOF HYD	75.95	10.30	20.64	16.83	0.03	20.87	0.11	26.58	0.04	38.25	18.96
JOF ORE	69.45	11.37	15.91	14.72	0.05	20.49	0.15	26.76	0.02	19.16	20.47
JOF WASTE	69.04	9.21	32.40	16.60	0.04	20.14	0.09	37.14	0.01	23.21	17.57
WS HYD	139.76	8.82	22.25	11.42	0.19	21.30	0.14	22.91	0.05	25.73	23.39
WS ORE	100.98	9.42	17.52	11.16	0.17	20.83	0.19	19.51	0.04	17.34	28.44
WS WASTE	238.53	8.72	46.67	18.24	0.30	24.21	0.12	34.10	0.03	38.54	31.58
DG HYD	100.40	9.73	22.10	11.75	0.07	24.94	0.11	27.86	0.04	21.72	20.32
DG ORE	98.30	9.40	13.67	12.33	0.10	22.15	0.15	25.15	0.02	11.36	23.43
DG WASTE	74.54	8.31	23.94	11.45	0.07	19.50	0.10	25.96	0.01	13.90	21.16
FWZ ORE	205.61	9.89	23.09	14.21	0.17	30.04	0.17	21.07	0.02	17.38	40.50
FWZ WASTE	264.71	11.76	33.59	15.93	0.21	24.66	0.11	26.53	0.02	19.67	40.42
MCS WASTE	147.32	11.77	122.54	41.90	0.07	55.17	0.04	63.89	0.07	94.34	116.62
MTS ORE	613.33	33.33	51.67	21.11	0.34	31.67	0.12	8.33	0.02	52.22	84.44
MTS WASTE	77.81	7.86	117.04	33.83	0.09	39.60	0.04	32.12	0.02	82.89	79.16
ANG ORE	337.41	17.96	55.74	18.38	2.68	55.93	0.07	6.90	0.01	56.99	74.17
WF WASTE	298.55	25.27	124.45	60.36	1.50	98.36	0.05	15.29	0.02	125.05	125.36
NEW HYD	81.18	11.39	30.90	9.47	0.08	24.70	0.05	7.62	0.03	30.19	21.85
NEW ORE	61.91	12.77	20.27	7.43	0.16	23.50	0.06	7.37	0.01	16.94	20.13
NEW WASTE	60.19	8.09	15.78	11.37	0.20	17.57	0.04	8.26	0.01	13.08	18.71
MAC WASTE	149.01	9.16	34.39	18.66	0.19	24.60	0.04	8.19	0.02	35.95	39.80
NAM WASTE	5.00	5.62	13.70	17.22	0.02	15.19	0.06	6.48	0.10	10.31	21.73

* green (< trigger + 20%); yellow (> trigger + 20% and < trigger + 40%); red (> trigger + 40%)

7.4 BS3X/Lens G Project Area

Table 28 presents a summary of the geochemical enrichment review of BS3X/Lens G drillholes. Results are also summarised below.

- All rock types are either enriched or elevated in Fe and Sn.
- Most rock types are enriched or have an elevated concentration of arsenic.
- WF WASTE is elevated in Mn.
- Mn is enriched or elevated in DOR and MF WASTE.
- Zinc is elevated in CLA, CAL, DOR, MCS WASTE, WF WASTE, ANG ORE.
- Sulfur is elevated in WS HYD, WS ORE, WS WASTE, MCS WASTE and NAM ORE.

Table 28: Geochemical enrichment summary for BS3X/Lens G drillhole samples.

BS3X/Lens G Rock Types	Enriched (GAI >3)				Elevated
	Fe	As	Sn	Mn	(GAI = 1 or 2)
CLA		4			Fe, Sn, Zn
CAL		3	3		Fe, CaO, MgO, Zn
DET ORE	3	4			Sn
DET WASTE	3	4			Sn
DOR					Fe, Mn, As, Cu, Sn, V, Zn
JOF WASTE					Fe, Sn
WS HYD	3	4			S, Sn
WS ORE	3	3			S, Sn
WS WASTE	3	4			S, Sn
DG HYD	3	4			Sn
DG ORE	3	3			Sn
DG WASTE	3	3			Sn
FWZ ORE	3	5			Sn
FWZ WASTE		4			Sn
MCS WASTE		6	3		S, Pb, Zn
MTS WASTE		6			Pb, Sn
ANG ORE	3	4			Sn, Zn
WF WASTE		4		3	Mn, Sn, Zn
NEW HYD	3	3			As, Sn
NEW ORE	3				As, Sn
NEW WASTE					Fe, Sn
MAC WASTE					Fe, As, Sn
NAM WASTE					Fe, As, Sn
NAM ORE	3	3			S, Sn

Table 29 presents a summary of BS3X/Lens G drillhole data in comparison to EILs, HILs and Eco-SSLs triggers. Results are also summarised below.

- All rock types have mean elemental values less than the DEC/EPA triggers phosphorus.
- The majority of rock types exceed the trigger value for Cr, Cu, Mn, V and Zn.
- The mean concentrations of Ni exceeded the Eco-SSL trigger for CLA, DET WASTE, DOR, MCS WASTE, ANG ORE and WF WASTE.
- The mean concentrations of sulfur exceeded the Eco-SSL trigger in WS ORE, WS HYD, MCS WASTE and NAM ORE.

Table 29: Analysis of BS3X/Lens G mean concentrations compared to DEC/EPA trigger values*.

	Ba (ppm)	*Co (ppm)*	*Cr (ppm)*	*Cu (ppm)*	*Mn (%)*	*Ni (ppm)*	*P (%)*	*Pb (ppm)*	*S (%)*	*V (ppm)*	*Zn (ppm)*
GAI trigger	6000	240	1200	600	1.14	960	1.2	168	0.31	1920	900
DEC/EPA trigger	330	13	26	28	0.022	38	0.2	11	0.06	7.8	46
CLA	111.68	17.13	125.35	51.68	0.08	65.89	0.03	21.29	0.01	151.09	258.71
CAL	62.65	14.23	32.22	14.78	0.08	32.21	0.01	8.49	0.01	39.03	191.40
DET ORE	37.68	12.37	71.33	17.25	0.07	30.48	0.04	8.18	0.03	93.37	120.76
DET WASTE	88.80	9.93	139.72	34.30	0.06	39.85	0.04	12.67	0.02	156.47	77.12
DOR	52.60	19.40	125.38	142.37	0.26	65.34	0.05	6.77	0.02	357.34	184.12
JOF WASTE	-	-	-	-	0.06	-	0.05	-	0.01	-	-
WS HYD	113.77	6.60	30.09	5.75	0.03	13.02	0.13	6.51	0.07	23.02	17.92
WS ORE	85.26	5.00	28.16	5.26	0.05	8.16	0.18	9.74	0.12	25.53	23.68
WS WASTE	144.17	5.11	44.96	10.29	0.15	15.18	0.11	16.34	0.06	53.44	18.15
DG HYD	81.06	7.37	18.23	6.26	0.02	12.63	0.12	6.71	0.04	22.51	15.29
DG ORE	92.23	9.46	15.91	7.81	0.03	16.30	0.16	9.24	0.03	11.97	28.36
DG WASTE	55.45	5.54	12.15	6.50	0.03	10.31	0.10	9.28	0.02	11.68	14.84
FWZ ORE	78.75	11.25	30.63	16.88	0.04	11.88	0.10	5.00	0.01	37.50	41.25
FWZ WASTE	446.14	8.13	21.20	16.63	0.20	10.48	0.10	13.92	0.02	24.40	37.41
MCS WASTE	149.27	9.86	95.09	56.00	0.04	44.77	0.05	96.95	0.17	102.68	229.50
MTS WASTE	47.88	7.50	44.04	36.54	0.02	20.96	0.04	58.46	0.04	55.19	93.46
ANG ORE	41.38	15.13	40.33	29.46	0.26	41.09	0.06	5.59	0.02	47.66	234.72
WF WASTE	113.18	23.63	91.16	43.00	0.86	75.35	0.05	10.46	0.02	109.93	253.41
NEW HYD	48.35	11.30	22.88	14.29	0.10	24.84	0.05	6.21	0.04	28.08	87.18
NEW ORE	33.60	12.88	13.13	11.20	0.14	25.71	0.06	6.52	0.01	11.78	123.69
NEW WASTE	29.54	8.69	15.68	16.34	0.06	19.76	0.04	9.57	0.01	21.56	81.11
MAC WASTE	44.82	10.63	28.05	20.35	0.07	26.18	0.03	9.42	0.03	31.02	95.30
NAM WASTE	42.64	7.85	22.95	15.36	0.04	20.96	0.03	10.05	0.04	24.71	69.04
NAM ORE	16.67	16.67	5.00	13.33	0.04	36.67	0.04	20.00	0.09	5.00	26.67

* green (< trigger + 20%); yellow (> trigger + 20% and < trigger + 40%); red (> trigger + 40%) "- "No data available

7.5 BSMM Project Area

Table 31 presents a summary of BSMM drillhole data in comparison to EILs, HILs and Eco-SSLs triggers. Results are also summarised below.

- Phosphorus concentrations were below the trigger value for all rock types.
- The mean concentrations of Co, Cr, Mn, Pb, V and Zn typically exceeded the trigger values for most rock types.
- Mean Cu concentrations exceeded the trigger value for 7 out of 18 rock types.
- Mean Ni concentrations exceeded the trigger value for 9 out of 18 rock types.
- The mean concentrations of S are less than the Eco-SSL trigger in all rock types with the exception of FOR WASTE.

Table 30: Geochemical enrichment summary for BSMM drillhole samples.

BSMM Rock Type	Enriched (GAI >3)			Elevated
	Fe	As	Mn	(GAI = 1 or 2)
CLA		5		Fe, Mn, Cr, Sn
CAL		3		Fe, CaO, Mn, Cl, Sn
DET ORE	3	4		Sn

DET WASTE	3	4		Cl, Sn
DOR				Fe, Mn, As, Co, Cu, Sn, V
DG HYD	3	6		Cl, Sn
FWZ WASTE	3	5		Cl, Sn
MCS WASTE		7		Fe, Cl, Pb, Sn
MTS WASTE		5		Fe, Sn
ANG ORE	3	4		Mn, Sn, Zn
WF WASTE		5	4	Fe, Sn, Zn
NEW HYD	3	3		Sn
NEW ORE	3			Mn, As, Sn
NEW WASTE	3			As, Sn
MAC WASTE	3	3		Sn
NAM ORE	3	3		Mn, Sn
NAM WASTE				Fe, As, Sn
FOR WASTE		3		Fe, S, Cl, Cr, Cu, Sn

Table 31: Analysis of BS3X/Lens G mean concentrations compared to DEC/EPA trigger values*.

	Ba (ppm)	***Co (ppm)***	***Cr (ppm)***	***Cu (ppm)***	***Mn (%)***	***Ni (ppm)***	***P (%)***	***Pb (ppm)***	***S (%)***	***V (ppm)***	***Zn (ppm)***
GAI trigger	6000	240	1200	600	1.14	960	1.2	168	0.31	1920	900
DEC/EPA trigger	330	13	26	28	0.022	38	0.2	11	0.06	7.8	46
CLA	202.21	17.09	224.99	54.35	0.22	87.65	0.05	21.72	0.03	214.90	114.28
CAL	193.42	42.27	94.97	35.76	0.27	85.15	0.01	8.45	0.05	99.24	125.34
DET ORE	38.70	17.12	55.54	19.13	0.09	32.74	0.06	13.47	0.02	74.33	35.96
DET WASTE	89.92	18.22	147.52	36.27	0.14	60.41	0.04	14.54	0.04	180.69	70.55
DOR	208.55	42.58	199.13	168.38	0.52	133.81	0.06	11.61	0.02	348.77	155.42
DG HYD	12.50	7.50	8.33	5.83	0.02	31.67	0.17	10.83	0.02	35.83	48.33
FWZ WASTE	21.56	5.31	25.31	23.75	0.03	22.81	0.13	5.63	0.02	51.88	30.63
MCS WASTE	70.00	7.08	82.36	23.33	0.03	36.67	0.06	41.25	0.02	100.83	81.11
MTS WASTE	93.77	7.84	87.59	18.09	0.04	40.37	0.05	20.43	0.01	93.77	80.49
ANG ORE	67.27	20.68	43.31	26.11	0.44	58.44	0.08	17.27	0.01	41.27	163.62
WF WASTE	470.62	35.23	117.09	58.85	2.47	135.42	0.07	23.19	0.02	112.23	237.92
NEW HYD	87.07	14.68	31.76	18.55	0.10	28.62	0.05	12.89	0.03	30.73	32.36
NEW ORE	91.71	16.05	16.83	16.85	0.21	26.26	0.07	15.19	0.01	12.39	29.52
NEW WASTE	44.31	9.83	18.00	15.22	0.14	23.28	0.04	17.70	0.01	13.60	26.73
MAC WASTE	61.40	11.95	40.35	21.25	0.09	30.73	0.04	14.77	0.03	33.45	49.52
NAM ORE	160.53	21.60	35.49	32.10	0.38	42.70	0.09	10.54	0.01	23.21	47.93
NAM WASTE	70.19	11.62	33.07	20.74	0.11	28.13	0.05	13.27	0.02	25.62	33.44
FOR - Waste	127.18	39.70	286.65	123.27	0.16	125.98	0.03	13.71	0.09	311.52	154.48

* green (< trigger + 20%); yellow (> trigger + 20% and < trigger + 40%); red (> trigger + 40%)

7.6 Summary

In summary, Fe, As, Sn, Co, Cr, Cu, Mn, Ni, Pb, V and Zn are considered enriched or elevated in relation to GAI and/or DEC triggers. Given the mineralised nature of the Pilbara, elevated concentrations of metals are not unexpected, and it is considered likely that surrounding receptors have adapted to the naturally elevated concentrations. Regular groundwater monitoring in and around mining activities should be undertaken to determine background groundwater concentrations and confirm any impact from waste rock dumps.

8. AMD Hazard Scorecard Assessment

The innate AMD hazard associated with each project area and its type of mineral waste is assessed by the Rio Tinto AMD Hazard Score. This score considers the geology/geochemistry, incipient risk, the scale of disturbance, transport pathways, and receiving environments. The results of the assessment are presented in Appendix 3 and summarised below.

Table 32 - Calculated NPR, mining model data, and hazard score card ratings for Greater Brockman

Project area	In-pit waste NPR	Tonnes of waste estimated to be mined (Mt)	AMD hazard scorecard	AMD risk rating
BS1	58	276	41	Moderate
BS2	-	-	49*	Moderate*
BS3/BS4	3.83	698	43	Moderate
BS3X/BSNA (Lens G)	40	296	28	Low
BS4MM	8.44	295	32	Moderate

*Risk rating based on Preliminary Assessment Hazard Score

9. Conclusions

This AMD risk assessment of the Greater Brockman region has been undertaken to assess the risk associated with AMD at Rio Tinto's future mining operations. The assessment has considered sulfur concentrations within drillhole samples, logging data to indicate the presence of sulfide or sulfate minerals, estimated tonnages and pit shells, ABA data from regional investigations and geochemical data to identify enriched concentrations of elements which may pose an environmental risk.

Considering ABA data compiled from a number of investigations including RGS (2021), RTIO (2017), SRK (2016), SRK (2015) and SRK (2013) the majority of samples collected representing the geological formations likely to be encountered during mining are broadly Non-Acid Forming with only a small portion classified as Potentially Acid Forming. Sequences with samples identified as PAF include detritals, Mt McRae Shale and Wittenoom Formation and those samples typically containing lignite (within detritals and not identified within the Greater Brockman area) and pyrite. This would suggest the risk of AMD from across the Greater Brockman project area as low with a focus for future work suggested at targeting detritals, MCS and WF sequences.

The project area and in-pit sulfur analysis identified a number of low and moderate risk sequences, with high risk sequences limited to MCS WASTE (Black) and NAM WASTE within BS1, BS2 and BS3/4 at the project level. The in-pit sulfur analysis identified only a single high risk sequence and was based on the project level risk due to an absence of pit shell data for the BS2 project.

Considering the mine models / pit shells for the Greater Brockman area, sulfur Risk 2 and 3 material was identified in BS1, BS3/4 and BSMM pits, with BS1 containing the largest quantity Risk 2 and 3 waste. A review of the likely exposure of Risk 2 and 3 material in the final pit void identified BS1, BS3/4 and BSMM likely exposing Risk 2 and 3 material. Based on this assessment the existing sulfur cut-off levels of both 0.1% and 0.3% in defining Risk 2 and 3 material are considered appropriate until additional site specific data are collected.

Geochemical data suggests following elements as being enriched or commonly elevated in both the Brockman and Marra Mamba deposit rock types and should be considered in any source-path-receptor modelling related to potential AMD impacts: Fe, As and Sn (based on GAI triggers) and Co, Cr, Cu, Mn, Ni, Pb, V and Zn (based on DEC/EPA triggers).

On the basis of the above data, an AMD hazard score ranks each deposit as follows:

- BS1 – Moderate AMD risk
- BS2 – Moderate AMD risk
- BS3/4 – Moderate AMD risk
- BS3X/Lens G – Low AMD risk
- BSMM – Moderate AMD risk

10. Recommendations

The following work is recommended to improve the understanding of AMD risks in the Greater Brockman area and ensure that the management of mineral waste upon closure will effectively mitigate the associated risks.

- Any wet processing of ore should have additional static ABA and liquid extract analysis undertaken on tailings material associated with mining.
- An in-pit sulfur analysis should be undertaken for the BS2 deposits once pit shells become available.
- Undertake regular groundwater monitoring in areas impacted by PAF excavation and/or storage.
- Any encountered PAF material should be managed in accordance with the SCARD.
- This risk assessment should be reviewed an updated (where required) every 18 months or when relevant additional data is collected.

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12. Appendices

Appendix 1 – RGS Technical Report (2021)

TECHNICAL REPORT

Greater Brockman Geochemistry Assessment

Brockman Iron Ore Site

Prepared for: **Rio Tinto Iron Ore Ltd.**

RGS

MINE WASTE AND
WATER MANAGEMENT

TECHNICAL REPORT

Greater Brockman Geochemistry Assessment

Prepared for: **Rio Tinto Iron Ore Ltd.**

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Executive Summary

Background and Objectives

RGS Environmental Pty Ltd (RGS) was commissioned by Rio Tinto Iron Ore Ltd. (RTIO) to complete a geochemical assessment of representative samples from the Greater Brockman Operation (GBO) in the Pilbara, Western Australia. The key objective of the assessment is to identify the potential for acid and metalliferous drainage (AMD), including soluble metal/metalloid and salt release.

The RGS scope of work involved completing a geochemical assessment of waste rock materials sampled from the GBO. The scope of work was undertaken as a phased approach and is outlined below:

- Co-ordinate static material assessment of waste rock materials associated with the GBO; and,
- Produce a material characterisation report that will document the measured geochemical characteristics of the materials.

Sampling and Analytical Plan

RTIO geological and mineral waste personnel developed the sampling strategy for the GBO. RTIO was responsible for the initial sample selection of 390 samples and delivery of these samples to Australian Laboratory Services (ALS) Perth. The consignment was then sent to ALS Brisbane (a NATA accredited laboratory) under the guidance of RGS.

The analytical program was developed by RTIO, and designed to quantify the potential for AMD from the presence of reactive sulfides, acid generation, and leaching of soluble metals/metalloids and salts in accordance with relevant mine waste geochemistry and mine closure guidelines (COA, 2016; and DMP and EPA, 2015). The analytical program was separated into two phases of work outlined in **Table A**.

Table A: Geochemical analytical program and number of samples

Phase	Parameter	Number of samples
Phase 1	Dry, Crush and Pulverise as/ if required	390
	Paste pH and EC	390
	NAPP (includes Total S and ANC)	390
	Single addition NAG	390
	Multi element chemical assay (Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, F, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, N, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Tl, Ti, U, V, W, Y, Zn, Zr)	390
Phase 2	Sulfur speciation (CRS)	60
	Sulfate total (as SO_4)	60
	Carbon speciation (TOC, TIC)	40
	ABCC	60
	XRD (semi-quantitative)	40
	DI water leach (2:1 solid:liquid):	145
	pH, EC, acidity, alkalinity, Cl, SO_4	145
	Nitrogen suite (total N, NO_2, NO_3 and NH_3)	145
	Ca, K, Mg, Na	145
	Metals by ICP-MS (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Hf, Hg, La, Li, Mn, Mo, Nb, Ni, Pb, Rb, Re, Sb, Se, Si, Sn, Sr, Ta, Th, Tl, Ti, U, V, W, Y, Zn, Zr)	145

Key Conclusions

RGS completed a geochemical characterisation program of 390 representative waste rock samples from the GBO (i.e. inclusive of Brockman 2, Brockman 4, Nammuldi and Silvergrass deposits). The geochemical results are summarised below.

- The majority of samples are dominated by the presence of quartz, iron (oxy)hydroxides (goethite > hematite > magnetite) and kaolinite (e.g. Dales Gorge Member, Dolerite, Joffre Member, Mount McRae Shale, Mount Sylvia and Whaleback Shale). Wittenoom Formation and Calcrete Detrital samples are dominated by dolomite/ ankerite and calcite. Less prevalent minerals include muscovite, montmorillonite, siderite, with lesser gibbsite, alunite, stilpnomelane, opaline (silica) and trace quantities of pyrite, microcline, illite, gypsum, albite and talc.
- The total sulfur content of the samples was <0.01 %S to 1.8%S, with an average value of 0.04 %S. Of the 390 samples 366 have low total sulfur concentrations that are comparable to the average crustal abundance for sulfur of 0.1 % (INAP, 2009). Materials with a sulfur content less than or equal to 0.1 %S are essentially barren of sulfur and have negligible capacity to generate acidity.
- There are barren samples associated with each of the stratigraphic units, and this suggests that there are structural controls that govern the distribution of the acid producing and consuming minerals.
- Sulfur speciation tests using the chromium reducible sulfur method verify that ~63 to 100% of the total sulfur is present as sulfide sulfur in samples with a total sulfur content >0.5 %S. A 1:1 (total sulfur: sulfide sulfur) relationship is more evident for the Mount McRae Shale and the Marra Mamba Formation.
- Samples with higher ANC are generally associated with the Wittenoom Formation (Dolomite lithology) (mean = 139.6 H_2SO_4/t) and Detrital (Calcrete lithology) (mean = 58.8 kg H_2SO_4/t). The corresponding ABCC results indicate that the majority of measured ANC is readily available to buffer acidification; this is particularly evident for samples associated with Detrital (average = 94% available) and Wittenoom Formation (average = 93 % available). These samples correspond well with the presence of dolomite and/ or calcite in the XRD results.
- The other stratigraphic units have mean measured ANC values of <11.5 kg H_2SO_4/t. The Joffre Member (mean = 2.5 kg H_2SO_4/t) and Whaleback Shale (mean = 3.1 kg H_2SO_4/t) showed the lowest average ANC values, indicating that these samples have little capacity to buffer any existing, or additional acidity generated through sulfide oxidation. The ABCC results indicate the samples associated with the Dales Gorge Member and Dolerite contain less readily available ANC (average < 65%) compared to the measured ANC value.
- The calculated NAPP values ranges from -996 to +27.7 kg H_2SO_4/t. Positive NAPP values (NAPP > +10 kg H_2SO_4/t) are generally associated with some Mount McRae Shale and Detrital samples, while marginally positive NAPP values (i.e. 0 < NAPP < +10 kg H_2SO_4/t) are present in a variety of stratigraphic units with higher sample numbers contained in Whaleback Shale, Dales Gorge Member, Joffre Member and Mount McRae Shale samples.
- The NAG pH is variable for different samples from within the same stratigraphic and lithological units; however, the vast majority of samples reported circum neutral NAG pH values. Of the 390 samples tested, only 15 samples showed acidic NAG pH values (i.e. NAG pH < 4.5); these were typically associated with the Mount McRae Shale (7 samples), Detrital (5 samples) and Wittenoom Formation (1 sample).
- Classification of the samples according to AMIRA (2002) (NAG pH versus NAPP) indicates the waste rock samples from the GBO typically fall within the 'NAF' quadrant (336 samples), with only 8 samples falling within the 'PAF' quadrant (Mount McRae Shale (5 samples), Detrital (2 samples) and Wittenoom Formation (1 sample)) and 46 samples being classified as 'uncertain' Whaleback Shale (9 samples), Dales George Member (8 samples), Detrital (6 samples), Joffre Member (8 samples), Mount Sylvia (4 samples), Mount McRae Shale (3 samples), Marra Mamba (3 samples) though largely falling on the border of 'NAF' and 'uncertain' quadrants. The uncertain classification for these samples is likely due to i) an overestimation of NAPP using total sulfur values since these samples typically have a total sulfur value < 0.1% (and thus did not warrant sulfur speciation tests) or ii) due to an overestimation of readily available ANC.
- The RGS classification criteria are consistent with AMIRA (2002) and show that 366 samples are classified as NAF-Barren, 7 samples are classified as NAF (Marra Mamba), 11 samples are classified as Uncertain

(Detrital, Mount McRae Shale, Whaleback Shale and Marra Mamba), 3 samples classified as PAF- low capacity (Whaleback Shale and Mount McRae Shale), and 3 sample are classified as AF (Detrital, Mount McRae Shale and Wittenoom Formation).

- The collective results discussed above highlight that there is a high factor of safety and generally a low potential of acid generation from these materials.
- The GBO waste rock materials typically have low total metal/metalloid concentrations. Application of the NEPC (HIL(C)) guideline for soils indicate: nine samples for As, eight samples for Cr and six samples for Mn were above the guidelines. The majority of arsenic above NEPC (HIL(C)) values are derived from Detrital followed by shale from Wittenoom Formation. Chromium samples above guidelines are derived mainly from shale and manganiferrous shale from Wittenoom Formation, followed by a variety of lithology types such as dolerite, low grade aluminous, BIF and hydrated waste. Manganese exceedances were associated more with Detrital (Detrital waste or silcrete), followed by manganiferrous shale and BIF in Wittenoom Formation and Mount McRae Shale.
- The GAI results indicate that of the metal(loid)s measured, Fe, As and Te are highly enriched compared to average crustal abundance in the majority of samples from each of the stratigraphic units (excluding As and Te in Dolerite, and Te in Mount Sylvia). Furthermore, Ca, Mg, Mn and Se are at times enriched in Detrital; Mg, Mn, Hg, Se and Tl are at times enriched in the Wittenoom Formation; Mn is at times enriched in the Mount McRae Shale; and, Se is at times enriched in the Dales Gorge and Joffre Member.
- The multi-element leach testing of water extracts (1:2 sample:water) have a pH range from pH 4.2 (acidic) to 9.4 (alkaline) with the majority of samples circum neutral (mean = 5.9). There are, however, 3 samples with a pH less than 6 (Dolomite from Wittenoom Formation and Mount McRae Shale) and 10 samples with a pH greater than 9 (distributed in the stratigraphic units). The water extracts have EC values ranging from 91 to 2,610 µS/cm (median 369 µS/cm). There were only a few samples that showed elevated leached metal/metalloid concentrations; this included selenium, boron and arsenic from the Mount McRae Shale; and, selenium from Detrital and Wittenoom Formation.

Recommendations

RGS suggest that RTIO consider the following recommendations in order to supplement the geochemical testing undertaken as part of this investigation. The additional analyses and programs should include:

- Laboratory kinetic testing (oxygen consumption rate testing and kinetic leach column tests);
- Field kinetic testing (potentially field barrel kinetic tests or test piles);
- Rehabilitation material sampling and analysis program with a focus on physical testing;
- Develop a waste rock and rehabilitation material classification criteria (i.e. for waste rock and beneficial mine waste that could be used for rehabilitation);
- Develop a waste rock and rehabilitation material block model (or incorporate geochemical and physical properties into the current geological model based on the above classification criteria); and,
- Site surface water and groundwater monitoring.

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1 Introduction

RGS Environmental Pty Ltd (RGS) was commissioned by Rio Tinto Iron Ore Ltd. (RTIO) to complete a geochemical assessment of representative samples from the Greater Brockman region in the Pilbara, Western Australia. The key objective of the assessment is to identify any potential for acid and metalliferous drainage (AMD)[1], including soluble metal/metalloid and salt release.

This report summarises the results of static geochemical testing.

1.1 Background

The Brockman iron ore operation includes the Brockman 1 (BS1), Brockman 2 (BS2), Brockman 3 (BS3), Brockman 3 Extension (BS3X), Brockman 4 (BS4), Brockman Syncline South Marra Mamba (BSMM) and Nammuldi Project Area (referred to herein as the GBO), located approximately 45 – 60 km north-west of Tom Price and 250 km SSW of the port of Dampier in the Pilbara region of Western **(Figure 1-1**). A background summary of the deposits is provided in the following points by Rio Tinto:

- **Brockman 1 (BS1)**

BS1 lies on the northern limb of the Brockman Syncline and largely consists of outcropping Brockman Iron Formation rocks with colluvium and alluvium to the North. The deposit is a High Phosphorus Brockman (HPB) deposit and it occurs as two discrete mineralised areas, BS1 East (BS1E) and BS1 West (BS1W). Mineralisation occurs as a series of semi continuous pods in the Joffre (JOF), Dales Gorge (DG) and Whaleback Shale (WS) Members of the Brockman Iron Formation. The deposit comprises hematite-goethite mineralisation with high goethite content; the mineralisation style is similar to that of the BS4 deposit. The Brockman Iron Formation dips to the south at 30-50 degrees and is cross-cut by several NW trending dolerite dykes.

- **Brockman 2 (BS2)**

The deposit lies along the northern side of the Brockman Syncline in the central part of the Hamersley Province. The deposit infill's the valley between the Brockman Iron Formation escarpment to the south and the low strike ridge of the Nammuldi Marra Mamba Deposits to the north. A Detrital Complex occurs as a shallow blanket of hematite-rich outwash scree draped against the Brockman escarpment. The stratigraphy exposed at Brockman 2 Deposit consists of nearly continuous exposure from the Wittenoom Formation, Bee Gorge Member to the lower Joffre Member of the Brockman Iron Formation. Mineralisation appears to be restricted to the Brockman Iron Formation. The Brockman Iron Formation consists of the Dales Gorge Member, the Whaleback Shale Member, the Joffre Member and the Yandicoogina Shale Member.

- **Brockman 3 (BS3)**

The BS3 deposit is located on the southern limb of the Brockman Syncline, north east of the BS4 deposit. It is a High Phosphorous Brockman deposit and it occurs as three discrete mineralised areas, BS3 Central (BS3C), BS3 North East (BS3NE) and BS3 South West (BS3SW). The mineralisation is contained within the Dales Gorge (DG), Whaleback Shale and the Joffre (JOF) Members of the Brockman Iron Formation. The deposit comprises hematite-goethite mineralisation with high goethite content. The mineralisation runs to a maximum depth of 108 m from surface and covers a horizontal area of approximately 1 km by 1.5 km. The stratigraphy dips generally to the northwest at 20-30 degrees, it is cross-cut by several narrow NW trending dolerite dykes and a thick dolerite sill has been identified within the Joffre member. The bedded mineralisation is generally shallow, parallel to the surface profile and has a strong hydrated overprint.

[1] Acid and metalliferous drainage (AMD) refers collectively to acidic, saline and metalliferous (metal(loid)) drainage. AMD is also commonly or formally referred to as acid mine drainage or acid rock drainage (ARD) in other jurisdictions around the world.

- **Brockman 3 Extension (BS3X)**

The BS3 Marra Mamba mineralisation lies along the southern side of the Brockman Syncline. The BS3 Extension area covers 7 separate prospects, Sandleford, Monkey, Lauriston, Brokenwood, Diesel, Creekside and BSMJ. The dip of the strata varies from near horizontal at the contact of the MacLeod Member with the Nammuldi Member along the eastern side of the syncline to around 35 degrees NW across the central part of the tenement. At BS3 Extension, the lower section of the West Angelas Member is partly mineralised. Mineralisation is typically high in alumina due to the included shale bands and there are occasional zones with elevated manganese. Extensive but patchy detrital mineralisation occurs along the margins of the main valley separating the iron formations. The detrital deposits occur as shallow accumulations of well cemented canga and iron rich fragments and pisolites that have been partly cemented. These deposits occur within semi-consolidated clay rich colluvium.

- **Brockman 4 (BS4)**

The Brockman Syncline 4 (BS4) deposit lies within the Brockman Iron Formation along the southern limb of the Brockman Syncline. The deposit covers a strike length of approximately 14km along a prominent east – west ridge formed by the Brockman Iron Formation. The deposit is divided into three sections where the outcropping ridge is cut by small, colluvium filled, NW trending strike valleys. BS4 is a typical high phosphorus Brockman (HPB) martite-goethite type deposit. Mineralisation occurs in both Dales Gorge Member and the Joffre Member of the Brockman Iron Formation over a strike length of approximately 14km with mineralised thicknesses over 100m encountered during drilling. Minor mineralisation also occurs in the Whaleback Shale Member. In addition to the bedded mineralisation, small deposits of secondary surficial ironstone have accumulated as cover over the bedded Brockman mineralisation and along the valley between the Marra Mamba and Brockman Iron Formations.

- **Brockman Syncline South Marra Mamba (BSMM)**

The BS4MM Project Area covers the southern limb of the Brockman Syncline, hosting northward dipping (20° - 50°) rocks of the Marra Mamba Iron, Wittenoom and Mt Sylvia Formations, as well as overlying Mt McRae shale. Rocks belonging to the Brockman Iron Formation outcrop to the north of the Project Area, forming a prominent east-west ridge that dominates the neighboring BS4 Brockman Mine Area. An extensive plain, covered by a series of mesas representing the Beasley pisolites, flanks the southern boundary of the Project Area.

- **Nammuldi Project Area**

The Nammuldi deposits are located in the Marra Mamba Iron Formation on the northern flank of the Brockman Syncline. This syncline consists of two ridges of Brockman and Marra Mamba Iron Formation, and plunges gently to the south-west. Extensive bedded and detrital iron mineralisation occurs around the syncline. The deposits consist of six lenses from lens A through to lens F and extend over a strike distance of 14 kilometres. The central Nammuldi Lenses B, C and D are located close to Brockman 2 mine infrastructure. To the west, a north-west trending lineament (fault/dyke) separates them from Lens A and to the east a deeply eroded valley filled with low grade detritals separates them from Lens E & F.

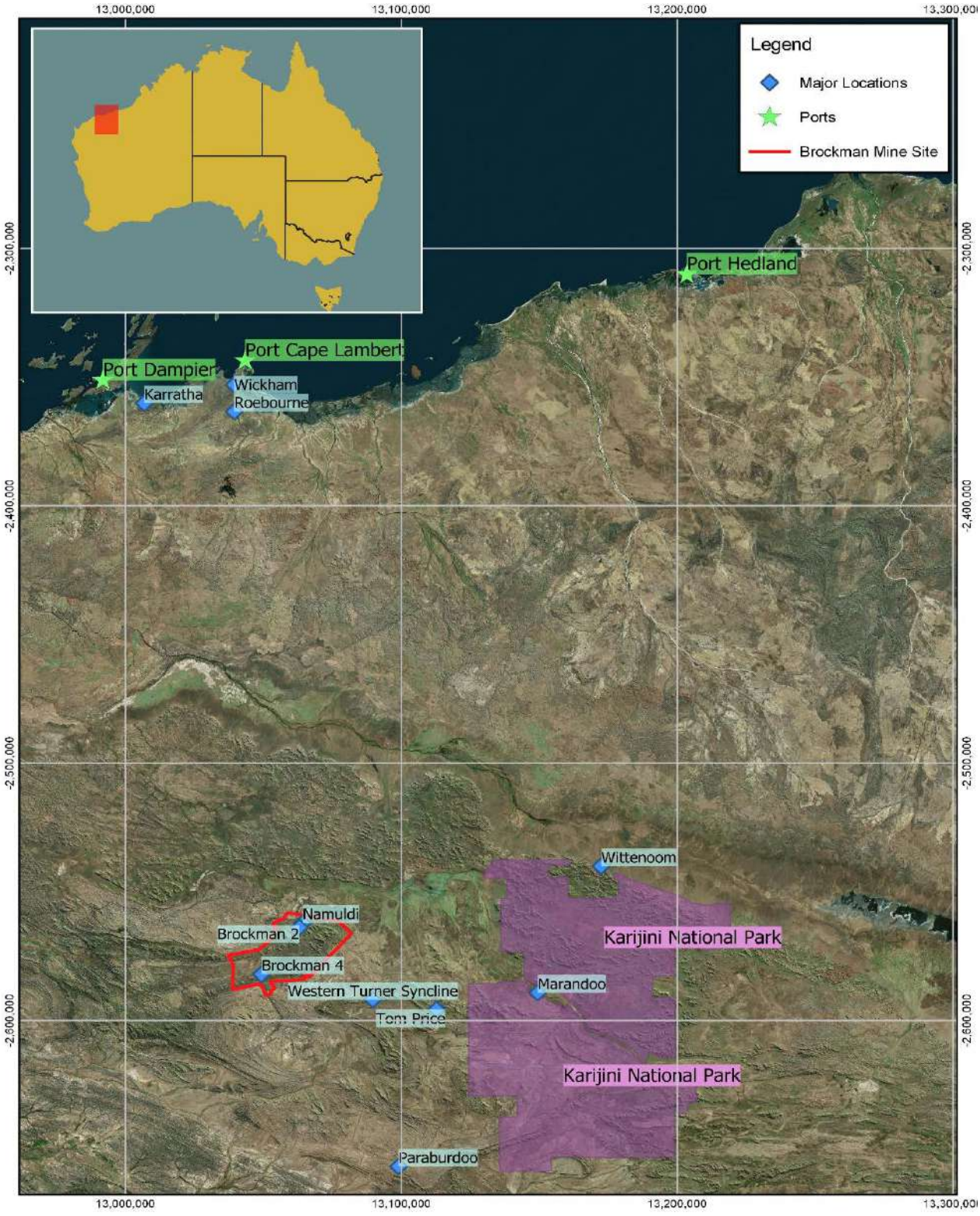


Figure 1-1 RTIO Brockman General Location

1.2 Geology

A conceptual cross section of the underlying geology of the GBO is shown in **Figure 1-2**. Each of the Hamersley Group units are encountered at the Brockman Syncline. A geological summary of the key units is provided in **Table 1-1** (from Porter GeoConsultancy, 2010).

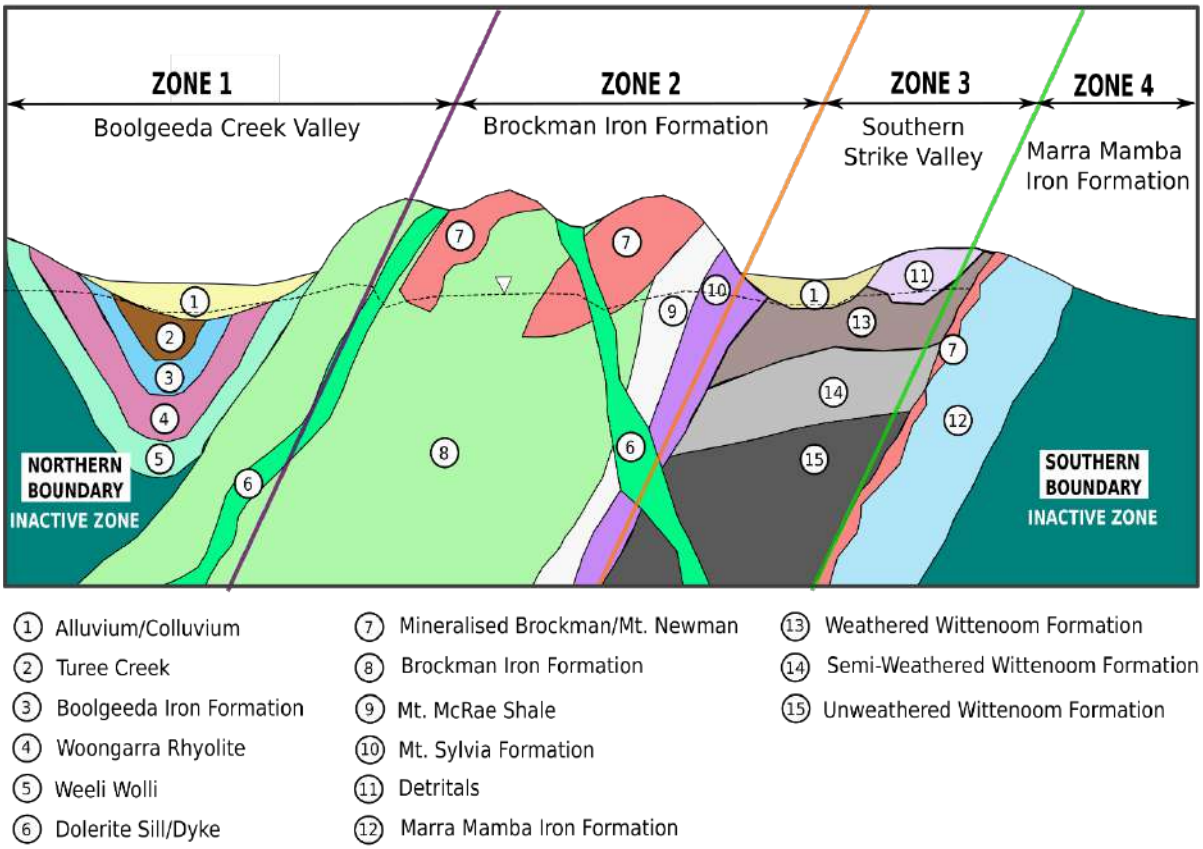


Figure 1-2 Conceptual Hydrogeological Model from Original Proposal (Aquatera 2005)

Table 1-1: Hamersley Group Units

Unit (approximate thickness)	Geological Description
Marra Mamba Formation (Thickness: 230 m)	Nammuldi Member – Cherty BIF with occasional shale bands
	MacLeod Member – BIF with extensive interbedded shales and "podded" horizons
	Mount Newman Member – BIF with thin shale bands
Wittenoom Formation (Thickness: Max 700 m)	West Angelas Member - Manganese-rich shale with minor BIF and chert bands
	Paraburdoo Member – Dolomite with some karstic dolomite
	Bee Gorge Member - Calcareous shale and dolomite
Mount Sylvia Formation (Thickness: 30 m)	Mudstone, siltstone, chert, dolomite and BIF bands
Mount McRae Shale (Thickness: About 50 m)	Graphitic shales (2-8 wt.% TOC)
	Pyritic shales (1-10 wt.% S)
	Chloritic shales interbedded with BIF
Brockman Iron Formation (Thickness: 620 m)	Dales Gorge Member - interbedded BIF and shale,

Unit (approximate thickness)	Geological Description
	Whaleback Shale Member - interbedded shale, chert and BIF,
	Joffre Member - BIF with minor shale bands,
	Yandicoogina Shale Member - shale and BIF
Weeli Wolli Formation (Thickness: ~600 m)	BIF (commonly jaspilitic), mudstone and siltstone with common interlayered metadoleritic sills
Woongarra Volcanics (Thickness: ~800 m)	Rhyolite, rhyodacite and rhyolitic lavas and volcaniclastic breccia, pyroclastic rocks and BIF
Boolgeeda Iron Formation (Thickness: 450 m)	Fine-grained, laminated, dark grey-brown to black flaggy BIF, minor chert, jaspilite, shale

1.3 Scope of Work

The scope of work, developed by RTIO, involved completing a geochemical assessment of waste rock materials sampled from the GBO. The scope of work was undertaken as a phased approach and is outlined below:

- Co-ordinate static material assessment of waste rock materials associated with the GBO; and,
- Produce a material characterisation report that will define the measured geochemical characteristics of the materials.

The results may be used to select samples for an additional phase of testing: kinetic leach column (KLC) tests.

2 Methodology

2.1 Sampling Program

RTIO geological and mineral waste personnel developed the sampling strategy for the GBO. RGS was provided a list of samples that were selected for the program and supplied with an excel file containing the associated sampling locations and assay results. The drill hole locations from which samples were selected is in **Figure 2-1**

RTIO was responsible for the initial sample selection and delivery of samples to Australian Laboratory Services (ALS) Perth. The consignment was then sent to ALS Brisbane (a NATA accredited laboratory) under the guidance of RGS. RGS understands that the samples selected are representative of the waste rock material types of the GBO.

The total number of samples selected for the geochemical program was 390; a breakdown of the sample numbers according to lithology and stratigraphy is in **Table 2-1**.

Table 2-1 Summary of samples RTIO selected for geochemical testing

Lithology	Number of Samples
Siliceous - Low grade	14
Silcrete	3
Shale- Manganiferrous	4
Shale - Cherty	4
Shale - Carbonaceous	3
Shale	83
Red Ochre Waste	1
Red Ochre High Grade	1
Red Ochre Detrital - Low Grade	3
Pisolite Waste	1
Pisolite - Low Grade	1
Manganese	1
Limonitic Waste	3
Limonite - Low Grade	8
Lignite	2
Hydrated Waste	6
Hydrated	18
High grade - High Phos	7
High Grade	10
Dolomite	9
Dolerite	7
Detritals - High Grade	1
Detrital Waste	50
Detrital - Low Grade	20
Clay	2
Chert	1
Calcrete	10
Banded Iron Formation	97
Aluminous - Low Grade	20
Total	**390**

Stratigraphy	Number of Samples
Detrital	109
Dales Gorge Member	60
Dolerite	7
Joffre Member	41
Mount McRae Shale	38
Marra Mamba	42
Mount Sylvia	8
Wittenoom Formation	59
Whaleback Shale	26
Total	**390**

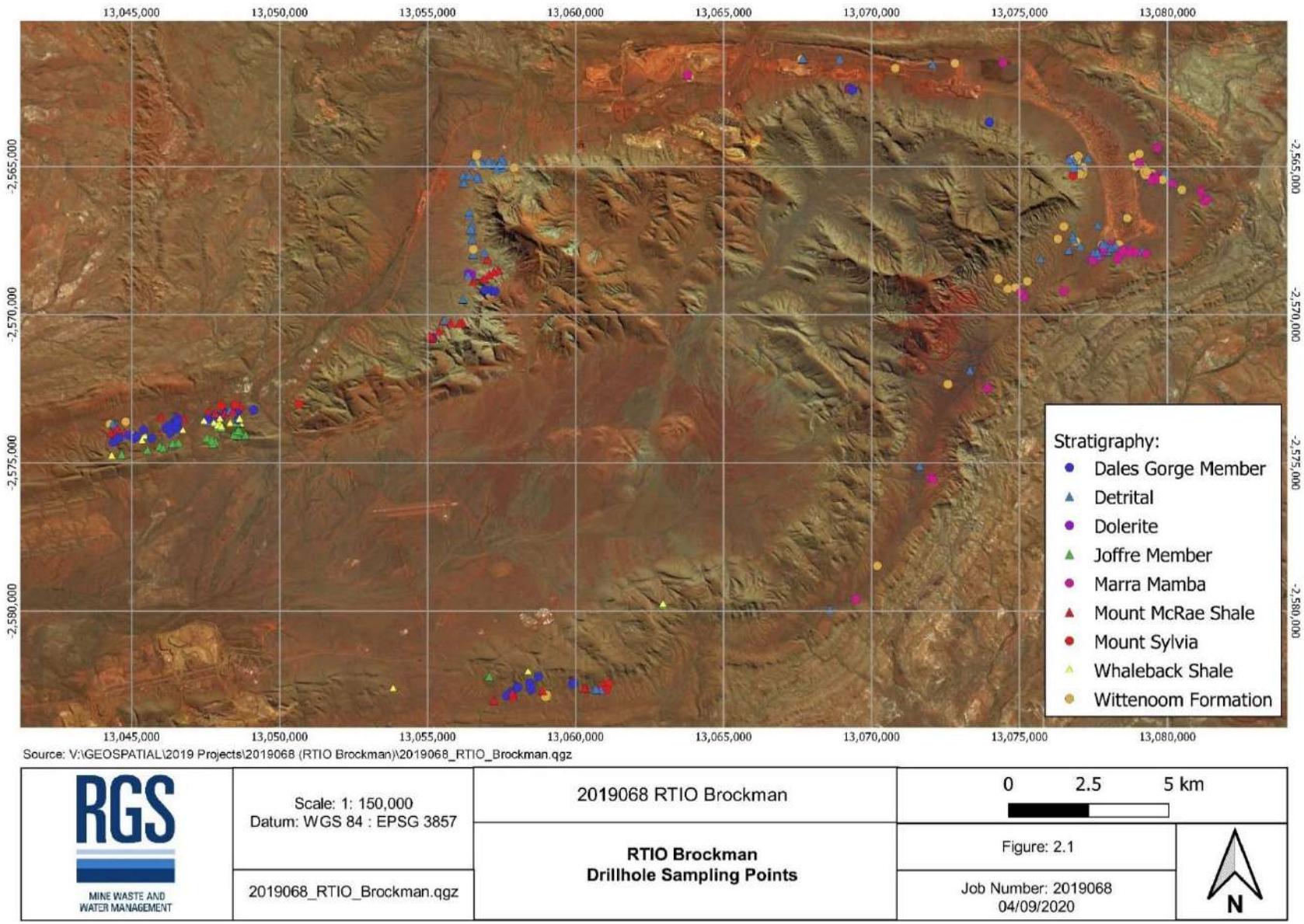


Figure 2-1 RTIO Brockman Drill hole Sampling Locations

2.2 Geochemical Testing

The analytical program was developed by RTIO. A series of analytical methods were completed on the samples. The analytical program was designed to quantify the potential for AMD from the presence of reactive sulfides, acid generation, and leaching of soluble metals/metalloids and salts in accordance with relevant mine waste geochemistry and mine closure guidelines (COA, 2016; and DMP and EPA, 2015).

The analytical program was separated into three phases of work outlined in **Table 2-2**. The Phase 3 kinetic testing is not included as part of this scope of work.

The analyses used in this geochemical assessment are in **Attachment A**.

Table 2-2 Geochemical characterisation program and number of samples

Phase	Parameter	Number of samples
Phase 1	Dry, Crush and Pulverise as/ if required	390
	Paste pH and EC	390
	NAPP (includes Total S and ANC)	390
	Single addition NAG	390
	Multi element chemical assay (Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, F, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, N, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Tl, Ti, U, V, W, Y, Zn, Zr)	390
Phase 2	Sulfur speciation (CRS)	60
	Sulfate total (as SO_4)	60
	Carbon speciation (TOC, TIC)	40
	ABCC	60
	XRD (semi-quantitative)	40
	DI water leach (2:1 solid:liquid):	145
	pH, EC, acidity, alkalinity, Cl, SO_4	145
	Nitrogen suite (total N, NO_2, NO_3 and NH_3)	145
	Ca, K, Mg, Na	145
	Metals by ICP-MS (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Hf, Hg, La, Li, Mn, Mo, Nb, Ni, Pb, Rb, Re, Sb, Se, Si, Sn, Sr, Ta, Th, Tl, Ti, U, V, W, Y, Zn, Zr)	145
Phase 3	Kinetic leach testing (not part of this scope of work)	-

2.2.1 Static Tests

Static geochemical tests were completed to screen all samples before selecting individual samples for more detailed static test and mineralogical tests.

Acid Base Accounting (ABA) was undertaken to quantify the pH, electrical conductivity and net acid producing potential (NAPP) of 390 samples. The ABA screening procedure included static geochemical testing according to the following methods:

- Paste pH and Electrical conductivity (EC) [USEPA 600/2 – 78 - 054];
- Total sulfur [LECO method]; and,
- Acid neutralising capacity (ANC) [AMIRA, 2002 method].

From the total sulfur and ANC results, the maximum potential acidity (MPA) and net acid producing potential (NAPP) values were inferred.

Single addition Net Acid Generation (NAG) tests (Miller, 1998) were also undertaken on the 390 samples.

All samples were subjected to whole rock multi-element analysis. The samples were specifically tested for:

- Multi element chemical assay (Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, F, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, N, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Tl, Ti, U, V, W, Y, Zn, Zr) [4-acid and Aqua Regia digestion method, finished with ICP-MS and FIMS].

Based on the results of the ABA screening and whole rock multi-element tests, samples were selected for more comprehensive static testing. The selection of these samples considered material type, location and lithology type. The selected samples were specifically tested for:

- Chromium Reducible Sulfur (CRS %) [Sullivan et al., 1998];
- Total Organic Carbon, Total Inorganic Carbon and Total Carbon [LECO method];
- Acid Buffering Characterisation Curve (ABCC) [Miller and Jeffery, 1995];
- X-Ray Diffraction (XRD) (semi-quantitative); and,
- DI Water Leach (2:1 solid: liquid; 12 hr tumble) with subsequent analysis off:
- pH and EC (2:1 leach, probes and meter);
- Acidity and alkalinity (automatic titrator measured as $CaCO_3$);
- Dissolved major anions (Cl, SO_4) [ICP-AES];
- Nitrogen suite (Total Nitrogen + NO_2 + NO_3 + NH_3);
- Dissolved major cations (Ca, Mg, Na and K) [ICP-AES]; and,
- Dissolved metals/metalloids (Ag, Al, As, B, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Hf, Hg, La, Li, Mn, Mo, Nb, Ni, Pb, Rb, Re, Sb, Se, Si, Sn, Sr, Ta, Th, Tl, Ti, U, V, W, Y, Zn, Zr) [ICP-AES and FIMS].

3 Results

Results are discussed according to key stratigraphical and lithological domains encountered within the GBO.

Summary results tables for the geochemical test programs are provided in **Attachment B** and consist of:

- **Table B1:** Acid Base Account (ABA) Test Results
- **Table B2:** Multi-Element Test Results
- **Table B3:** Geochemical Abundance Index (GAI)
- **Table B4:** Multi-Element Test Results for Water Extracts

The raw ALS test results for the static geochemical test program are provided in **Attachment C**.

3.1 Acid Base Account Results

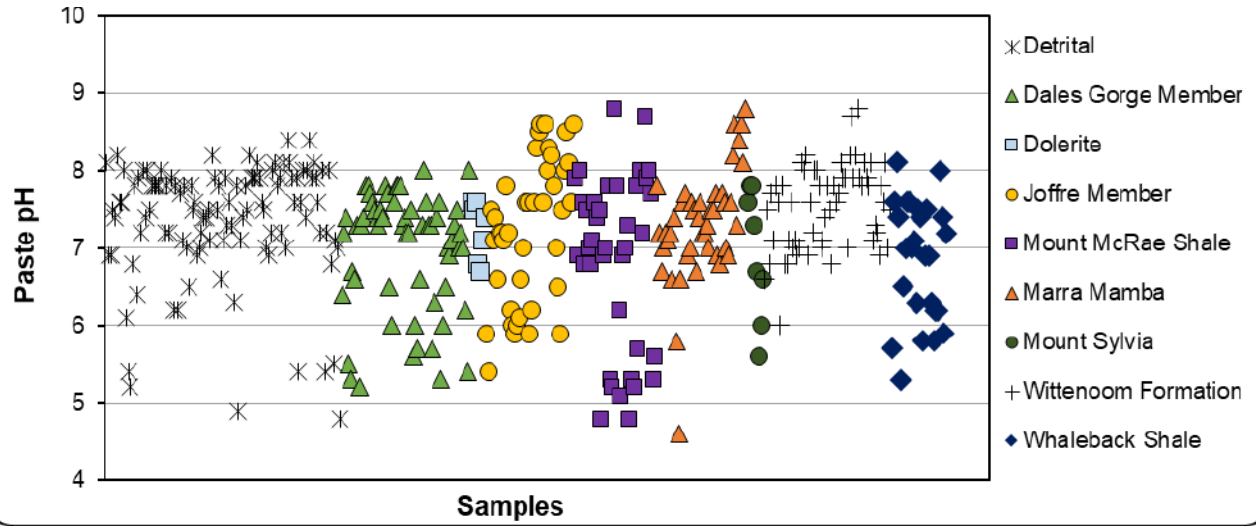
An explanation of the terminology used in this section, including a description of the ABA test methodology, is provided in **Attachment A**. Complete ABA results for the 390 samples are in **Attachment B.**

The key ABA data trends are summarised in the following points:

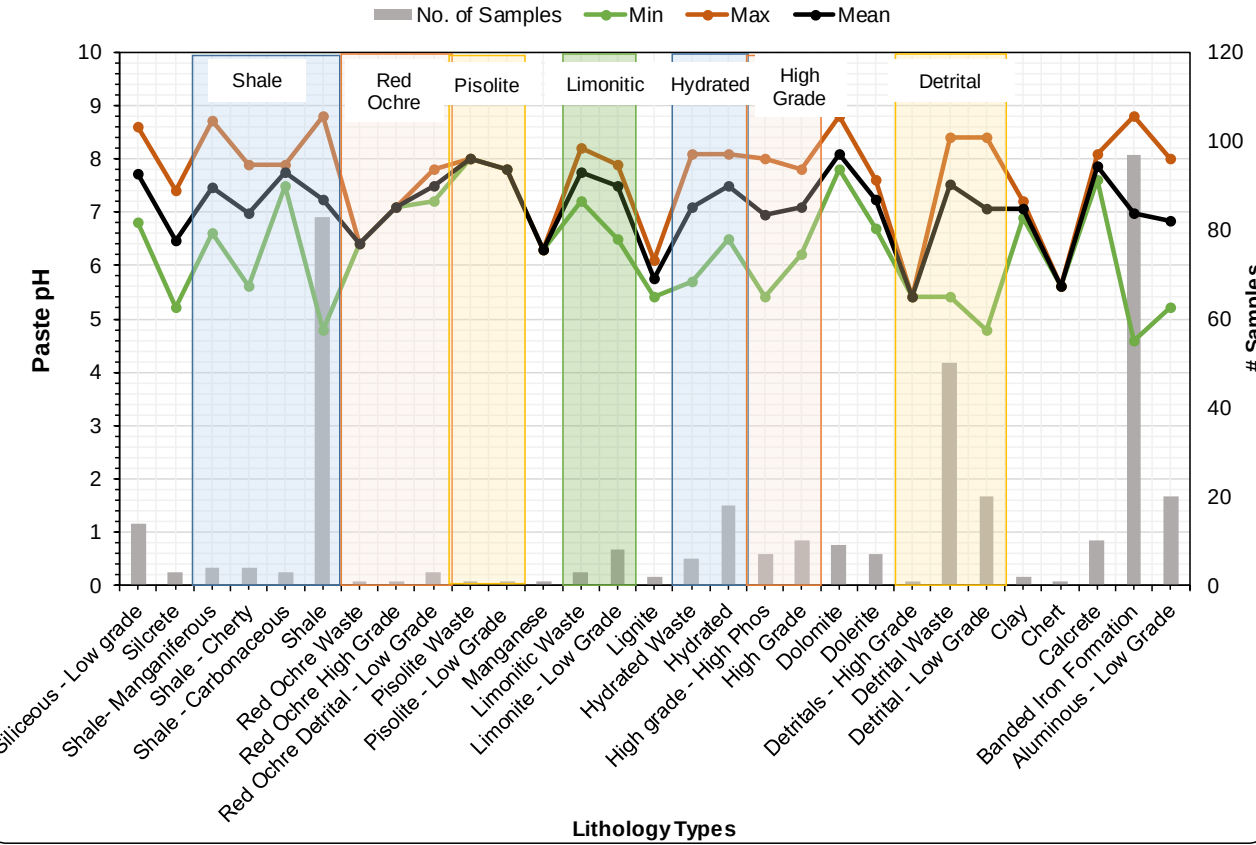
3.1.1 Paste pH

The paste pH ranges from pH 4.6 (slightly acidic) to 8.8 (slightly basic) (**Graph 3-1).** The spread of paste pH values is not influenced by stratigraphy and lithology (**Graph 3-2**) with a large range in paste pH values within a particular stratigraphic unit (**Graph 3-1**) or lithology type (**Graph 3-2**). Approximately 75% of samples had a paste pH between 6 to 8 (circum neutral) with only ~1% of samples with a paste pH <5 (slightly acidic); the acidic samples were associated with the Detrital (n=2), Mount McRae Shale (n=2) and Marra Mamba (n=1) stratigraphy types. Approximately 15% of sample has a paste pH > 8 (alkaline).

Graph 3-1 Paste pH values according to stratigraphy

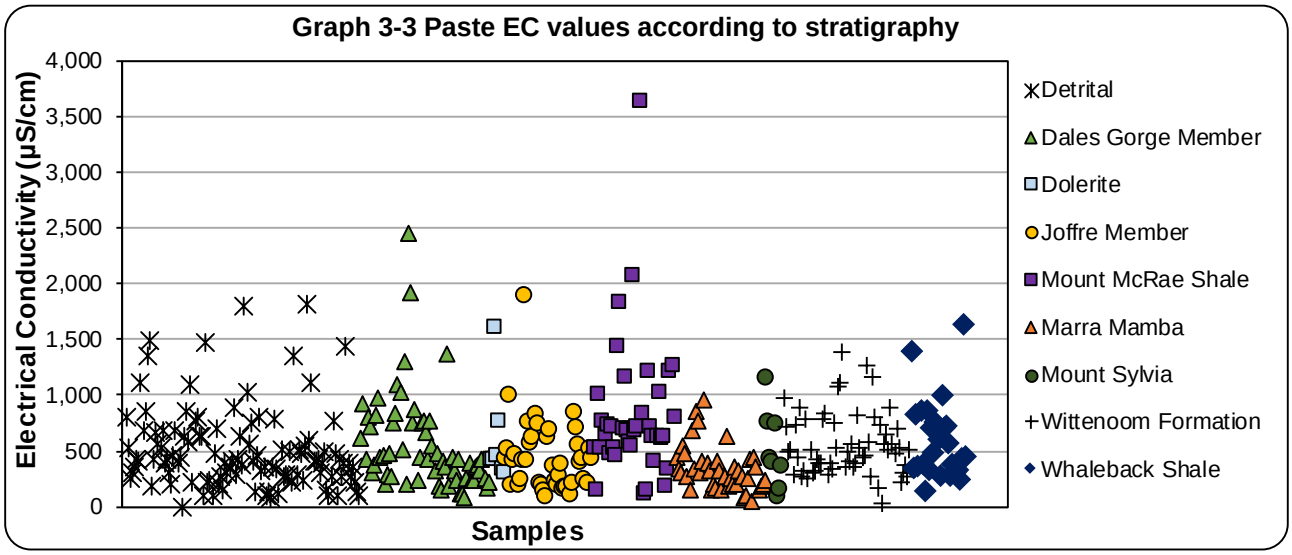


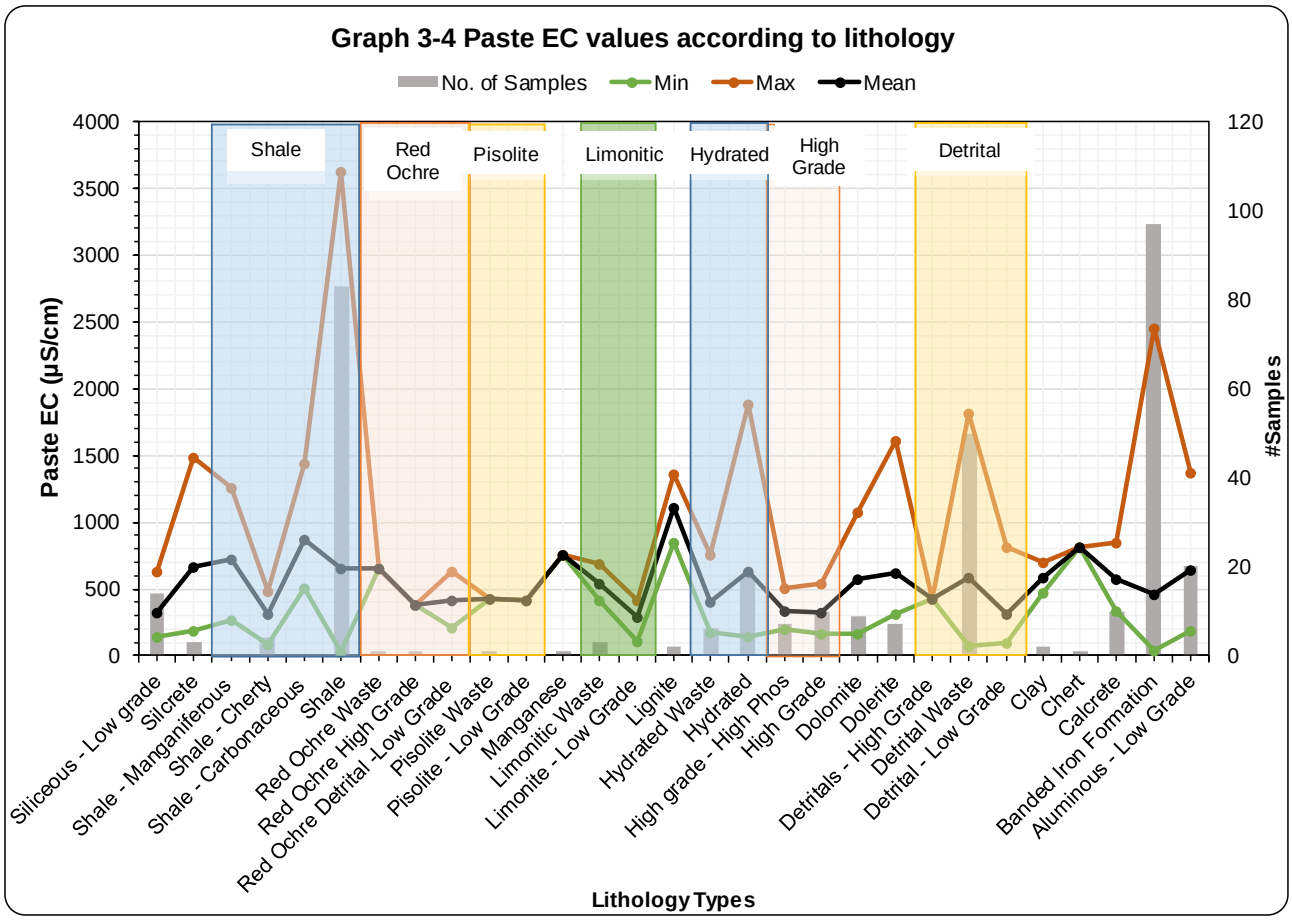
Graph 3-2 Paste pH range according to lithology



3.1.2 Paste EC

The paste EC of the 390 samples ranges from 27 to 3,630 µS/cm (**Graph 3-3**), with a median and mean value of 428 and 534 µS/cm, respectively. The paste EC values generally varies according to stratigraphic unit and lithology types (**Graph 3-4**); however, the relationship is not clear, with a large range in paste EC values within a particular stratigraphic unit or lithology type. Mount McRae Shale registers an outlier of 3,630 µS/cm and shows the greatest range in paste EC values. However, all of the stratigraphic units show a paste EC range of > 1,000 µS/cm.

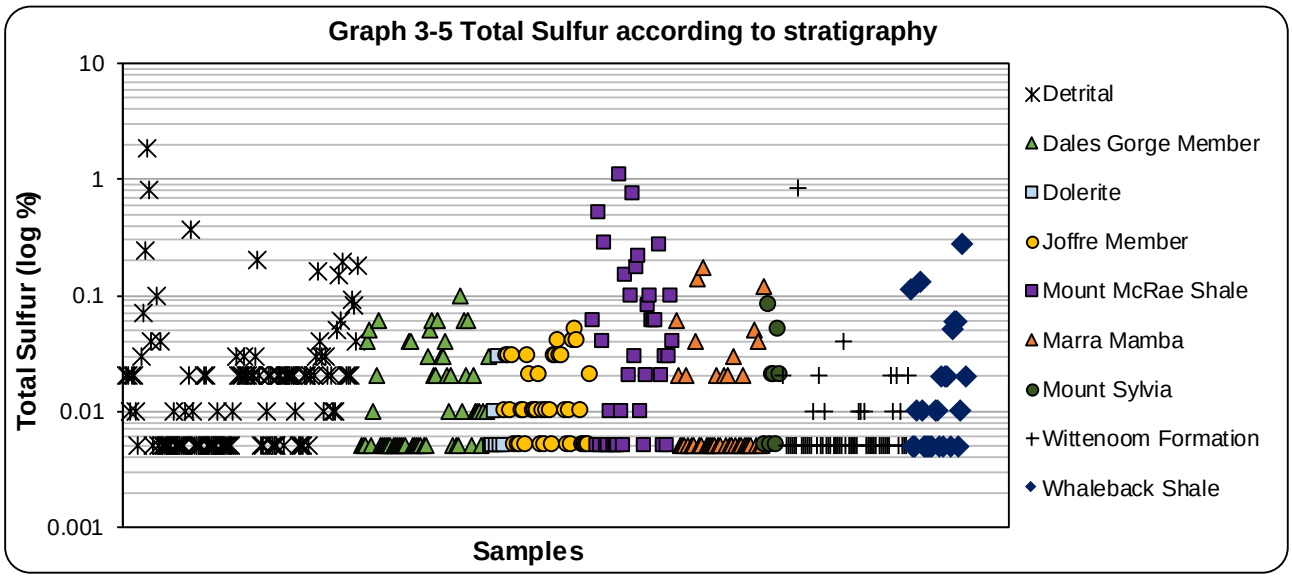




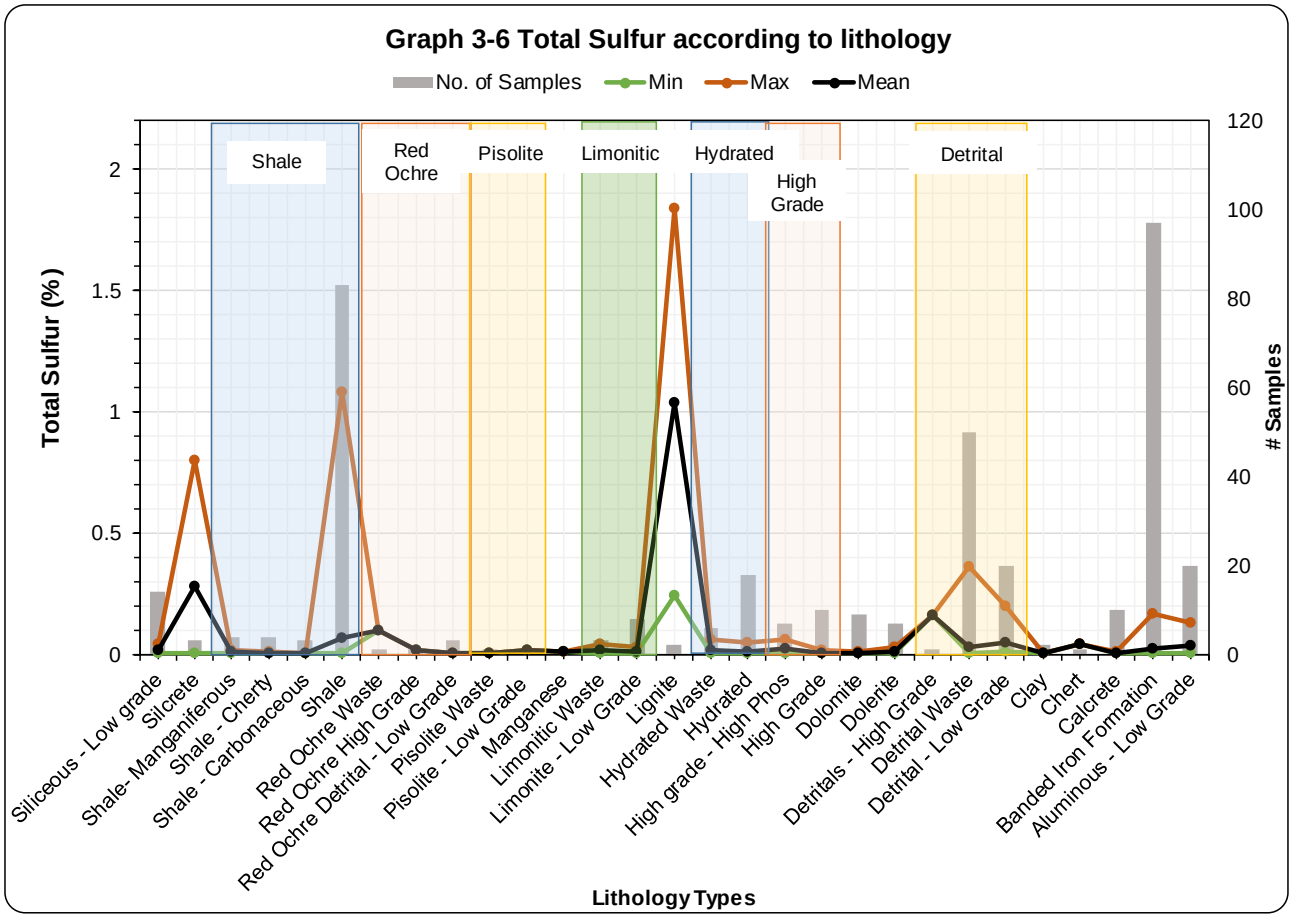
3.1.3 Total sulfur and sulfide sulfur

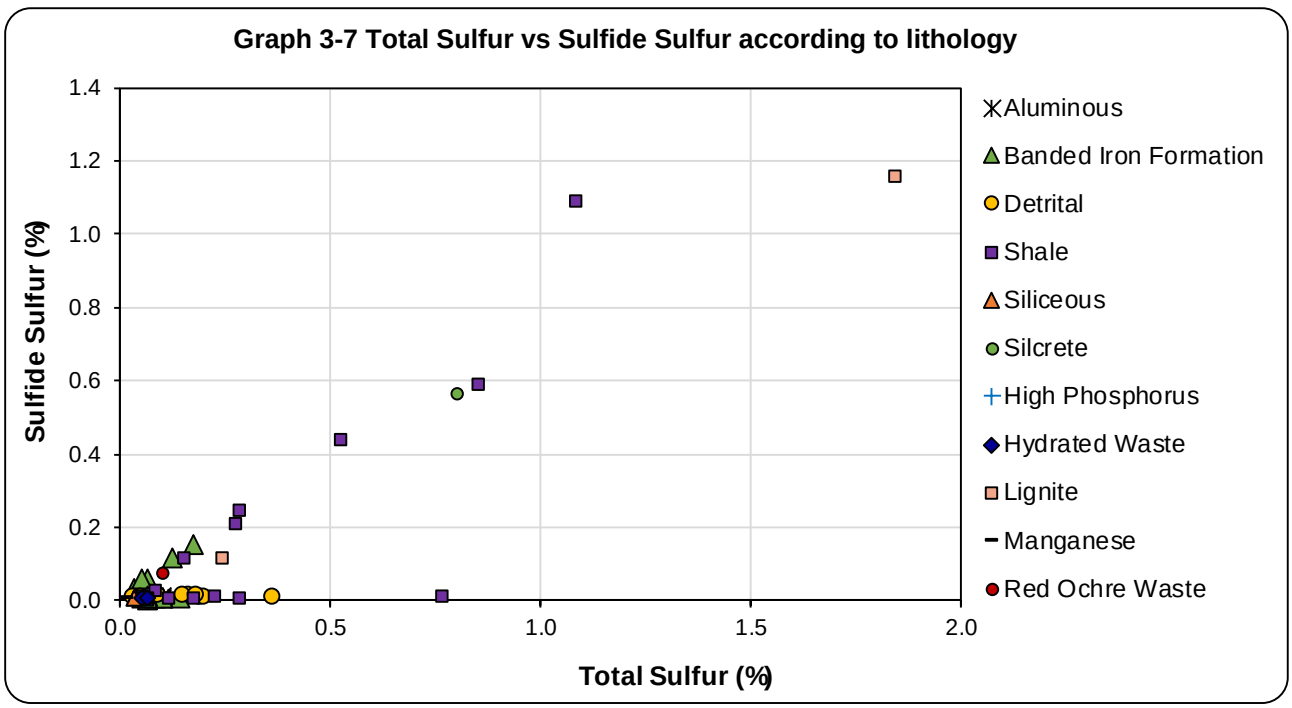
Sulfide-bearing minerals are the primary source of acidity. The total sulfur (TS) content of the GBO samples ranges from <0.01 %S (below instrumental detection limits (IDL)), to 1.84 %S (Detrital Lignite) (**Graph 3-5; Graph 3-6**), with median and mean values of 0.01 and 0.04 %S, respectively. There are 366 samples which have <0.1 %S which is average crustal abundance for S (INAP, 2009). Materials with a TS content less than or equal to 0.1 %S are essentially barren of sulfur and have negligible capacity to generate additional acidity[2]; there are barren samples associated with each of the stratigraphic units. Approximately 1.5% of samples from the Detrital, Mount McRae Shale and Wittenoom Formation stratigraphic units contain TS > 0.5%.

The chromium reducible sulfur (CRS) method measures the sulfide sulfur content or un-oxidised portion of sulfur (e.g. pyrite and marcasite). CRS was measured on select samples with a TS > 0.1%. The results indicate that ~63 to 100% of the TS is present as sulfide sulfur in samples with a TS content >0.5 %. A positive linear relationship (1:1; TS: sulfide sulfur) is more evident for the Mount McRae Shale and the Marra Mamba Formation (**Graph 3-7**) reflecting the pyrite content.



[2] The average crustal abundance of sulfur is approximately 0.1 % (INAP, 2009).

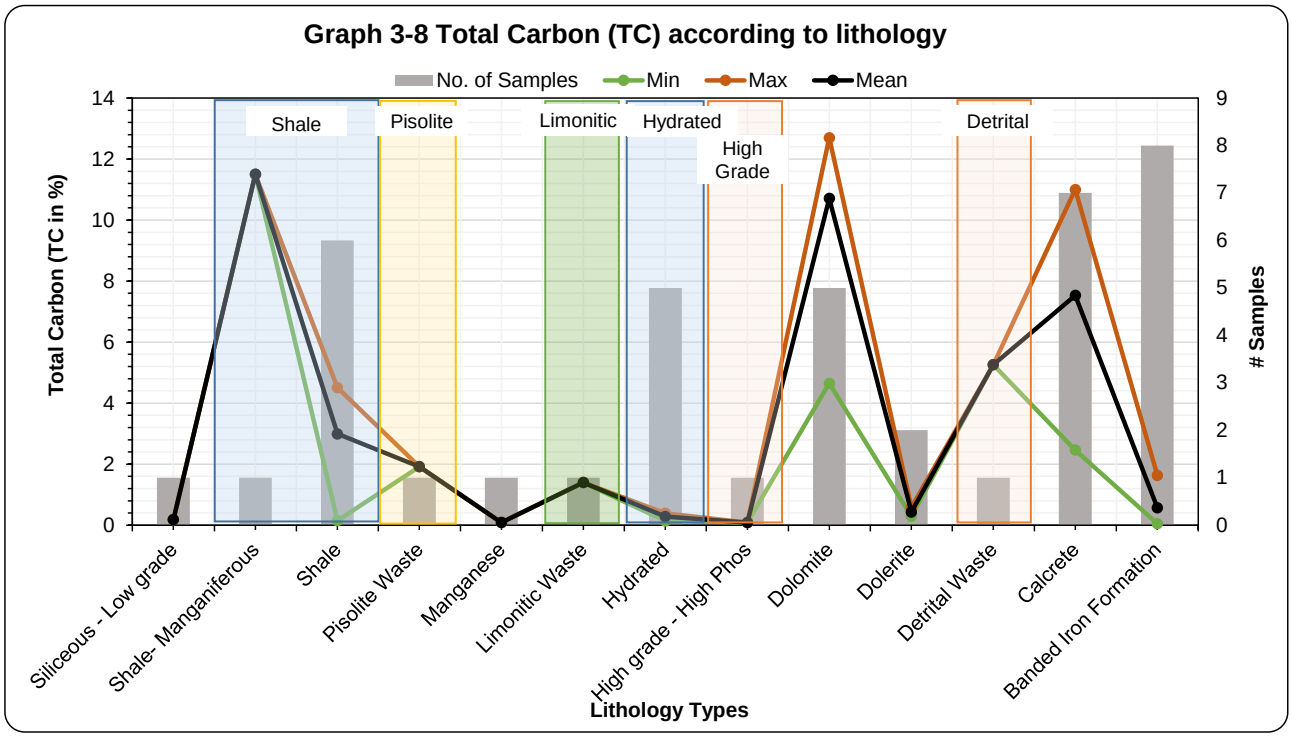

Graph 3-6 Total Sulfur according to lithology
No. of Samples
Min
Max
Mean
Shale
Red Ochre
Pisolite
Limonitic
Hydrated
High Grade
Detrital
Total Sulfur (%)
Samples
Lithology Types
Siliceous - Low grade
Silcrete
Shale- Manganiferous
Shale - Cherty
Shale - Carbonaceous
Shale
Red Ochre Waste
Red Ochre High Grade
Red Ochre Detrital - Low Grade
Pisolite Waste
Pisolite - Low Grade
Manganese
Limonitic Waste
Limonite - Low Grade
Lignite
Hydrated Waste
Hydrated
High grade - High Phos
High Grade
Dolomite
Dolerite
Detrials - High Grade
Detrital Waste
Detrital - Low Grade
Clay
Chert
Calcrete
Banded Iron Formation
Aluminous - Low Grade

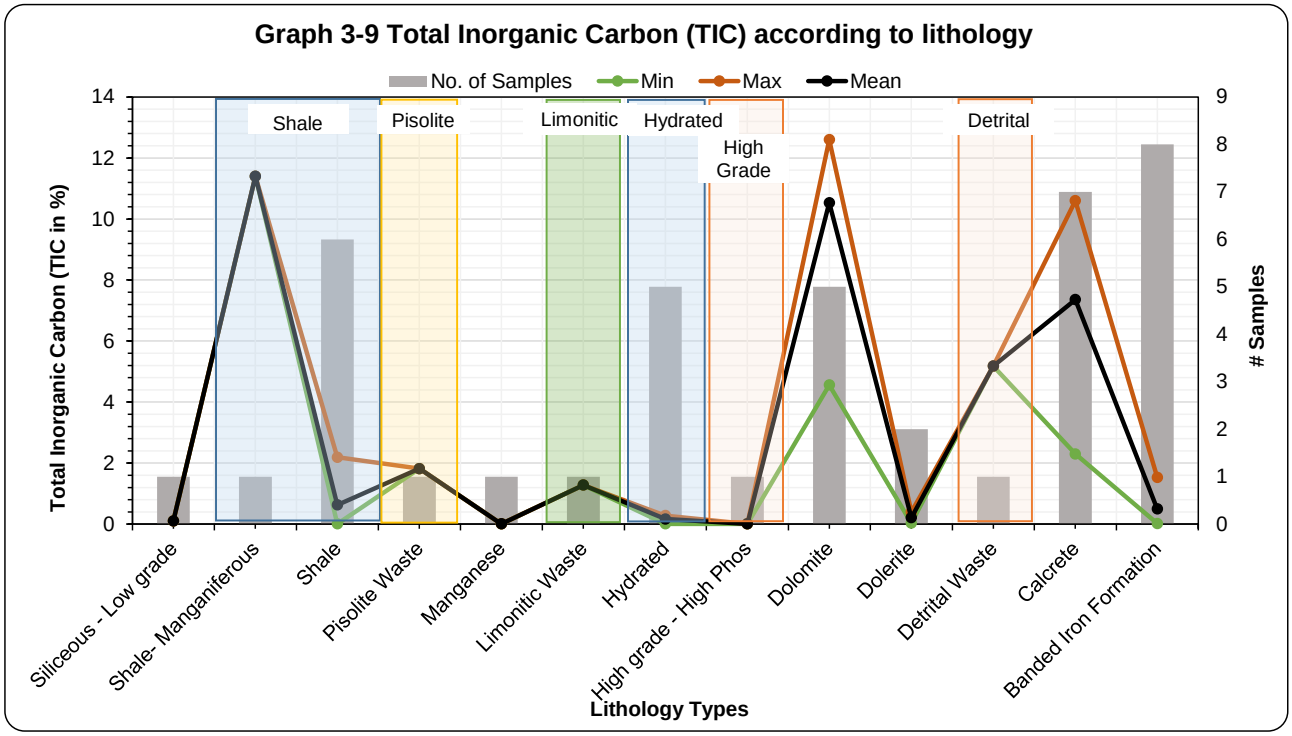

Graph 3-7 Total Sulfur vs Sulfide Sulfur according to lithology
Sulfide Sulfur (%)
Total Sulfur (%)
Aluminous
Banded Iron Formation
Detrital
Shale
Siliceous
Silcrete
High Phosphorus
Hydrated Waste
Lignite
Manganese
Red Ochre Waste

3.1.4 Total Organic Carbon (TOC), Total Carbon (TC) and Total Inorganic Carbon (TIC)

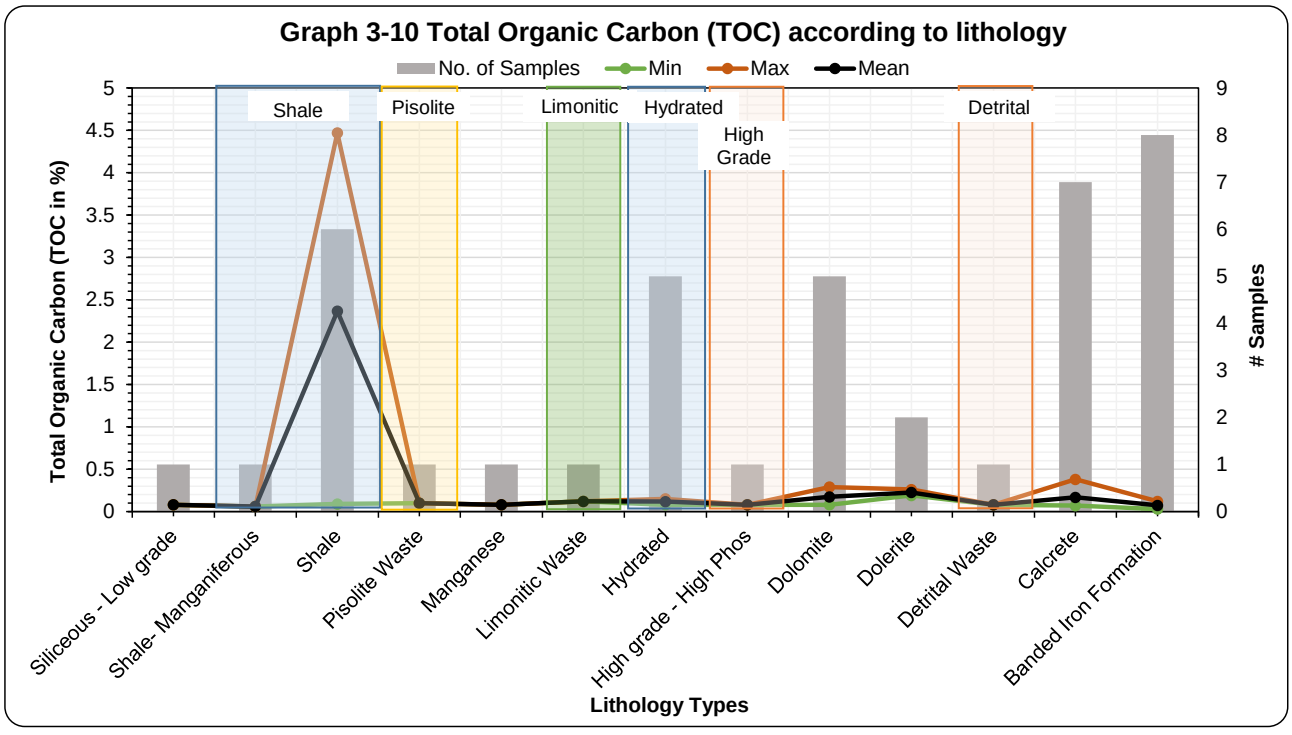
Carbon in minerals consist of either organic carbon through organic matter in sediments or inorganic carbon from carbonaceous minerals. The total carbon (TC) content ranges from 0.05 % to 12.7 % (**Graph 3-8**), with median and mean values of 1.52 % and 3.6 %, respectively. The greatest TC is associated with the Dolomite and Calcrete lithologies (**Graph 3-8**) due to TIC (**Graph 3-9**). Total inorganic carbon (TIC) content range from 0.01 % (below instrumental detection limits (IDL)) to 12.6 % (**Graph 3-9**), with median and mean values of 0.65 and 3.1 %, respectively. The distribution of TIC matches the lithologies where carbonates are largely found in Dolomite and Calcrete, followed by moderate amounts in Detrital, Limonitic, and Pisolite Waste.

The total organic carbon (TOC) content of the GBO samples range from 0.03 % to 4.47 % (Shale) (**Graph 3-10**), with median and mean values of 0.11 and 0.46 %, respectively. The TOC is almost exclusively associated with Shale with an average or 2.4%.





Graph 3-9 Total Inorganic Carbon (TIC) according to lithology



Graph 3-10 Total Organic Carbon (TOC) according to lithology

3.1.5 Maximum Potential Acidity

The maximum potential acidity (MPA) is usually inferred using total sulfur (TS) and assumes that all TS is present as pyrite and will completely oxidise to produce actual acidity. CRS was used to infer MPA for those samples where CRS was measured. The MPA ranges from 0.08 to 35.5 kg H_2SO_4/t with a median and mean value of 0.2 and 0.7 kg H_2SO_4/t, respectively.

3.1.6 Acid Neutralisation Capacity (ANC)

The ANC results for each unit is in **Table 3-1**. Median ANC results are very similar verifying that a small number of samples are skewing the ANC values in some units e.g. the Wittenoom Formation has mean and 95th percentile values of 139.6 and 930.8 kg H_2SO_4/t, respectively, and the Detrital Formation has mean and 95th percentile values of 58.8 kg H_2SO_4/t and 438.3 kg H_2SO_4/t, respectively. The wide distribution in ANC results is likely to reflect carbonate mineralisation in in-filled fractures. The Joffre Member (mean = 2.5 kg H_2SO_4/t) and Whaleback Shale (mean = 3.1 kg H_2SO_4/t) showed the lowest ANC values, indicating that these samples have little capacity to buffer any existing, or additional, acidity generated through sulfide oxidation.

Table 3-1 Summary statistics of measured ANC according to stratigraphy

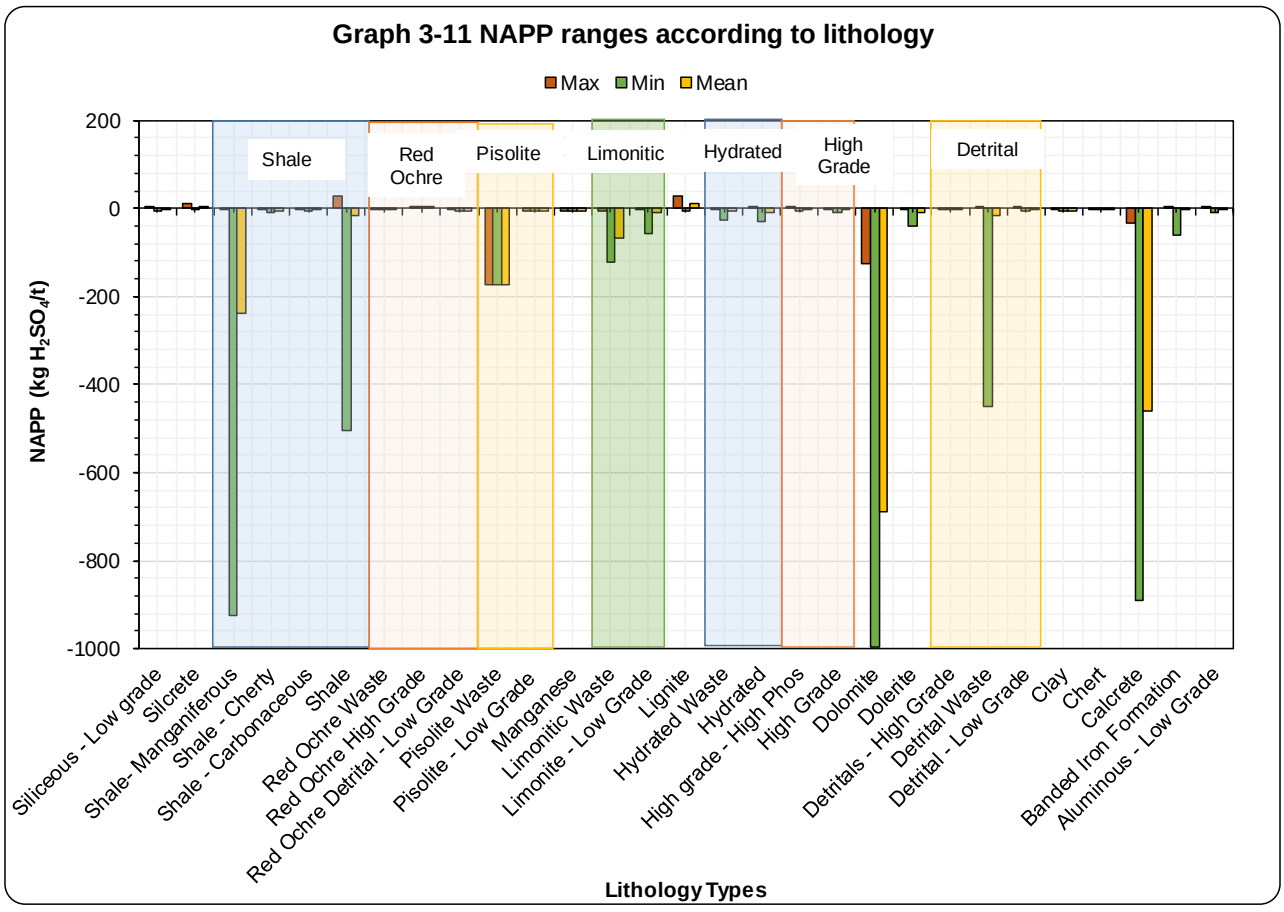
Summary Statistics	Measured ANC (kg H_2SO_4/t)				
	Min	Max	Median	Ave	P95
Detrital	0.9	891	5.7	58.8	438.3
Dales Gorge Member	0.5	29.8	2.6	5.1	16
Dolerite	2.2	38.6	3	9.3	29.7
Joffre Member	0.6	7.7	2	2.5	5.3
Mount McRae Shale	0.7	146	3.1	11.5	53.2
Marra Mamba	0.7	61.8	3	7.8	36.2
Mount Sylvia	0.2	66.4	0.5	9	44.2
Wittenoom Formation	1	996	7.2	139.6	930.8
Whaleback Shale	0.5	19.2	2.2	3.1	6.3

3.1.7 Net Acid Production Potential (NAPP)

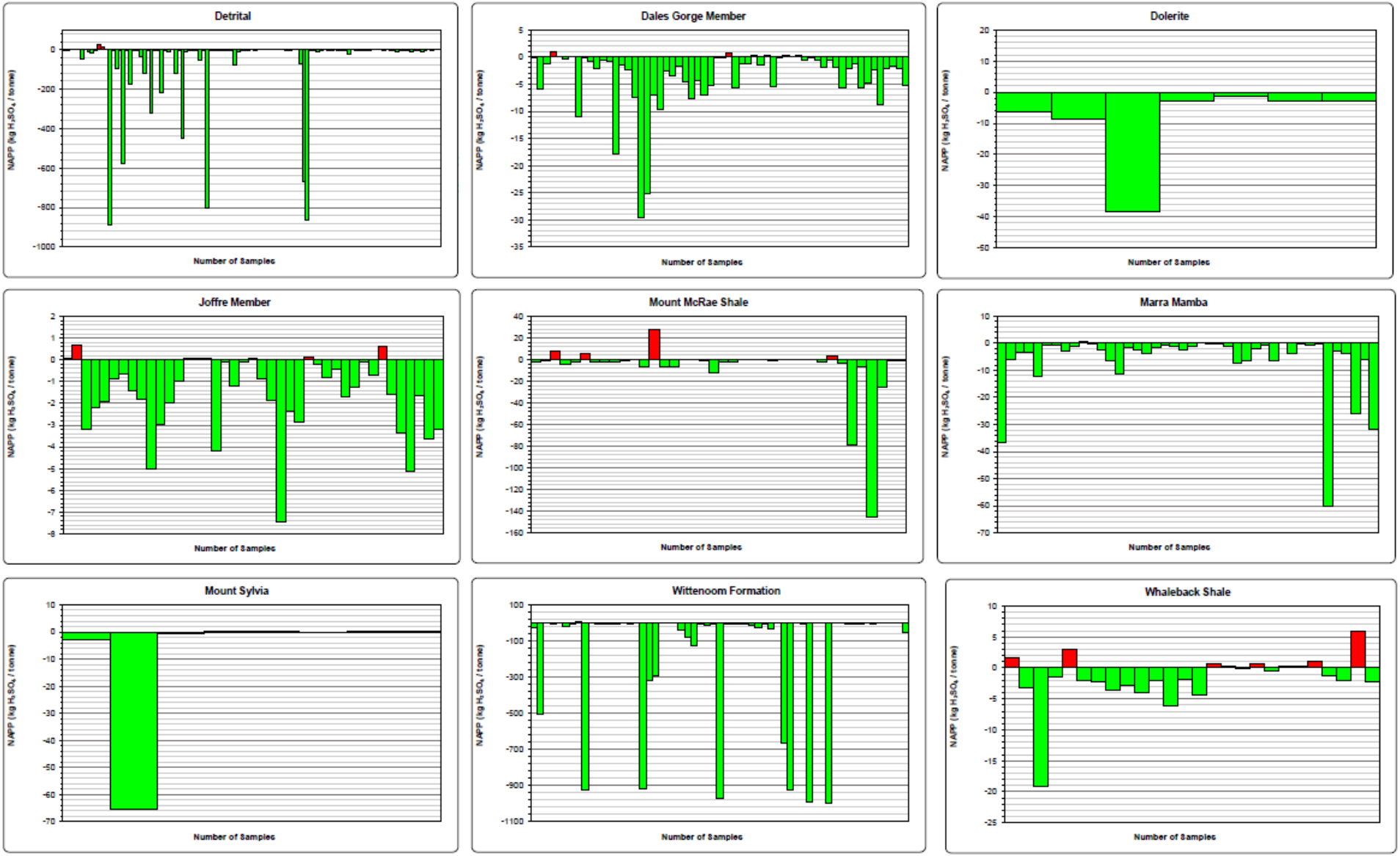
The NAPP is the balance between the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC). The calculated NAPP values for all the waste rock samples range from -996 to +27.7 kg H_2SO_4/t and are provided in **Graph 3-11** and **Graph 3-12** according to lithology and stratigraphy type, respectively. A summary of the number of samples with a positive NAPP according to stratigraphy and lithology type are shown in **Table 3-2.** High positive NAPP values (NAPP > +10 kg H_2SO_4/t) are generally associated with Mount McRae Shale and Detrital samples (**Table 3-2**), while marginally positive NAPP values (i.e. 0 < NAPP < +10 kg H_2SO_4/t) are associated in a variety of stratigraphy with higher sample numbers contained in Whaleback Shale, Dales Gorge Member, Joffre Member and Mount McRae Shale samples. Dolomite and shale lithology types associated with the Wittenoom Formation and a few samples from Detrital (calcrete, limonite, pisolite and detrital waste) and McRae Shale have much higher acid neutralising capacity and hence, lower NAPP values which were generally < -100 kg H_2SO_4/t.

Table 3-2 Number of samples for positive NAPP values (>0 kg H_2SO_4/t) across lithology types

Stratigraphy	Number of samples when NAPP > 0 kg H_2SO_4/t	Number of samples when NAPP > +10 kg H_2SO_4/t	Lithology type (NAPP > +10 kg H_2SO_4/t)
Detrital	7	2	Lignite (1), Silcrete (2), High Grade Red Ochre (1), Detrital Waste (2) and Low Grade Detrital (3)
Dales Gorge Member	8	-	Low Grade Aluminous (2), Hydrated (1), Shale (1) and Banded Iron Formation (4)
Joffre Member	8	-	Banded Iron Formation (6), High Grade High Phosphorus (1), Low Grade Siliceous (1)
Mount McRae Shale	8	1	Shale (6) and Banded Iron Formation (2)
Marra Mamba	3	-	Banded Iron Formation (3)
Mount Sylvia	4	-	Shale (4)
Wittenoom Formation	1	-	Shale (1)
Whaleback Shale	9	-	Low Grade Aluminous (1), Banded Iron Formation (1) and Shale (7)



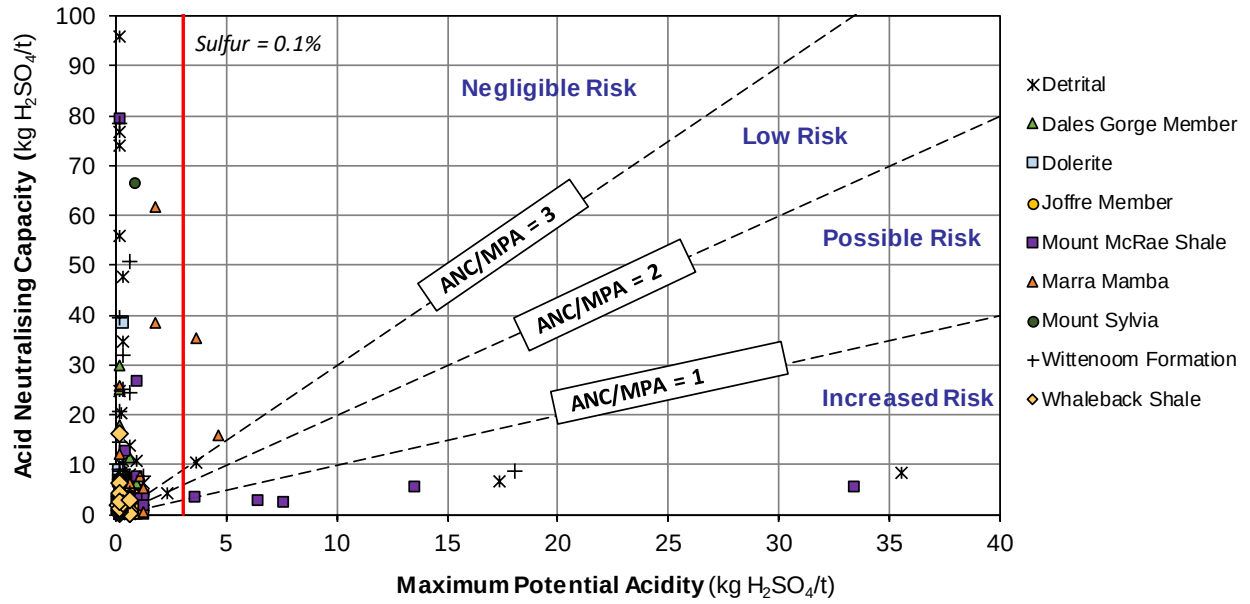
Graph 3-12 NAPP values according to stratigraphy



3.1.8 Net Potential Ratio (NPR)

The ANC:MPA ratio, referred to as the Net Potential Ratio (NPR), of the waste rock samples ranges from 0.02 to 6,504, with a median and mean value of 9.7 and 240, respectively (NPR higher than 100 are not shown in **Graph 3-13**). Generally, those samples with an NPR of greater than 2 or sulfur content <0.1% are considered to represent material with a low to negligible risk of generating additional acidity and generally have a high factor of safety in terms of potential for AMD (COA, 2016; INAP, 2009). There are 349 samples within this category from a variety of stratigraphy and lithological units, while shale from Mount McRae Shale and Wittenoom Formation and Lignite, Silcrete and Detritals from Detrital units fall within the 'increased risk' category with NPR of < 1.

Graph 3-13 Net Potential Ratio according to stratigraphy

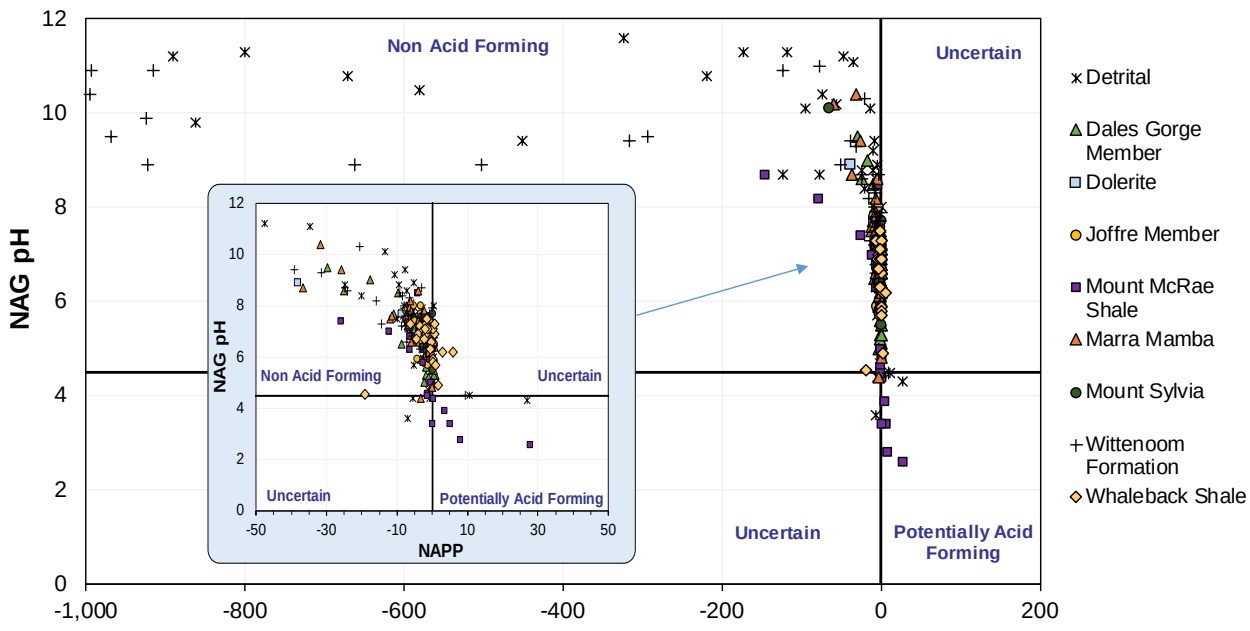


3.1.9 Net Acid Generation (NAG)

Of the 390 samples, 15 samples had NAG pH < 4.5; these were in the Mount McRae Shale (n=7), Detrital (n=5) and Wittenoom Formation (n=1).

The samples were also classified according to the AMIRA (2002) classification system (NAG pH versus NAPP) and are displayed in **Graph 3-14**. The classification indicates the waste rock samples from the GBO typically fall within the 'non-acid forming' quadrant (336 samples), with only 8 samples falling within the 'potentially-acid forming' quadrant and 46 samples being classified as 'uncertain' though largely falling on the border of 'non-acid forming' and 'uncertain' quadrants. The PAF samples are associated with the Mount McRae Shale (5 samples), two samples are associated with Detrital (although only marginally PAF) and one samples from the Wittenoom Formation (again only marginally PAF). The 'uncertain' samples with a positive NAPP and neutral NAG pH are generally related to the Whaleback Shale (9 samples), Dales George Member (8 samples), Detrital (6 samples), Joffre Member (8 samples), Mount Sylvia (4 samples), Mount McRae Shale (3 samples), Marra Mamba (3 samples); the uncertain classification for these samples is likely to results from an overestimation of NAPP using total sulfur values since these samples typically have a total sulfur value < 0.1% (and thus did not warrant sulfur speciation tests). The uncertain samples with a negative NAPP and acidic NAG pH are mostly borderline, and could result due to (amongst other reasons) an overestimation of readily available ANC.

Graph 3-14 NAG pH vs NAPP according to stratigraphy tigraphies



3.1.10 Geochemical Classification

The data in **Table 3-3** provide the criteria used by RGS to classify the AMD potential of the samples into five waste classes, and the number of samples in each AMD class. The results verify that 94 % of the 390 samples are NAF-Barren, < 2% samples are classified as NAF, < 3% samples are classified as Uncertain, < 1% samples are classified as PAF-low capacity and < 1% sample are classified as Acid Forming (AF). Complete results are provided in **Table B1 (Attachment B)**.

Table 3-3 Geochemical classification criteria for waste rock materials according to stratigraphy

Geochemical Classification (stratigraphy)	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	NPR	No. of Samples (%)
Non-Acid Forming (Barren)				
Detrital	≤ 0.1	-	-	100 (92%)
Dales Gorge Member	≤ 0.1	-	-	60 (100%)
Dolerite	≤ 0.1	-	-	7 (100%)
Joffre Member	≤ 0.1	-	-	41 (100%)
Mount McRae Shale	≤ 0.1	-	-	20 (53%)
Marra Mamba	≤ 0.1	-	-	39 (93%)
Mount Sylvia	≤ 0.1	-	-	8 (100%)
Wittenoom Formation	≤ 0.1	-	-	58 (98%)
Whaleback Shale	≤ 0.1	-	-	23 (88%)
Non-Acid Forming				
Detrital	> 0.1	≤ -5	≥ 2	4 (3.5%)
Mount McRae Shale	> 0.1	≤ -5	≥ 2	1 (2.5%)
Marra Mamba	> 0.1	≤ -5	≥ 2	2 (5%)
Uncertain[2]				

Geochemical Classification (stratigraphy)	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	NPR	No. of Samples (%)
Detrital	> 0.1	> -5 to ≤ +5	< 2	3 (3%)
Mount McRae Shale	> 0.1	> -5 to ≤ +5	< 2	5 (13%)
Marra Mamba	> 0.1	> -5 to ≤ +5	< 2	1 (2.5%)
Whaleback Shale	> 0.1	> -5 to ≤ +5	< 2	2 (7.5%)
Potentially Acid Forming – Low Capacity				
Mount McRae Shale	> 0.1	> 5 to ≤ 10	< 2	1 (2.5%)
Wittenoom Formation	> 0.1	> 5 to ≤ 10	< 2	2 (2%)
Whaleback Shale	> 0.1	> 5 to ≤ 10	< 2	1 (4%)
Acid Forming				
Detrital	> 0.1	> 10	< 2	2 (2%)
Mount McRae Shale	> 0.1	> 10	< 2	1 (2.5%)

Notes:

1. If total sulfur is ≤ 0.1 %, NAPP and ANC:MPA ratio are not required for material classification as sample is essentially barren of sulfur.
2. Samples that fall outside the stated classification categories based on the criteria provided are classified as Uncertain.

3.2 Mineralogy

The results of X-ray diffraction (XRD) analysis for 40 samples are in **Graph 3-15** below. The semi-quantitative XRD method is detailed in **Attachment A** and full results are in **Attachment D**.

The results are similar for major mineral constituents for a particular stratigraphic unit (**Graph 3-15**). The majority of samples are dominated by the presence of quartz, iron (oxy)hydroxides (goethite > hematite > magnetite) and kaolinite (e.g. Dales Gorge Member, Dolerite, Joffre Member, Mount McRae Shale, Mount Sylvia and Whaleback Shale). Some samples are also dominated by dolomite/ ankerite and calcite (Wittenoom Formation and calcrete Detrital). Less prevalent minerals include (at times) muscovite, montmorillonite, siderite, with lesser gibbsite, alunite, stilpnomelane, opaline (silica) and trace quantities of pyrite, microcline, illite, gypsum, albite and talc.

The primary acid forming mineral present in some samples is represented as pyrite (up to 1.9 wt.%). The presence of pyrite generally corresponds with the samples classified as PAF (**Section 3.1.10**). Gypsum ($CaSO_4.2H_2O$), a secondary mineral precipitate formed due to the oxidation of sulfides (namely pyrite), is present (up to 0.8 wt.%) in trace quantities in some samples.

Calcium and magnesium carbonates are commonly the most effective acid neutralising minerals (e.g. calcite and dolomite); calcite (up to 91 wt.%) and dolomite/ ankerite (up to 94 wt.%) were detected in some samples, generally associated with Detrital (calcrete lithology) and Wittenoom Formation (Dolomite lithology). The acid neutralising capacity of ankerite is associated with the CaO component and is thus less than that of pure dolomite (cnf. ANC of approximately 630 kg H_2SO_4/t for ankerite vs ANC of approximately 1,060 kg H_2SO_4/t for dolomite). The lower ANC associated with ankerite compared to dolomite is due to the production of acidity through release and subsequent hydroxylation of Fe and Mn during dissolution.

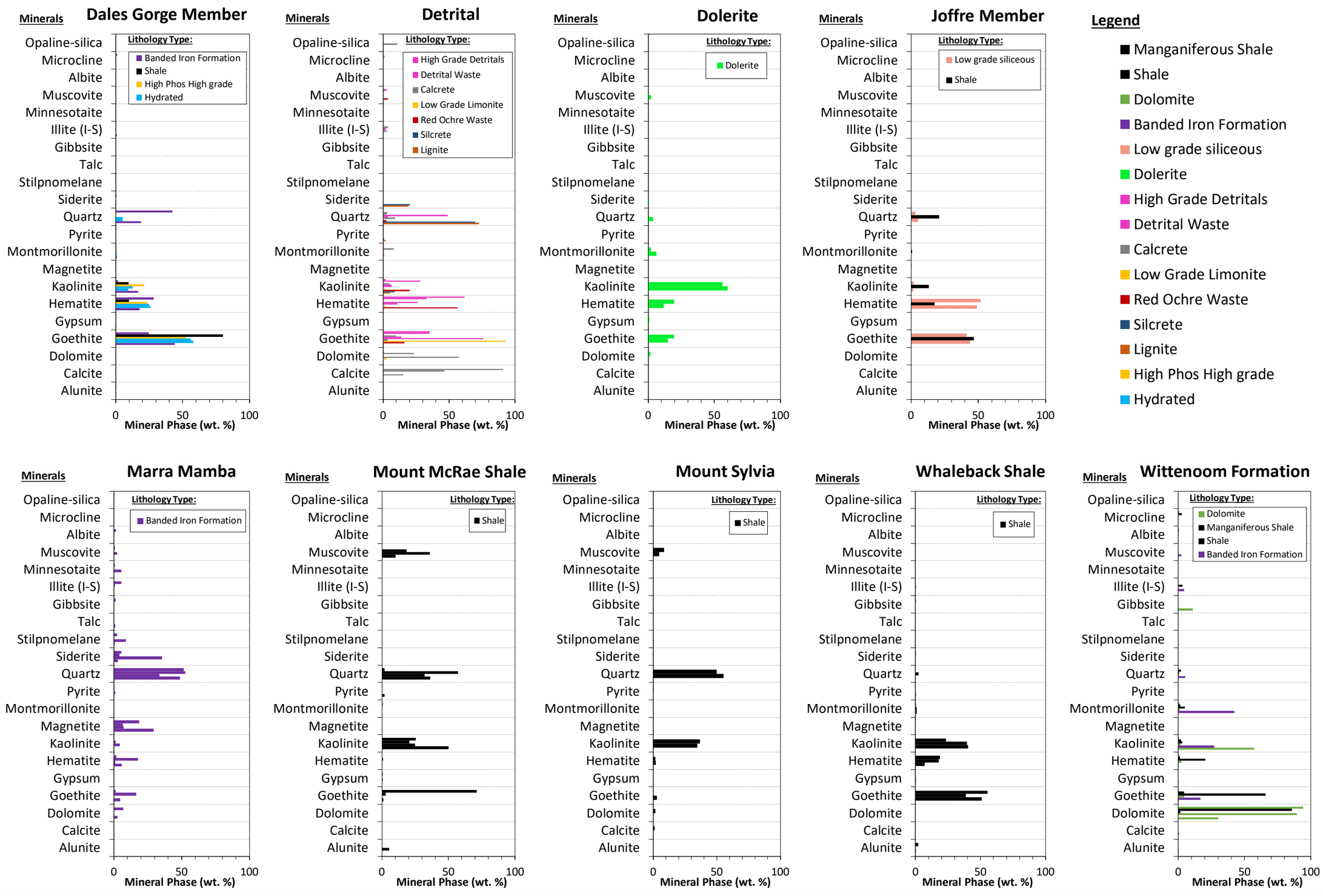
The XRD results indicated the presence of siderite ($FeCO_3$) in samples from the Marra Mamba Formation and Detrial (up to 36 wt.% and 20 wt.%, respectively); siderite has limited or negligible capacity to neutralise acidity due to acid producing reactions resulting from the oxidation of Fe^{2+} to Fe^{3+} and subsequent hydrolysis.

The neutralisation potential of most silicate minerals is minimal (e.g. quartz and muscovite). In addition, it is generally recognised that the availability of ANC from silicates is limited due to their very slow reaction and dissolution rates. Similarly, ANC from silicate only becomes available after/if acidification has occurred (i.e. silicates are soluble under acidic conditions); this is particularly evident in the ABCC results (**Section 3.3**).

A large portion of the samples was composed of clays (montmorillonite and kaolinite) and clay minerals (iron/aluminium (oxy)hydroxides: goethite, hematite and gibbsite). Clays and clay minerals have a high capacity for cation exchange, adsorption/desorption and/or structural incorporation (isomorphous substitution) of trace elements and may therefore affect leaching kinetics of the waste rock materials. This was supported by the broad peaks of the XRD patterns which generally indicate moderate to poor crystallinity or very fine particle sizes for the clays and iron (oxy)hydroxides. Similarly, the slight peak shifts indicate that some minerals are likely to contain adsorbed or structurally incorporated impurities.

It needs to be highlighted that minerals below ~1 wt.% and amorphous phases may not be accurately identified using XRD; therefore, trace minerals, which may be present within the sample, are not detected. The XRD patterns do not indicate significant non-diffracting/ amorphous components; however, the three samples ITV838 and IVN891 (Mount McRae Shale) and IVN449 (Mount Sylvia) clearly contain amorphous carbon in minor to trace quantities. A broad swell on the pattern from ITV767 (Calcrete from Detrital) at ~25°2Θ is likely due to opaline silica.

Graph 3-15 XRD mineral phase distribution by stratigraphy and lithology



3.3 Acid Buffering Characteristic Curves (ABCC)

The ABCC results for 60 samples are plotted in **Graph 3-16** with summary statistics of the ABCC at pH 4.5 and measured total ANC in **Table 3-4** and **Graph 3-17.**

The ABCC results are summarised in the following points.

- Some samples from within the same stratigraphic units have highly variable ABBC's (e.g. Detrital and Wittenoom Formation stratigraphic units); this typically reflects the lithology type, for example, Detrital with calcrete (i.e. calcite) compared to Detrital with limonite.
- Samples associated with the Wittenoom Formation and some Detrital (calcrete) show moderate to high available ANC.
- The samples with high available ANC correspond well with the XRD results which indicate the presence of dolomite and/ or calcite.
- Most samples associated with the Whaleback Shale, Mount McRae Shale and Joffre Member (including some other samples from other stratigraphy's) have very low available ANC meaning they have limited or negligible capacity to buffer against acid generated due to sulfide oxidation.
- **Table 3-4** reports the percentage of available ANC (from the ABCC at ~pH 4.5) relative to measured ANC. The general results indicate that the majority of measured ANC is readily available to buffer acid produced by sulfide oxidation; this is particularly evident for samples associated with the stratigraphic units: Detrital (average = 94%) and Wittenoom Formation (average = 93%). On the contrary, samples associated with the Dales Gorge Member and Dolerite contain less readily available ANC (average < 65%) compared to the measured ANC value.
- The difference in measured ANC compare to ABCC for some samples is likely related to surface-inhibition (e.g. surface coating of carbonate minerals) or kinetic-inhibition (i.e. slow reactivity of carbonate minerals).
- As mentioned above, the minerals responsible for sustained acid buffering levels around pH 5.5 to 7 is predominantly due to calcite and dolomite (**Table 3-5**, and XRD results).
- Samples that show sustained acid buffering around pH 3 are due to the presence of iron (oxy)hydroxides (goethite and hematite; **Table 3-5** and XRD results).

Table 3-4 Summary statistics and comparison of measured ANC and ABCC ANC (at ~pH 4.5)

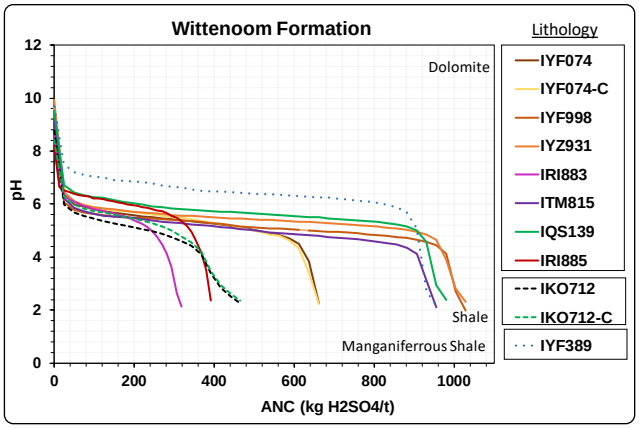
Summary Statistics	ABCC ANC at ~pH 4.5 (kg H_2SO_4/t)					Measured ANC (From Table 3-1) (kg H_2SO_4/t)					Average ANC Available (%)
	Min	Max	Median	Ave	P95	Min	Max	Median	Ave	P95	
Detrital	66.2	857	208	336	838	0.9	891	5.7	59	438	94%
Dales Gorge Member	2	22	6.6	9.1	21	0.5	30	2.6	5.1	16	59%
Dolerite	3.2	27	3.7	8.2	22	2.2	39	3	9.3	30	63%
Joffre Member	0.7	7.6	3.9	4.1	7.4	0.6	7.7	2	2.5	5.3	74%
Mount McRae Shale	1.2	152	5.6	14	51	0.7	146	3.1	11	53	79%
Marra Mamba	13.2	51	17	22	49	0.7	62	3	7.8	36	86%
Mount Sylvia	1.2	59	59	40	59	0.2	66	0.5	9	44	87%
Wittenoom Formation	2.9	955	355	472	953	1	996	7.2	139	931	93%
Whaleback Shale	1.2	16	2.9	4.4	12	0.5	19	2.2	3.1	6.3	73%

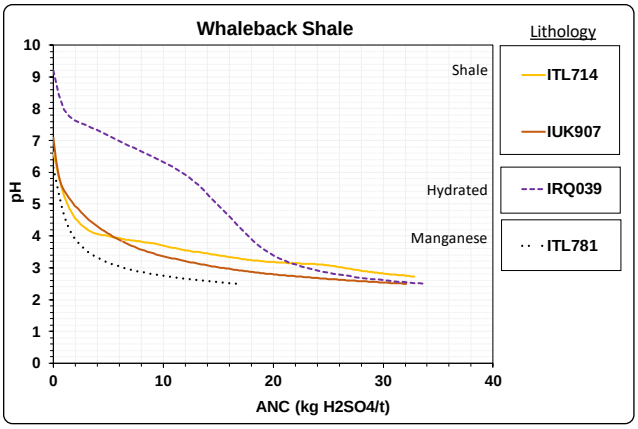
Table 3-5 shows the common pH ranges defined by key mineral pH buffers (after Blowes et al. 1994).

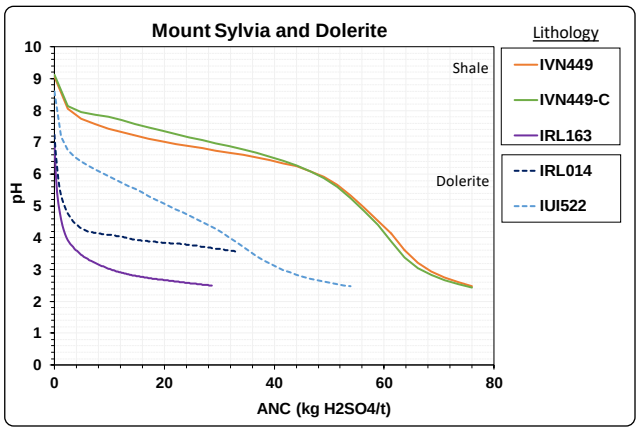
Table 3-5 pH range of common acid neutralising minerals in mine waste rock

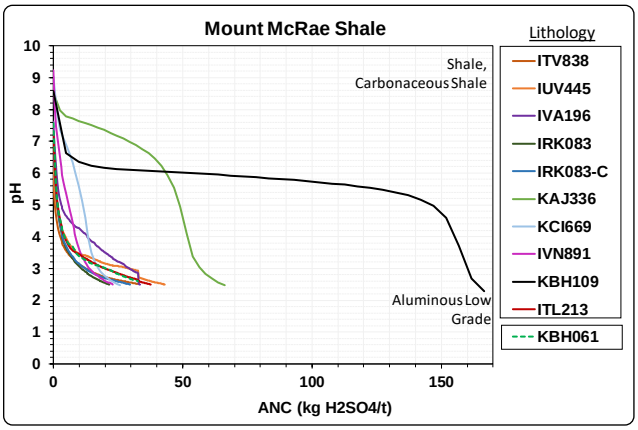
Mineral Phase	pH Range
Calcite	5.5 – 6.9
Dolomite	5.3 – 6.8
Siderite	5.1 – 6.0
Gibbsite	3.7 – 4.3
Goethite	3.0 – 3.7
Aluminosilicates	4.0 – 4.3
Iron Oxides	2.5 – 3.5

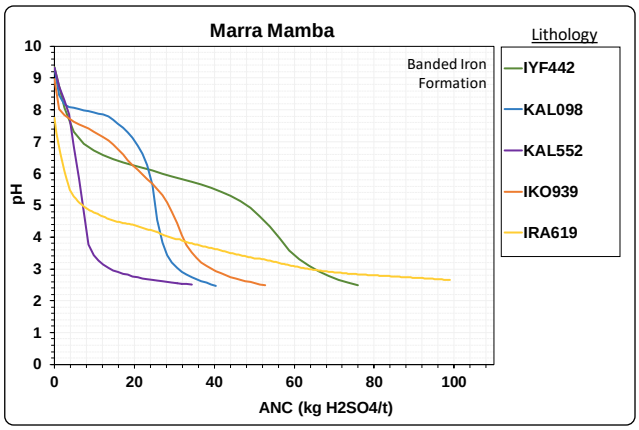
Graph 3-16 ABCC Graphs according to Rio Tinto Brockman stratigraphy

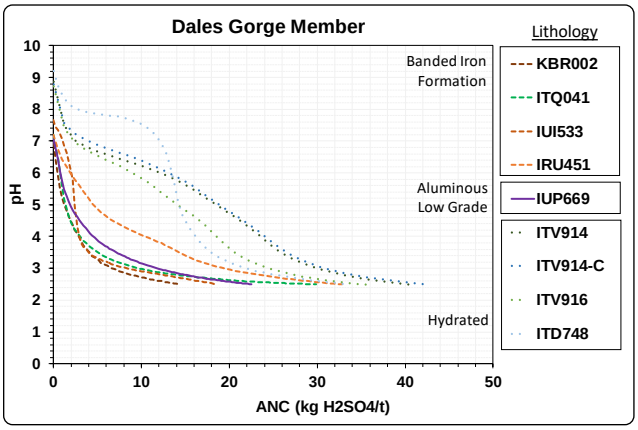


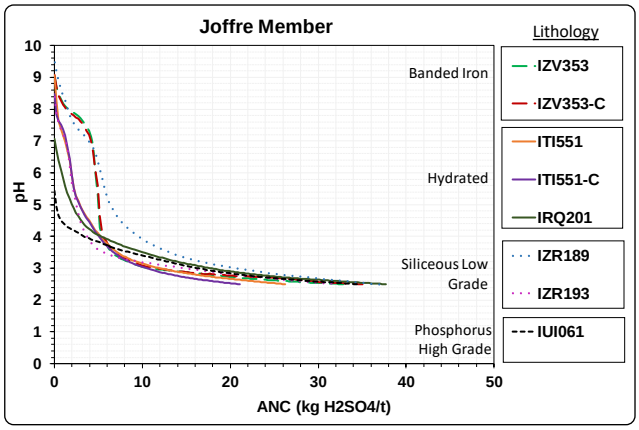


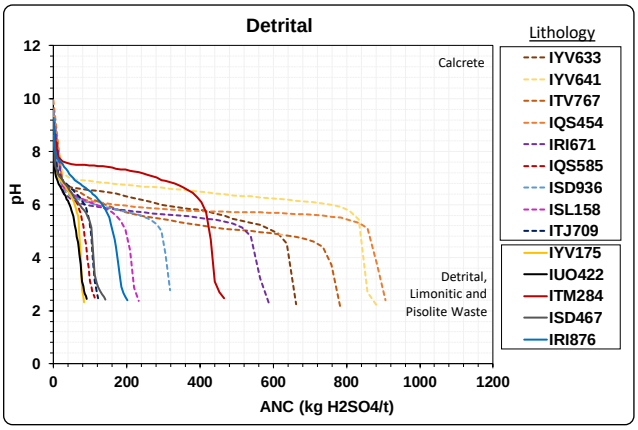




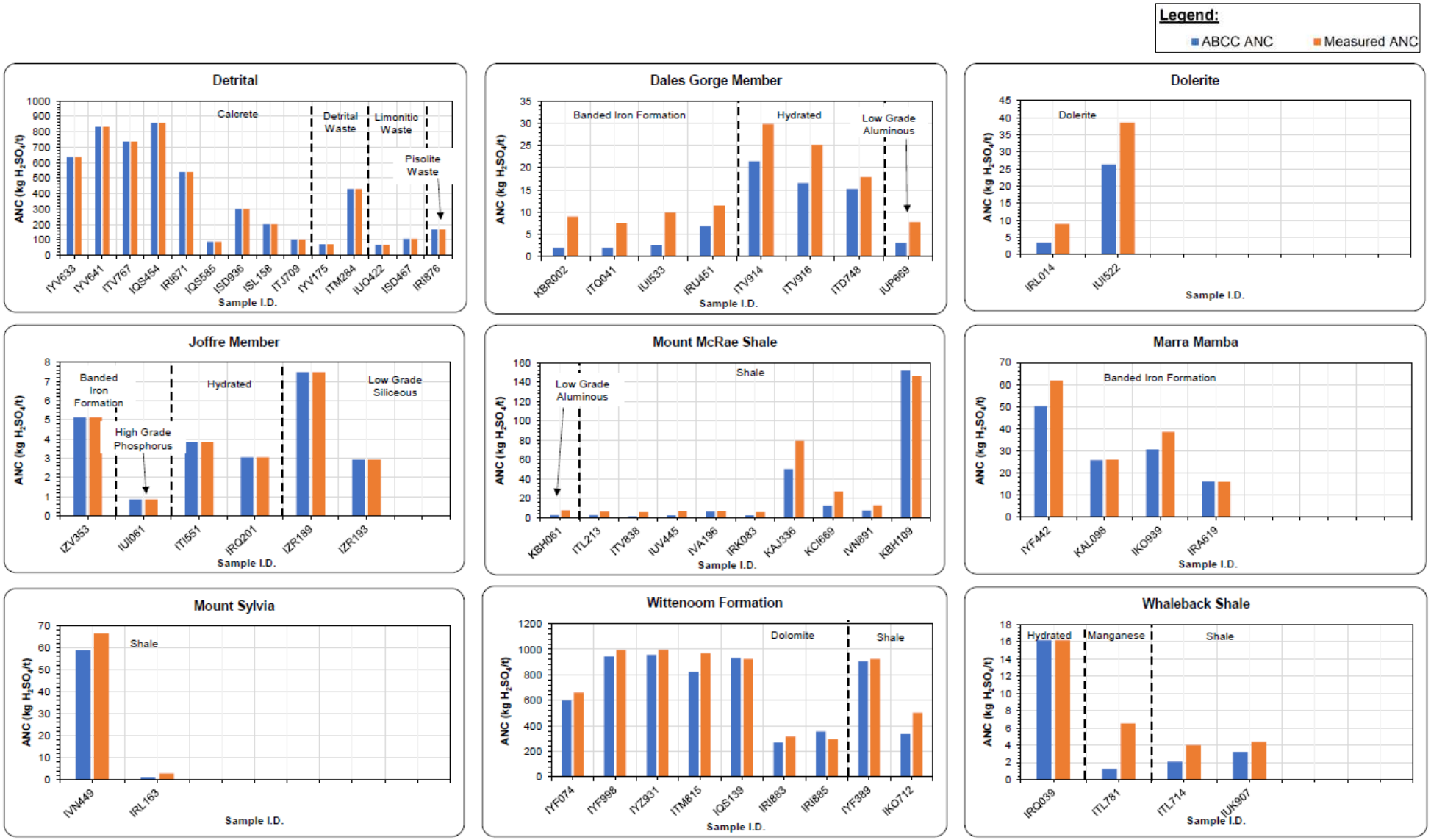








Graph 3-17 Comparison between measured ANC and ABCC ANC at pH 4.5



3.4 Whole Rock Multi-Element Concentration in Solids

A 4-acid and Aqua Regia digestion method and analysis by ICP-MS and FIMS was used to quantify the mass of the major, minor, and trace elements in the samples. The results were compared to potentially relevant guideline criteria to determine any concerns related to mine operation and final rehabilitation. There are no specific guidelines and/or regulatory criteria in WA specifically related to total metal/metalloid concentrations in waste rock. In the absence of these and to provide relevant context, RGS has compared the total metal concentration in samples (solids) to National Environmental Protection Council health-based investigation levels (HIL(C)) for open spaces (NEPC, 2013). The applicability of the NEPC guidelines for 'open spaces' results from the likely final land use of the mine following closure (e.g. a return to low intensity livestock grazing and ecological values). The total metals/metalloids concentration for individual elements in mine materials can be relevant for revegetation activities and/or where the potential exists for human contact (e.g. if the material was to be used off-site).

The results from multi-element testing of 390 samples are presented in **Table B2 (Attachment B).**

The GBO waste rock materials typically have low total metal/metalloid concentrations in solids, some below the laboratory limit of reporting (LoR), and most below the applied NEPC (HIL(C)) guideline for soils. A summary of the metals/metalloids above NEPC (HIL(C)) guidelines is in **Table 3-6;** nine samples for arsenic (As), eight samples for chromium (Cr) and six samples for manganese (Mn) were above the NEPC (HIL(C)) guideline for soils. The majority of arsenic above NEPC (HIL(C)) values are derived from Detrital followed by shale from Wittenoom Formation. Chromium samples above guidelines are derived mainly from shale and manganiferrous shale from Wittenoom Formation, followed by a variety of lithology types such as dolerite, low grade aluminous, BIF and hydrated waste. Manganese exceedances were associated more with Detrital (Detrital waste or silcrete), followed by manganiferrous shale and BIF in Wittenoom Formation and Mount McRae Shale.

Table 3-6 Summary of elements above NEPC (HIL(C)) Guidelines

Stratigraphy	Elements above NEPC (HIL(C)) Guidelines		
	Arsenic	Chromium	Manganese
Number of Samples > NEPC (HIL(C))	9	8	8
Detrital	Red Ochre Waste, Calcrete, Detrital Waste, Hydrated Waste	Hydrated Waste	Detrital Waste, Detrital Waste, Silcrete
Wittenoom Formation	Shale	Shale, Manganiferrous Shale, Carbonaceous Shale	Banded Iron Formation, Shale, Manganiferrous Shale
Marra Mamba	Banded Iron Formation	Banded Iron Formation	
Joffre Member	Banded Iron Formation	Banded Iron Formation	
Dolerite		Dolerite	
Mount McRae Shale		Low Grade-Aluminous	Banded Iron Formation

All sample compositions are dominated by varying quantities of iron (Fe), calcium (Ca), Magnesium (Mg), aluminium (Al), potassium (K), sodium (Na) and manganese (Mn).

3.5 Geochemical Abundance Index

Total metal/metalloid concentrations in waste rock materials can be compared to median crustal abundance for unmineralised soils (Bowen, 1979, INAP, 2009). The extent of enrichment is reported as the Geochemical Abundance Index (GAI), which relates the actual concentration in a sample with the median (or average) crustal abundance on a $\log_{10}$ scale. GAI is expressed in integer increments from 0 to 6, where a GAI value of 0 indicates that the element is present at a concentration less than, or similar to, the median crustal abundance; and a GAI value of 6 indicates approximately a 100-fold enrichment above median crustal abundance (**Table 3-7).** As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination.

Metals/metalloids identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. The GAI only provides an indication of metals/metalloids that may be enriched relative to the global average crustal abundance[3] , some points to consider:

- The median crustal abundance varies between different literature sources (at times order of magnitude), therefore affecting the calculated GAI values.
- If a sample is shown to be enriched relative to the average crustal abundance, there is no direct correlation that the sample will also leach metals/metalloids at elevated concentrations. The mobility of metals/metalloids is dependent on mineralogy, adsorption/desorption and the chemical environment in which it occurs (e.g. pH and redox).
- Although there are a number of metals/metalloids elevated relative to the median crustal abundance, the nature of an ore deposit means the background levels are always expected to be elevated. For instance, Tellurium is found to be naturally occurring at higher GAI factors from volcaniclastic sandstone in the Pilbara Region

Similarly, because metals/metalloids is not enriched does not mean it will never be a concern, because under some conditions (e.g. low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

The GAI for the 390 waste rock samples is presented in **Table B3 (Attachment B).** A summary of the GAI values according to stratigraphy and lithology are provided in **Table 3-8** and **Table 3-9**, respectively.

The GAI results indicate that of the meatal(loid)s measured, Fe, As and Te are highly enriched compared to average crustal abundance in the majority of samples from each of the stratigraphic units (excluding As and Te in Dolerite, and Te in Mount Sylvia). Furthermore, Ca, Mg, Mn and Se are at times enriched in Detrital; Mg, Mn, Hg, Se and Tl are at times enriched in the Wittenoom Formation; Mn is at times enriched in the Mount McRae Shale; and, Se is at times enriched in the Dales Gorge and Joffre Member.

The potential solubility of these and other metals/metalloids is investigated further through the use of static leach tests (**Section 3.6**).

Table 3-7 Geochemical Abundance Index (GAI) values and enrichment factors

GAI	Enrichment factor	GAI	Enrichment factor
0	Less than 3-fold enrichment	4	24 – 48 fold enrichment
1	3 – 6 fold enrichment	5	48 – 96 fold enrichment
2	6 – 12 fold enrichment	6	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

[3] Average crustal abundance values were sourced from the "GARD Guide", Chapter 5 (INAP, 2009) and where values were not available, they were taken from Bowen (1978).

Table 3-8 GAI Values above Enrichment Factor of 3 by stratigraphy

Elements by Stratigraphy (GAI > 3)	Major Elements				Minor Elements															
	Sulfur (S)	Calcium (Ca)	Iron (Fe)	Magnesium (Mg)	Arsenic (As)	Bismuth (Bi)	Boron (B)	Chromium (Cr)	Cobalt (Co)	Fluorine (F)	Lanthanum (La)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Rhenium (Re)	Selenium (Se)	Silver (Ag)	Tellurium (Te)	Thallium (Tl)	Vanadium (V)
Whaleback Shale	0	1	13	0	6	1	0	1	1	0	0	2	0	0	0	0	0	10	1	0
Wittenoom Formation	0	2	29	5	16	1	2	1	1	1	1	4	4	0	1	5	2	30	3	0
Detrital	1	3	65	3	31	2	1	0	1	2	0	3	1	0	0	6	0	49	1	1
Mount McRae Shale	0	0	19	0	7	1	0	0	0	0	0	3	0	0	0	1	0	17	0	0
Dales Gorge Member	0	1	34	1	13	2	1	0	1	0	0	1	0	1	0	5	0	33	0	0
Joffre Member	1	2	28	1	15	1	1	1	0	1	0	1	1	0	1	4	1	24	1	0
Dolerite	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Mount Sylvia	0	0	5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Marra Mamba	0	1	25	1	13	2	1	0	1	1	0	0	1	0	1	1	0	26	2	0
TOTAL (GAI > 3)	**2**	**10**	**222**	**11**	**104**	**10**	**6**	**3**	**5**	**5**	**1**	**14**	**7**	**1**	**3**	**22**	**3**	**193**	**8**	**1**

Table 3-9 GAI Values above Enrichment Factor of 3 by lithology

Lithology Group	Elements by Lithology (GAI > 3)	Major Elements				Minor Elements															
		Sulfur (S)	Calcium (Ca)	Iron (Fe)	Magnesium (Mg)	Arsenic (As)	Bismuth (Bi)	Boron (B)	Chromium (Cr)	Cobalt (Co)	Fluorine (F)	Lanthanum (La)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Rhenium (Re)	Selenium (Se)	Silver (Ag)	Tellurium (Te)	Thallium (Tl)	Vanadium (V)
Siliceous	Siliceous - Low grade	0	0	13	0	4	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0
Silcrete	Silcrete	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Shale	Shale- Manganiferrous	0	0	4	0	1	0	0	0	0	0	0	1	0	0	0	0	0	4	1	0
	Shale - Cherty	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
	Shale - Carbonaceous	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Shale	0	1	54	1	23	2	0	1	1	1	1	3	4	0	1	7	1	48	1	0
Red Ochre	Red Ochre Waste	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
	Red Ochre High Grade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red Ochre Detrital - Low Grade	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisolite	Pisolite Waste	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pisolite - Low Grade	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	Manganese	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limonite	Limonitic Waste	0	0	2	0	0	0	0	0	1	0	0	1	0	0	0	1	0	2	0	0
	Limonite - Low Grade	0	0	7	0	3	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0
Lignite	Lignite	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hydrated	Hydrated Waste	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Hydrated	0	0	10	0	2	1	0	0	0	0	0	1	0	0	0	0	0	9	0	0
Mixed – High Grade	High grade - High Phos	0	0	7	0	2	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0
	High Grade	0	0	6	0	4	2	0	0	0	1	0	0	1	0	0	0	0	7	1	0
Dolomite	Dolomite	0	2	3	3	5	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0
Dolerite	Dolerite	0	0	4	0	2	0	1	1	0	0	0	0	0	0	0	0	0	4	0	0
Detrital	Detritals - High Grade	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Detrital Waste	0	3	29	1	15	0	0	0	1	0	0	2	0	0	0	1	0	22	1	0
	Detrital - Low Grade	0	0	14	0	5	1	0	0	0	0	0	0	0	0	0	1	0	10	1	0
Clay	Clay	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chert	Chert	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcrete	Calcrete	0	1	4	2	4	1	0	0	0	1	0	0	0	0	0	1	0	6	0	0
Ferrous	Banded Iron Formation	1	4	46	4	24	3	5	1	2	2	0	3	2	1	2	8	2	47	3	1
Aluminous	Aluminous - Low Grade	0	0	10	0	5	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0
TOTAL (GAI > 3)		**2**	**11**	**224**	**11**	**105**	**10**	**6**	**3**	**5**	**5**	**1**	**14**	**7**	**1**	**3**	**22**	**3**	**196**	**8**	**1**

3.6 Water Quality of Leachates

There are no specific regulatory criteria for metal/metalloid concentrations in leachate from waste materials on mine sites in Western Australia. As such, RGS has compared the multi-element results in water extracts from 145 drill hole samples from the GBO, described in **Section 3.4,** with Australian guidelines for livestock drinking water and aquatic freshwater ecosystems (ANZECC & ARMCANZ, 2000). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge, or to indicate probable water quality likely to occur at a site.

It should be recognised that direct comparison of geochemical data with guideline values can be misleading. For the purpose of this study, guideline values are only provided for broad context and should not be interpreted as arbitrary 'maximum' values or 'trigger' values. Using sample pulps (ground to passing 75 µm) provides a very high surface area to solution ratio, which encourages mineral reaction and dissolution of the solid phase. As such, the results of screening tests on water extract solutions are assumed to represent an assumed 'worst case' scenario for initial surface runoff and seepage from spoil materials.

The results from multi-element testing of water extracts (1:2 sample:water) from 145 mine waste rock samples are presented in **Table B4 (Attachment B)** and summarised in **Table 3-10**. The water extracts have a pH range from pH 4.2 (mildly acidic) to 9.4 (alkaline) (mean and median = 5.9 and 7.6 respectively) and is typically within the pH range (pH 6 to 9) for 95 % species protection in freshwater aquatic ecosystems (ANZECC & ARMCANZ, 2000). There are, however, 3 samples with a pH less than 6 (Dolomite from Wittenoom Formation and Mount McRae Shale) and 10 samples with a pH greater than 9 (distributed in the stratigraphy layers). The water extracts generally have low to moderate EC values ranging from 91 to 2,610 µS/cm (median 369 µS/cm) indicating low to moderate salinity (and low to moderate concentrations of dissolved solids).

The total alkalinity in the water extracts ranges from low to moderate (2 to 263 mg $CaCO_3$) /L) and has a median value of 68 mg $CaCO_3$/L. The majority of the alkalinity is in the form of bicarbonate (HCO_3^-) with lesser carbonate (CO_3^{2-}) alkalinity in the samples. Most water extracts have a <1 mg $CaCO_3$/L acidity, excluding those samples that reported acidic pH values.

The concentration of major ions in the water extracts is generally low compared with Australian guidelines for livestock drinking water and aquatic freshwater ecosystems (ANZECC & ARMCANZ, 2000), with the dominant major ions being bicarbonate, sulfate, calcium, magnesium and sodium. The concentration of soluble sulfate in the water extracts ranges from 2 to 1,490 mg/L (median 33 mg/L) with all samples (except one Detrital sample with a neutral pH) below the ANZECC & ARMCANZ, 2000 sulfate water quality guideline criterion of 1,000 mg/L for livestock drinking water. The more elevated leached sulfate concentrations are generally associated with the acidic pH samples.

The concentration of trace metals/metalloids tested in the water extracts is predominantly below the laboratory LoR. Most metal/metalloid concentrations tested in the water extracts are below the applied water quality guideline criteria. **Table 3-10** summarises the number of samples that are above the recommended aquatic freshwater ecosystem guideline limit and recommended livestock drinking water guideline limit. There were only a few samples that showed leached metal/metalloid concentrations above the applied livestock drinking water guidelines; this included selenium, boron and arsenic from the Mount McRae Shale; and, selenium from Detrital and Wittenoom Formation.

Table 3-10 Summary of number of samples above ANZECC and ARMCANZ 2000 Guidelines

Elements	Aquatic Ecosystems (Freshwater)[1]	Livestock Drinking Water[2]	Amount above Aquatic Ecosystems (Freshwater)	Amount above Livestock Drinking Water
Chloride (Cl)	0.003	-	145	0
Nitrate as N	0.7	-	10	0
Aluminium (Al)	0.055	5	12	0
Arsenic (As)	0.013	0.5	3	1
Boron (B)	0.37	5	9	1
Cadmium (Cd)	0.0002	0.01	3	0
Chromium (Cr)	0.001	1	25	0
Copper (Cu)	0.001	1	41	0
Lead (Pb)	0.003	0.1	2	0
Manganese (Mn)	1.9	-	5	0
Nickel (Ni)	0.011	1	4	0
Selenium (Se)	0.011	0.02	8	5
Zinc (Zn)	0.008	-	21	0

[1,2.] Both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

4 Conclusions

RGS completed a geochemical characterisation program of 390 representative waste rock samples from the GBO (i.e. inclusive of Brockman 2, Brockman 4, Nammuldi and Silvergrass deposits). The geochemical results are summarised below.

- The majority of samples are dominated by the presence of quartz, iron (oxy)hydroxides (goethite > hematite > magnetite) and kaolinite (e.g. Dales Gorge Member, Dolerite, Joffre Member, Mount McRae Shale, Mount Sylvia and Whaleback Shale). Wittenoom Formation and Calcrete Detrital samples are dominated by dolomite/ ankerite and calcite. Less prevalent minerals include muscovite, montmorillonite, siderite, with lesser gibbsite, alunite, stilpnomelane, opaline (silica) and trace quantities of pyrite, microcline, illite, gypsum, albite and talc.
- The total sulfur content of the samples was <0.01 %S to 1.8%S, with an average value of 0.04 %S. Of the 390 samples 366 have low total sulfur concentrations that are comparable to the average crustal abundance for sulfur of 0.1 % (INAP, 2009). Materials with a sulfur content less than or equal to 0.1 %S are essentially barren of sulfur and have negligible capacity to generate acidity.
- There are barren samples associated with each of the stratigraphic units, and this suggests that there are structural controls that govern the distribution of the acid producing and consuming minerals.
- Sulfur speciation tests using the chromium reducible sulfur method verify that ~63 to 100% of the total sulfur is present as sulfide sulfur in samples with a total sulfur content >0.5 %S. A 1:1 (total sulfur: sulfide sulfur) relationship is more evident for the Mount McRae Shale and the Marra Mamba Formation.
- Samples with higher ANC are generally associated with the Wittenoom Formation (Dolomite lithology) (mean = 139.6 H_2SO_4/t) and Detrital (Calcrete lithology) (mean = 58.8 kg H_2SO_4/t). The corresponding ABCC results indicate that the majority of measured ANC is readily available to buffer acidification; this is particularly evident for samples associated with Detrital (average = 94% available) and Wittenoom Formation (average = 93 % available). These samples correspond well with the presence of dolomite and/ or calcite in the XRD results.
- The other stratigraphic units have mean measured ANC values of <11.5 kg H_2SO_4/t. The Joffre Member (mean = 2.5 kg H_2SO_4/t) and Whaleback Shale (mean = 3.1 kg H_2SO_4/t) showed the lowest average ANC values, indicating that these samples have little capacity to buffer any existing, or additional acidity generated through sulfide oxidation. The ABCC results indicate the samples associated with the Dales Gorge Member and Dolerite contain less readily available ANC (average < 65%) compared to the measured ANC value.
- The calculated NAPP values ranges from -996 to +27.7 kg H_2SO_4/t. Positive NAPP values (NAPP > +10 kg H_2SO_4/t) are generally associated with some Mount McRae Shale and Detrital samples, while marginally positive NAPP values (i.e. 0 < NAPP < +10 kg H_2SO_4/t) are present in a variety of stratigraphic units with higher sample numbers contained in Whaleback Shale, Dales Gorge Member, Joffre Member and Mount McRae Shale samples.
- The NAG pH is variable for different samples from within the same stratigraphic and lithological units; however, the vast majority of samples reported circum neutral NAG pH values. Of the 390 samples tested, only 15 samples showed acidic NAG pH values (i.e. NAG pH < 4.5); these were typically associated with the Mount McRae Shale (7 samples), Detrital (5 samples) and Wittenoom Formation (1 sample).
- Classification of the samples according to AMIRA (2002) (NAG pH versus NAPP) indicates the waste rock samples from the GBO typically fall within the 'NAF' quadrant (336 samples), with only 8 samples falling within the 'PAF' quadrant (Mount McRae Shale (5 samples), Detrital (2 samples) and Wittenoom Formation (1 sample)) and 46 samples being classified as 'uncertain' Whaleback Shale (9 samples), Dales George Member (8 samples), Detrital (6 samples), Joffre Member (8 samples), Mount Sylvia (4 samples), Mount McRae Shale (3 samples), Marra Mamba (3 samples) though largely falling on the border of 'NAF' and 'uncertain' quadrants. The uncertain classification for these samples is likely due to i) an overestimation of

NAPP using total sulfur values since these samples typically have a total sulfur value < 0.1% (and thus did not warrant sulfur speciation tests) or ii) due to an overestimation of readily available ANC.

- The RGS classification criteria are consistent with AMIRA (2002) and show that 366 samples are classified as NAF-Barren, 7 samples are classified as NAF (Marra Mamba), 11 samples are classified as Uncertain (Detrital, Mount McRae Shale, Whaleback Shale and Marra Mamba), 3 samples classified as PAF- low capacity (Whaleback Shale and Mount McRae Shale), and 3 sample are classified as AF (Detrital, Mount McRae Shale and Wittenoom Formation).
- The collective results discussed above highlight that there is a high factor of safety and generally a low potential of acid generation from these materials.
- The GBO samples typically have low total metal/metalloid concentrations. Application of the NEPC (HIL(C)) guideline for soils indicate: nine samples for As, eight samples for Cr and six samples for Mn were above the guidelines. The majority of arsenic above NEPC (HIL(C)) values are derived from Detrital followed by shale from Wittenoom Formation. Chromium samples above guidelines are derived mainly from shale and manganiferrous shale from Wittenoom Formation, followed by a variety of lithology types such as dolerite, low grade aluminous, BIF and hydrated waste. Manganese exceedances were associated more with Detrital (Detrital waste or silcrete), followed by manganiferrous shale and BIF in Wittenoom Formation and Mount McRae Shale.
- The GAI results indicate that of the metal(loid)s measured, Fe, As and Te are highly enriched compared to average crustal abundance in the majority of samples from each of the stratigraphic units (excluding As and Te in Dolerite, and Te in Mount Sylvia). Furthermore, Ca, Mg, Mn and Se are at times enriched in Detrital; Mg, Mn, Hg, Se and Tl are at times enriched in the Wittenoom Formation; Mn is at times enriched in the Mount McRae Shale; and, Se is at times enriched in the Dales Gorge and Joffre Member.
- The multi-element leach testing of water extracts (1:2 sample:water) have a pH range from pH 4.2 (acidic) to 9.4 (alkaline) with the majority of samples circum neutral (mean = 5.9). There are, however, 3 samples with a pH less than 6 (Dolomite from Wittenoom Formation and Mount McRae Shale) and 10 samples with a pH greater than 9 (distributed in the stratigraphic units). The water extracts have EC values ranging from 91 to 2,610 µS/cm (median 369 µS/cm). There were only a few samples that showed elevated leached metal/metalloid concentrations; this included selenium, boron and arsenic from the Mount McRae Shale; and, selenium from Detrital and Wittenoom Formation.

4.1 Recommendations

This geochemical assessment was undertaken to assess the potential for AMD of the waste rock materials within the GBO. While RGS consider the potential of acid generation to be low for the majority of samples analysed as part of this assessment, there are several recommendations which should be implemented in order to ascertain the potential for the materials to generate saline and metalliferous drainage. Similarly, there is a need to understand the physical properties of these materials as the bulk of the material tested could potentially be used for rehabilitation purposes. The key recommendations are provided below.

4.1.1 Laboratory Kinetic Testing Program

Kinetic tests are strongly recommended to supplement static testing already undertaken for the GBO. The kinetic tests are required to quantify estimates of lag times to the onset of acidic conditions (when this occurs), primary sulfide oxidation rates, primary neutralisation potential dissolution rates, changes in leachate chemistry and changes in long-term loading rates (i.e., kg of contaminant per tonne of material per unit time).

Common laboratory scale kinetic geochemical test work include the following:

- Free draining kinetic leach column (KLC) test work (simulating reactions in the unsaturated zone of a waste rock dump).
- Saturated kinetic leach column (KLC) test work (simulating the reactions occurring when waste rock is inundated by rebounding groundwater).
- Humidity cell (HC) test work.
- Oxygen consumption rate method (OCR).

Kinetic geochemical test work involves measurement of key parameters as a function of time to measure or infer sulfide oxidation rate. In addition, kinetic test work allow assessment of metal and metalloids release rates and provide insight into long-term water quality.

KLC tests and humidity cells infer sulfide oxidation rates based on the rate of sulfate release over time in the leachate from the sample, while oxygen consumption methods measure sulfide oxidation rates directly by monitoring trends in oxygen concentration over time. Water quality is inferred from leachate collected from the samples following irrigation / flushing over a period of time.

Field based kinetic test work are scaled up versions of those conducted in the laboratory. Irrigation of the columns under field conditions may be manual or based only on rainfall.

A short summary of laboratory based kinetic method is presented below.

Free draining KLC testwork

KCL is commonly used to assess sulfide oxidation rates and help assist with prediction of long-term water quality. The method described below is consistent with AMIRA (2002) guidelines. Leach columns are loaded with samples and subjected to cycles of wetting and drying to promote sulfide oxidation and flushing of oxidation and neutralisation products. Leachate collected from the columns is filtered and analysed for parameters of interest. The test period depends of the time required for concentrations of key parameters to stabilise, usually taking between 6-24 months.

Samples are usually crushed prior to the testwork to 4 mm grain size and 2-4 kg of material is loaded into the columns. Heat lamps are generally operated on a cyclic basis, 8-10 h per day 5 days a week, to maintain a temperature of approximately 30-35°C at the surface of the sample. Deionised water is used to irrigate and flush the materials on a weekly basis, with sample collection for water quality testing usually occurring every 4th week. Leachate chemistry and volumes are used to quantify sulfate release rate and indirectly sulfide oxidation rates. Similarly, metals and metalloids concentrations overtime are used to estimate metal loadings. Estimates of sulfide oxidation rates are based on the assumption that all sulfate generated by the oxidation of sulfate minerals is released into the leachate (no sinks) and that all sulfate is associated with sulfide oxidation (i.e. not released from sulfate phases).

RGS prefer to use an improved KLC method which incorporates ~20 kg of materials, reduces scale-up/ particle size effects and allows in situ monitoring of redox, temperature, etc (**Figure 4-1**).



Figure 4-1 Example of large kinetic leach column (KLC) tests operated as 'free-leach' and saturated.

Humidity cell testwork

AMIRA (2002) and the ASTM D5744-07e1 are the most common protocols for conducting HC testwork. The AMIRA method, which is specifically designed for waste rock, requires the testwork to be conducted at constant temperature (25°C) and humidity (65% relative humidity) in order to optimise sulfide oxidation process. The test period depends on the time required for concentrations of key parameters to stabilise, usually taking between 6-24 months.

Tests are conducted on 1 kg of material, air-dried on materials with 1.7mm grain size. Samples are flooded weekly with deionised water, with leachate not allowed to drain for at least one hour. After this time, the columns are free drained and sample collected for water quality testwork. The ASTM method is consistent with the AMIRA method, but in addition it requires periodic drying cycles.

Similarly to the KCL method, leachate chemistry and volumes are used to quantify sulfate release rate and indirectly sulfide oxidation rates. Estimates of sulfide oxidation rates are based on the assumption that all sulfate generated by the oxidation of sulfate minerals is released into the leachate (no sinks) and that all sulfate is associated with sulfide oxidation (i.e. not released from sulfate phases). Metals and metalloids concentrations overtime are used to estimate metal loadings.

Oxygen consumption (OC) testwork

Oxygen consumption methods involve the direct measurement of the rate of oxygen consumption, which in the case of sulphidic material is controlled by the rate of pyrite oxidation. Therefore, measurement of oxygen consumption can be used to obtain a direct measure of sulfide oxidation rates. At this stage, there is not a standard protocol for testing of sulfide oxidation rates using oxygen consumption with various methods developed in recent years by the Australian Nuclear Science and Technology Organisation (ANSTO), CSIRO, and several universities in North America.

In general, the sample is loaded in an airtight, rigid cell where oxygen consumption is measured using an electrochemical sensor in a constant temperature room. Carbon dioxide generated as a result of bacterial oxidation of organic carbon or from neutralisation reactions involving carbonate materials is measured using a carbon dioxide absorbent located inside the sample chamber. The mass change in absorbent is then used to assess the extent of neutralisation reactions. Furthermore, sulfide oxidation rates can be measured as a function of moisture, where moisture is a controlled variable.

The key differences between OC and KCL / HC is that OC testwork typically requires 2-8 weeks for assessment of sulfide oxidation and neutralisation rates, and determination of sulfide oxidation rates is not influenced by sulfate precipitation or dissolution reactions.

Although, this method can provide some indications on short-term water quality, it cannot be used to assess neutral mine drainage potentials in non-sulfide bearing materials.

4.1.1.1 *Proposed laboratory kinetic testing program for the Greater Brockman Operation*

Based on the specific knowledge gaps identified for the GBO and the strength and weaknesses associated with each of the kinetic methods described above, RGS recommends a two-phase kinetic laboratory geochemical testing program, as summarised below.

Phase 1: Oxygen consumption methods

RGS recommends that sulfide oxidation rate, carbonate dissolution rates and pollution generation rates be assessed using the oxygen consumption method. Information from this testwork will allow rapid identification of key lithological units at high risk for AMD (inclusive of saline and metalliferous drainage).

In addition, results from this phase can be used as guide to select future samples for further testwork (i.e. KCL). This technique can provide fast determination of kinetic properties of the sample and will guide selection of future samples for further testing.

Phase 2: KLC Tests

RGS recommends KLC tests (RGS method) to assess long-term water quality, provide additional details on sulfide oxidation rates and pollution generation rate, and allow assessment of metal loadings from both sulfidic and non-sulfide bearing materials.

4.1.1.2 *Field Kinetic Testing Program*

The laboratory kinetic test work provides a controlled laboratory experiment which is standardised against guideline criteria and the results can be compared to different materials and against other mine sites. However, there are several limitations to laboratory kinetic test work. Laboratory kinetic test work are undertaken under a controlled temperature, often with a reduced particle size (increasing surface area and thus reactivity), and without seasonal variations in weather regimes (extremes of both temperature and precipitation); therefore, they may provide poor analogues for heterogeneous drainage and secondary mineral precipitation and dissolution (controlling factors for metal leaching under neutral and acidic pH conditions).

The greater the amount of material included in the test, the greater the likelihood that a well-designed method will adequately reflect the chemical and mineralogical composition and physical properties of a mine site (GARD Guide). RGS recommends the implementation of in situ kinetic testing of waste units (e.g. field barrel leaching experiments) and/or implementation of test piles to assess waste units and some of the proposed WRD design parameters.

4.1.1.2.1 Field Barrel Leach Investigation

The field barrel leach investigation is constructed from a large barrel (~ 120 L plastic barrels) which is packed with material (waste rock) and leached under site conditions (natural weathering) (e.g. **Figure 4-2**). The results from the field barrel leaching experiments will provide insight into:

- The rate at which metals leach from the materials.
- The rate at which acidity is produced.
- The rate at which alkalinity is produced.
- Mitigation strategies.
- Neutral drainage of metals.
- The different classes of PAF and NAF (i.e. saline, metalliferous, etc.).
- Scaling from laboratory to site.
- The results may also provide the basis for geochemical modelling.



Figure 4-2 Example of field leach barrel tests.

4.1.1.2.2 Field Test Piles

Test piles are generally constructed on mine sites to investigate waste rock contact water quality and to evaluate the effectiveness of treatments and management practices. The general construction involves a known pile of material placed over a lysimeter which is used to capture all water infiltrating into the test pile. The infiltrated water is directed by gravity to a drainage pipe in the centre of the lysimeter, which transports the water to a sampling point. The test piles are instrumented according to the experimental output of each test pile. Generally, the instrumentation is selected to measure the specific hydrogeochemical conditions existing within the test piles (e.g. moisture content, temperature and gases) and to characterise the water balance and water quality evolution.

RGS suggests tests piles as a simplified, cost effect means to:

- Assess the sulfide oxidation, metal(loid)/ salt leaching rates and weathering of waste rock materials under site-specific field conditions;
- Assess leachate quality generated under site-specific field conditions;
- Provide information that can be used to understand and scale sulfide oxidation, weathering reaction rates from laboratory tests to site-specific field conditions;
- Provide information that can be used for water quality estimation;
- Evaluate the effectiveness of design parameters on oxygen ingress and water infiltration as an engineered strategy to minimise/mitigate AMD;
- Evaluate the effectiveness of strategies to mitigate/minimise metalliferous and saline drainage; and,
- Evaluate the effectiveness of the proposed waste rock cover design on oxygen ingress and water infiltration as an engineered strategy to minimise/mitigate AMD.

4.1.2 Waste Rock and Rehabilitation Material Block Model

RTIO is likely to have a geological block model incorporating assay samples from exploration and resource drilling programs (inclusive of total sulfur, MgO and CaO). This provides the foundations for developing a waste rock and rehabilitation material block model to allow segregation of different waste units according to a range of geochemical and physical properties (e.g. PAF, NAF, metalliferous/saline NAF, acid consuming, etc.). Waste rock and rehabilitation material block models are essential to allow proper management and handling of waste and beneficial materials, and assist with closure options for the pit voids (as pit walls may be exposed to atmospheric oxidation for a period of time and contribute to final pit void water quality). The effectiveness of a waste rock and rehabilitation material block model is determined by many factors; however, the key considerations are the classicisation criteria and sampling density (i.e. extrapolation between sampling points).

RGS recommend using any existing historical geochemical data together with the outcomes of this assessment to develop a waste rock classification criteria so that a AMD block model can be developed to include geochemical environmental layers to highlight zones within the pit characterised by elevated metal(loid) concentrations, zones that have potential for AMD/ generation and PAF/NAF characteristics of the material. The waste block model can be used to assist with management of waste material (e.g. quantify that PAF units are mined and placed in the best spot within a WRD) as well as pit rock.

After the waste rock block model is developed, RGS recommend incorporation classification criteria to differentiate waste materials that can be used for rehabilitation and closure objectives. These criteria would focus on topsoil and NAF material associated with the regolith.

Once the waste rock and rehabilitation material classification criteria is refined and built into the waste rock and rehabilitation material block model, routine chemical and physical parameters should be analysed for all drilling and test pitting programs within the proposed pit extent so that the waste rock and rehabilitation material block model can be routinely updated.

4.1.2.1 *Identification (and quantification) of site rehabilitation materials*

At most mine sites, there is limited quantification of the mine waste outside of the orebody which will include deleterious mine waste requiring active management (i.e. PAF, saline NAF, metalliferous NAF) and beneficial mine waste that could be used for rehabilitation. Without reliable quantification of the material balance that is potentially available for rehabilitation work it is probable that the ability to develop robust, reliable and cost effective mine waste management strategies for the WRD will decrease, and potential for environmental harm will increase.

RGS recommend the following work program to reduce operational costs associated with rehandling mine waste, development of borrow areas, and rehabilitation of the WRD and (potentially) open pit. A progressive well thought out rehabilitation material sampling and analytical program (RMSaP) could lead to a substantial reduction in Financial Assurance (FA) and potential environmental harm.

- Review the geology model with RTIO geologists to understand the level of detail the geologists have of the mine materials outside the orebody.
- Develop and implement a targeted test pit and shallow diamond core drilling program to identify potential borrow materials for rehabilitation work; this could utilise existing core stored in the core farm. Aged core will provide valuable information of how the materials weather over time.
- Conduct geochemical and physical analyses of test pit and drill core samples to identify the most to least beneficial materials for rehabilitation work.
- Update the geological model with data from the test pit and drilling program, including producing a rehabilitation material balance that would determine the potential soil / rock cover configurations that would be possible given the overall volumes of each material type what will be available over the Life-of-Mine (LoM) .

- Develop a LoM rehabilitation material schedule (using software such as Deswik.LHS) to plan for the immediate use, or temporary stockpiling of material to reduce rehandling to the maximum extent possible.
- Utilise the schedule to quantify the cost of WRD rehabilitation.
- Utilise the information from the RMSaP to develop field scale soil cover test piles or similar.
- Apply the information from the RMSaP and field soil cover test pads to full scale progressive rehabilitation.

4.1.2.2 *Physical Tests*

As mentioned above, physical characterisation of waste rock materials should be considered for future assessments (e.g. identification of site rehabilitation materials). The physical properties are required to understand the waste rock (and thus WRD) hydrology; this could include developing a model used to determine water balance of the WRD (infiltration, evaporation, seepage, etc.) and oxygen diffusion into the dump or through a potential cover system/ cap. While this is not strictly relevant to this project, the physical characteristics of the waste rock will be required.

The key physical properties would need to include (amongst other things):

- Bulk density and porosity (to be done on in-situ “core” samples retrieved from test pits)
- Particle size distribution (PSD) (< 2.36 mm)
- Particle size distribution (PSD) on coarse fragments (>2.36 mm)
- Aggregate stability (Emerson Aggregate Test)
- Water repellence
- Soil water characteristic curves (SWCC).
- Falling head or constant head permeability analysis

4.1.3 Groundwater and Surface Water Monitoring

Monitoring of seepage volumes and water quality is required during operations and post closure. Seepage water quality monitoring would provide information on the quality of drainage coming from different portions of the waste facilities. Seepage water quality monitoring provides the first indication of drainage chemistry from the WRD.

Water quality monitoring both upstream and downstream of the waste facilities is required to determine how runoff and seepage from the waste facilities is influencing the downstream water quality.

Monitoring bores should be located at the lowest point of the original ground surface, and along the original drainage lines to allow detection of seepage and groundwater infiltration from the waste facilities. Consideration of potential higher permeability zones as identified with surface and airborne geophysics will be included to place these in the optimal positions for early detection and possible seepage interception.

Seepage monitoring should occur in the collection ponds/bunds and drains at the toe of the WRD.

The irregular sequence of expected flows (rainfall events) means that timing of seepage sampling events is important to obtain an accurate indication of water quality impacts. Quarterly monitoring of the seepage would provide a long-term record to understand the changes occurring in the waste facilities, but this must be supplemented by seepage monitoring after high rainfall events and at the end of the ‘wet season’ but also at the beginning of the wet season to quantify potential flush loads from the WRD. Full analyses would be required at selected times (at least at the quarterly sampling) but as a minimum pH, electrical conductivity and redox potential should be measured.

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ATTACHMENT A

Geochemical Assessment of Mine Materials

6 Attachment A

GEOCHEMICAL ASSESSMENT OF MINE MATERIALS

ACID GENERATION AND PREDICTION

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic S content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \rightarrow Fe(OH)_3 + 2\ H_2SO_4$$

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1 %S as pyrite would be 30.6 kg H_2SO_4/t. The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralization, which is mainly provided by inherent carbonates and to a lesser extent silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

Determination of pH and Electrical Conductivity

pH and Electrical Conductivity (EC) measured on saturated paste. This gives an indication of the inherent acidity and salinity of the mine material when initially exposed in an emplacement area.

Total Sulfur Content and Maximum Potential Acidity (MPA)

Total sulfur content is determined by the LECO high temperature combustion method. The total sulfur content is then used to calculate the MPA, which is based on the assumption that the entire sulfur content is present as reactive pyrite. Direct determination of the pyritic sulfur content can provide a more accurate estimate of the MPA.

Acid Neutralising Capacity (ANC)

By addition of acid to a known weight of sample, then titration with NaOH to determine the amount of residual acid. The ANC measures the capacity of a sample to react with and neutralise acid. The ANC can be further evaluated by slow acid titration to a set end-point in the Acid Buffering Characteristic Curve (ABCC) test through calculation of the amount of acid consumed and evaluation of the resultant titration curve.

Acid Buffering Characteristic Curve (ABCC)

The ABCC (AMIRA, 2002) provides an evaluation of the available ANC in a sample by slow acid titration to a set endpoint, evaluation of the resultant titration curve, and calculation of the amount of acid consumed. Essentially the ABCC results provide an indication of the proportion of the measured ANC that is likely to be readily available to buffer any acid generated through sulfide oxidation.

Net Acid Producing Potential (NAPP)

The net acid producing potential (NAPP) is used as an indicator of materials that may be of concern with respect to acid generation. The NAPP calculation represents the balance between the maximum potential acidity (MPA) of a sample, which is derived from the total or sulfide sulfur content, and the acid neutralising capacity (ANC) of the material, which is determined experimentally. By convention, the NAPP result is expressed in units of kg H_2SO_4/t sample. If the capacity of the solids to neutralise acid (ANC) exceeds their capacity to generate acid (MPA), then the NAPP of the material is negative. Conversely, if the MPA exceeds the ANC, the NAPP of the material is positive.

Total Organic Carbon/Total Inorganic Carbon/Total Carbon

Total Organic Carbon (TOC), Total Inorganic Carbon (TIC) and Total Carbon (TC) are determined by LECO high temperature combustion method. TOC represents all carbon covalently bonded in organic molecules

whereas TIC represents carbonate (CO_3^{2-}), bicarbonate (HCO_3^-) and dissolved carbon dioxide (CO_2) present in sample, with TC representing total carbon in both TOC and TIC forms present in samples.

Net Acid Generation (NAG)

The net acid generation (NAG) test involves the addition of hydrogen peroxide to a sample of mine rock or process residue to oxidise reactive sulfide, then measurement of pH and titration of any net acidity produced by the acid generation and neutralisation reactions occurring in the sample. A significant NAG result (*i.e.* final NAG_{pH} < 4.5) indicates that the sample is potentially acid forming (PAF) and the test provides a direct measure of the net amount of acid remaining in the sample after all acid generating and acid neutralising reactions have taken place. A NAG_{pH} > 4.5 indicates that the sample is non-acid forming (NAF). The NAG test provides a direct assessment of the potential for a material to produce acid after a period of exposure and weathering and can be used to refine the results of the theoretical NAPP predictions, if required. The NAG test can sometimes be used as a stand-alone test at some hard rock mines, but is recommended that this only be considered after site specific calibration work is carried out. The standard NAG test is generally unsuitable for coal mine waste samples and can produce a false positive result.

ASSESSMENT OF ELEMENT ENRICHMENT AND SOLUBILITY

In mineralised areas it is common to find a suite of enriched elements that have resulted from natural geological processes. Multi-element scans are carried out to identify any elements that are present in a material (or readily leachable from a material) at concentrations that may be of environmental concern with respect to surface water quality, revegetation and public health. The samples are generally analysed for the following elements:

Major elements	Al, Ca, Fe, K, Mg, Na, Ti and S.
Minor elements	Ag, As, B, Ba, Be, Bi, Cd, Ce, Cl, Co, Cr, Cs, Cu, F, Ga, Ge, Hf, Hg, In, La, Li, Mn, Mo, N, Nb, Nd, Ni, P, Pb, Rb, Re, Sb, Sc, Se, Si, Sn, Sr, Ta, Te, Th, Tl, U, V, W, Y, Zn, Zr

The concentration of these elements in samples can be directly compared with relevant state or national environmental and health-based concentration guideline criteria to determine the level of significance. Water extracts are used to determine the immediate element solubilities under the existing sample pH conditions of the sample. The following tests are normally carried out:

Multi-Element Composition of Solids

Multi-element composition of solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Multi-Element Composition of Water Extracts (1:2 w/v leach, 12 h tumble)

Multi-element composition of water extracts from solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Under some conditions (*eg*. low pH) the solubility and mobility of common environmentally important elements can increase significantly. If element mobility under initial pH conditions is deemed likely and/or subsequent low pH conditions may occur, kinetic leach column test work may be completed on representative samples.

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction (XRD) patterns were obtained from the samples with a Panalytical Aeris Powder Diffractometer, and linear Pixcel detector. Operating conditions were 40kV/8mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 80° 2Θ. Phases were identified by computer search/match of the ICDD PDF4 2020 Minerals Database. Quantitative results determined with full pattern Rietveld refinement software.

ATTACHMENT B

Static Test Results

7 Attachment B

7.1 Static Test Results

7.1.1 Attachment B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

7.1.2 Attachment B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

7.1.3 Attachment B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

7.1.4 Attachment B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t					
Detrital																						
RGS001	IKN091	Low Grade Detrital	Detrital	Mature Detritals	48	50	2	8.1	809	0.02		0.6	7.9	-7.3	12.9	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS007	ILA414	Detrital Waste	Detrital	Immature Detrital	30	32	2	6.9	524	0.02		0.6	3.9	-3.3	6.4	6.9	<0.1	1				Non-Acid Forming (Barren)
RGS008	ILA602	Low Grade Detrital	Detrital	Mature Detritals	38	40	2	6.9	260	0.01		0.3	2.1	-1.8	6.9	6.4	<0.1	1.6				Non-Acid Forming (Barren)
RGS014	ILD638	Detrital Waste	Detrital	Immature Detrital	22	24	2	7.5	303	0.02		0.6	2	-1.4	3.3	6.8	<0.1	1				Non-Acid Forming (Barren)
RGS017	IPN302	Detrital Waste	Detrital	Immature Detrital	16	18	2	7.4	355	0.02		0.6	1.2	-0.6	2.0	6.7	<0.1	1.1				Non-Acid Forming (Barren)
RGS020	IPP032	Detrital Waste	Detrital	Immature Detrital	22	24	2	8.2	431	0.01		0.3	47.8	-47.5	156.1	11.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS025	IPP981	Low Grade Limonite	Detrital	Limonitic Detritals	22	24	2	7.6	414	<0.01		0.2	<0.5	-0.1	1.6	5.6	<0.1	3.7				Non-Acid Forming (Barren)
RGS027	IPY508	Detrital Waste	Detrital	Immature Detrital	52	54	2	7.6	1110	0.03		0.9	10.9	-10.0	11.9	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS029	IPY819	Detrital Waste	Detrital	Immature Detrital	46	48	2	8	683	0.07	0.01	0.3	20.5	-20.2	74.4	8.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS037	IQS283	Lignite	Detrital	Lignite	86	88	2	6.1	852	0.24	0.12	3.6	10.6	-7.0	2.9	3.6	3.7	38				Non-Acid Forming
RGS038	IQS289	Lignite	Detrital	Lignite	98	100	2	5.4	1360	1.84	1.16	35.5	8.5	27.0	0.2	4.3	1.6	22.6				Potentially Acid Forming
RGS039	IQS300	Silcrete	Detrital	Silcrete	118	120	2	5.2	1490	0.8	0.57	17.3	6.8	10.5	0.4	4.5	<0.1	22.5				Potentially Acid Forming
RGS040	IQS307	Silcrete	Detrital	Silcrete	132	134	2	6.8	187	0.04		1.2	0.9	0.3	0.7	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS044	IQS454	Calcrete	Detrital	Calcrete	38	40	2	7.8	419	<0.01		0.2	891	-890.8	5818.8	11.2	<0.1	<0.1	0.38	11	10.6	Non-Acid Forming (Barren)
RGS046	IQS554	Red Ochre Waste	Detrital	Red Ochre Detritals	108	110	2	6.4	657	0.1	0.08	2.3	4.4	-2.1	1.9	6.3	<0.1	1				Non-Acid Forming (Barren)
RGS047	IQS585	Calcrete	Detrital	Calcrete	38	40	2	7.9	559	<0.01		0.2	95.8	-95.6	625.6	10.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS048	IQS975	Limonitic Waste	Detrital	Limonitic Detritals	82	84	2	7.2	528	0.04		1.2	6.4	-5.2	5.2	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS055	IRI671	Calcrete	Detrital	Calcrete	56	58	2	8	678	<0.01		0.2	580	-579.8	3787.8	10.5	<0.1	<0.1	0.11	6.86	6.75	Non-Acid Forming (Barren)
RGS056	IRI781	Low Grade Limonite	Detrital	Limonitic Detritals	48	50	2	7.4	382	<0.01		0.2	7.1	-6.9	46.4	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS058	IRI876	Pisolite Waste	Detrital	Pisolite	46	48	2	8	425	<0.01		0.2	174	-173.8	1136.3	11.3	<0.1	<0.1	0.1	1.92	1.82	Non-Acid Forming (Barren)
RGS062	IRJ297	Detrital Waste	Detrital	Immature Detrital	28	30	2	7.5	300	<0.01		0.2	7.8	-7.6	50.9	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS069	IRL691	Low Grade Red Ochre Detrital	Detrital	Red Ochre Detritals	108	110	2	7.8	206	<0.01		0.2	2.9	-2.7	18.9	7.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS070	IRM602	Calcrete	Detrital	Calcrete	0	2	2	7.8	457	0.01		0.3	34.9	-34.6	114.0	11.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS091	ISD467	Limonitic Waste	Detrital	Limonitic Detritals	48	50	2	7.8	684	<0.01		0.2	123	-122.8	803.3	8.7	<0.1	<0.1	0.12	1.4	1.28	Non-Acid Forming (Barren)
RGS092	ISD761	Low Grade Limonite	Detrital	Limonitic Detritals	74	76	2	7.8	387	<0.01		0.2	6.1	-5.9	39.8	8.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS096	ISD936	Calcrete	Detrital	Calcrete	58	60	2	8	434	<0.01		0.2	324	-323.8	2115.9	11.6	<0.1	<0.1	0.16	3.93	3.77	Non-Acid Forming (Barren)
RGS097	ISE024	Low Grade Red Ochre Detrital	Detrital	Red Ochre Detritals	96	98	2	----	----	<0.01		0.2	7.5	-7.3	49.0	7.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS098	ISE033	Low Grade Red Ochre Detrital	Detrital	Red Ochre Detritals	112	114	2	7.2	628	<0.01		0.2	7.3	-7.1	47.7	8.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS107	ISL158	Calcrete	Detrital	Calcrete	36	38	2	7.8	848	0.01		0.3	220	-219.7	718.4	10.8	<0.1	<0.1	0.16	2.46	2.3	Non-Acid Forming (Barren)
RGS109	ISL976	Detrital Waste	Detrital	Immature Detrital	50	52	2	7.2	583	0.02		0.6	5.9	-5.3	9.6	8.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS118	ITD802	Detrital Waste	Detrital	Immature Detrital	6	8	2	7.9	1090	0.36	0.01	0.3	8.4	-8.1	30.5	7.7	<0.1	<0.1				Non-Acid Forming
RGS134	ITJ305	Detrital Waste	Detrital	Immature Detrital	2	4	2	6.2	216	0.01		0.3	1.8	-1.5	5.9	6.1	<0.1	0.8				Non-Acid Forming (Barren)
RGS135	ITJ709	Calcrete	Detrital	Calcrete	44	46	2	7.8	762	<0.01		0.2	119	-118.8	777.1	11.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS142	ITM231	Detrital Waste	Detrital	Immature Detrital	38	40	2	6.2	809	<0.01		0.2	8	-7.8	52.2	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS143	ITM284	Detrital Waste	Detrital	Immature Detrital	42	44	2	7.7	636	<0.01		0.2	451	-450.8	2945.3	9.4	<0.1	<0.1	0.08	5.26	5.18	Non-Acid Forming (Barren)
RGS145	ITM458	Detrital Waste	Detrital	Immature Detrital	34	36	2	7.1	639	<0.01		0.2	8.3	-8.1	54.2	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS154	ITS268	Detrital Waste	Detrital	Immature Detrital	20	22	2	7.8	106	0.02		0.6	2.7	-2.1	4.4	6.9	<0.1	0.1				Non-Acid Forming (Barren)
RGS155	ITS739	Detrital Waste	Detrital	Immature Detrital	4	6	2	7	1480	0.02		0.6	3.3	-2.7	5.4	6.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS158	ITU361	Low Grade Limonite	Detrital	Limonitic Detritals	36	38	2	6.5	227	<0.01		0.2	6.6	-6.4	43.1	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS159	ITU378	Low Grade Limonite	Detrital	Limonitic Detritals	68	70	2	7.8	229	<0.01		0.2	56	-55.8	365.7	10.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS160	ITU558	Low Grade Limonite	Detrital	Limonitic Detritals	32	34	2	7.5	103	<0.01		0.2	3.4	-3.2	22.2	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS166	ITV767	Calcrete	Detrital	Calcrete	16	18	2	7.6	468	<0.01		0.2	800	-799.8	5224.5	11.3	<0.1	<0.1	0.21	9.64	9.43	Non-Acid Forming (Barren)
RGS171	ITW108	Clay	Detrital	Clay	30	32	2	6.9	700	<0.01		0.2	7.2	-7.0	47.0	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS173	ITW556	Detrital Waste	Detrital	Immature Detrital	36	38	2	7	204	0.01		0.3	6.1	-5.8	19.9	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS174	ITW668	Detrital Waste	Detrital	Immature Detrital	14	16	2	7.2	278	<0.01		0.2	6.5	-6.3	42.4	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS175	ITW975	Low Grade Limonite	Detrital	Limonitic Detritals	34	36	2	7.4	145	<0.01		0.2	5.6	-5.4	36.6	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS178	ITY943	Detrital Waste	Detrital	Immature Detrital	32	34	2	7.4	386	<0.01		0.2	7.1	-6.9	46.4	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS182	IUJ616	Hydrated Waste	Detrital	Limonitic Detritals	38	40	2	7.5	309	<0.01		0.2	7.1	-6.9	46.4	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS186	IUL857	Detrital Waste	Detrital	Immature Detrital	24	26	2	7.1	358	<0.01		0.2	6.6	-6.4	43.1	6.3	<0.1	1.2				Non-Acid Forming (Barren)
RGS190	IUO422	Limonitic Waste	Detrital	Limonitic Detritals	62	64	2	8.2	411	<0.01		0.2	76.9	-76.7	502.2	8.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS192	IUO484	Detrital Waste	Detrital	Immature Detrital	16	18	2	7.9	887	0.01		0.3	9.8	-9.5	32.0	8.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS193	IUO694	Detrital Waste	Detrital	Immature Detrital	40	42	2	7.5	285	0.03		0.9	5	-4.1	5.4	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS194	IUO927	Low Grade Pisolite	Detrital	Pisolite	26	28	2	7.8	419	0.02		0.6	4.8	-4.2	7.8	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS195	IUO947	Detrital Waste	Detrital	Immature Detrital	2	4	2	6.6	632	0.02		0.6	4.4	-3.8	7.2	6.7	<0.1	0.6				Non-Acid Forming (Barren)
RGS211	IVB424	Red Ochre High Grade	Detrital	Red Ochre Detritals	22	24	2	7.1	379	0.02		0.6	<0.5	0.4	0.4	7.3	<0.1	<0.1				Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t					
Detrital																						
RGS213	IVB619	Detrital Waste	Detrital	Immature Detrital	6	8	2	7.9	1800	0.03	0.01	0.2	7.9	-7.7	32.2	9.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS214	IVB621	Detrital Waste	Detrital	Immature Detrital	10	12	2	7.3	1020	0.02		0.6	<0.5	0.4	0.4	8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS215	IVB839	Detrital Waste	Detrital	Immature Detrital	74	76	2	7.6	555	0.02		0.6	1.8	-1.2	2.9	6.3	<0.1	1.2				Non-Acid Forming (Barren)
RGS216	IVB842	Detrital Waste	Detrital	Immature Detrital	78	80	2	7.3	757	0.02		0.6	2.1	-1.5	3.4	6.2	<0.1	1.2				Non-Acid Forming (Barren)
RGS217	IVB921	Low Grade Detrital	Detrital	Mature Detritals	98	100	2	6.3	402	0.02		0.6	<0.5	0.4	0.4	6	<0.1	0.9				Non-Acid Forming (Barren)
RGS221	IVK485	Detrital Waste	Detrital	Immature Detrital	24	26	2	7.8	134	0.03		0.9	2.4	-1.5	2.6	6.6	<0.1	0.9				Non-Acid Forming (Barren)
RGS226	IVM112	Low Grade Detrital	Detrital	Mature Detritals	34	36	2	4.9	464	0.2	0.01	0.2	1.3	-1.1	5.3	4.7	<0.1	2.1				Uncertain
RGS227	IVM713	Detrital Waste	Detrital	Immature Detrital	12	14	2	7.1	798	0.02		0.6	1.7	-1.1	2.8	6.8	<0.1	0.6				Non-Acid Forming (Barren)
RGS237	IWR529	Silcrete	Detrital	Silcrete	56	58	2	7.4	317	<0.01		0.2	<0.5	-0.1	1.6	6.8	<0.1	0.5				Non-Acid Forming (Barren)
RGS248	IWT902	Detrital Waste	Detrital	Immature Detrital	0	2	2	7.8	358	<0.01		0.2	5.1	-4.9	33.3	7.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS252	IYB792	Low Grade Detrital	Detrital	Mature Detritals	32	34	2	7.5	104	0.01		0.3	2.7	-2.4	8.8	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS253	IYC986	Detrital Waste	Detrital	Immature Detrital	18	20	2	8.2	140	0.02		0.6	<0.5	0.4	0.4	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS256	IYE845	Detrital Waste	Detrital	Immature Detrital	10	12	2	7.9	73	0.02		0.6	2.2	-1.6	3.6	6.6	<0.1	0.9				Non-Acid Forming (Barren)
RGS279	IYV175	Detrital Waste	Detrital	Immature Detrital	44	46	2	7.9	360	<0.01		0.2	74.1	-73.9	483.9	10.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS280	IYV633	Calcrete	Detrital	Calcrete	38	40	2	7.9	790	<0.01		0.2	672	-671.8	4388.6	10.8	<0.1	<0.1	0.07	8.33	8.26	Non-Acid Forming (Barren)
RGS281	IYV641	Calcrete	Detrital	Calcrete	54	56	2	8.1	331	<0.01		0.2	862	-861.8	5629.4	9.8	<0.1	<0.1	0.09	10.5	10.4	Non-Acid Forming (Barren)
RGS282	IYV899	Low Grade Detrital	Detrital	Mature Detritals	38	40	2	7.9	121	0.02		0.6	2.8	-2.2	4.6	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS284	IYW351	Low Grade Detrital	Detrital	Mature Detritals	8	10	2	7.6	508	0.02		0.6	3.1	-2.5	5.1	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS285	IYY280	Detrital Waste	Detrital	Immature Detrital	76	78	2	7.5	264	<0.01		0.2	8.3	-8.1	54.2	7.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS287	IYZ255	Low Grade Detrital	Detrital	Mature Detritals	36	38	2	7	289	0.02		0.6	3.2	-2.6	5.2	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS288	IYZ298	Low Grade Detrital	Detrital	Mature Detritals	50	52	2	6.9	271	0.02		0.6	2.1	-1.5	3.4	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS289	IYZ407	Detrital Waste	Detrital	Immature Detrital	122	124	2	7.2	501	0.02		0.6	3.5	-2.9	5.7	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS290	IYZ567	Detrital Waste	Detrital	Immature Detrital	4	6	2	8	221	0.02		0.6	2.7	-2.1	4.4	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS291	IYZ574	Detrital Waste	Detrital	Immature Detrital	16	18	2	8.1	1360	0.02		0.6	1.8	-1.2	2.9	6.7	<0.1	1				Non-Acid Forming (Barren)
RGS292	IYZ677	Detrital Waste	Detrital	Immature Detrital	28	30	2	7.8	292	0.01		0.3	3.4	-3.1	11.1	6.6	<0.1	1.1				Non-Acid Forming (Barren)
RGS296	IZA020	Detrital Waste	Detrital	Immature Detrital	40	42	2	7.9	506	<0.01		0.2	5.3	-5.1	34.6	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS298	IZA952	Clay	Detrital	Clay	20	22	2	7.2	473	<0.01		0.2	2.2	-2.0	14.4	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS299	IZA972	Hydrated Waste	Detrital	Limonitic Detritals	56	58	2	8.1	244	<0.01		0.2	24.9	-24.7	162.6	8.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS302	IZB745	High Grade	Detrital	Mature Detritals	194	196	2	7	538	0.02		0.6	0.9	-0.3	1.5	6.6	<0.1	1				Non-Acid Forming (Barren)
RGS303	IZB766	Detrital Waste	Detrital	Immature Detrital	6	8	2	8.4	1810	0.02		0.6	6	-5.4	9.8	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS304	IZC724	Detrital Waste	Detrital	Immature Detrital	68	70	2	8.1	600	<0.01		0.2	6.8	-6.6	44.4	8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS324	KAD179	Detrital Waste	Detrital	Immature Detrital	40	42	2	7.9	1110	0.02		0.6	3.5	-2.9	5.7	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS325	KAD240	Detrital Waste	Detrital	Immature Detrital	38	40	2	7.6	406	0.02		0.6	2.8	-2.2	4.6	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS326	KAG037	Low Grade Limonite	Detrital	Limonitic Detritals	78	80	2	7.9	405	0.03		0.9	3.6	-2.7	3.9	6.6	<0.1	0.2				Non-Acid Forming (Barren)
RGS328	KAH259	High Grade Detritals	Detrital	Mature Detritals	48	50	2	5.4	428	0.16	0.01	0.4	1.1	-0.7	2.6	4.4	0.1	3.6				Uncertain
RGS329	KAI049	Low Grade Detrital	Detrital	Mature Detritals	24	26	2	7.6	313	0.04		1.2	1.9	-0.7	1.6	6.6	<0.1	0.2				Non-Acid Forming (Barren)
RGS330	KAI758	Low Grade Detrital	Detrital	Mature Detritals	16	18	2	8	386	0.03		0.9	2.5	-1.6	2.7	6.8	<0.1	0.2				Non-Acid Forming (Barren)
RGS332	KAJ625	Low Grade Detrital	Detrital	Mature Detritals	52	54	2	7.4	486	0.01		0.3	2.9	-2.6	9.5	6.8	<0.1	0.2				Non-Acid Forming (Barren)
RGS333	KAK169	Detrital Waste	Detrital	Immature Detrital	16	18	2	8	153	0.03		0.9	1.9	-1.0	2.1	6.6	<0.1	0.7				Non-Acid Forming (Barren)
RGS334	KAK399	Low Grade Detrital	Detrital	Mature Detritals	82	84	2	8.4	105	0.02		0.6	4.4	-3.8	7.2	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS335	KAK464	Low Grade Detrital	Detrital	Mature Detritals	66	68	2	7.9	264	0.02		0.6	3.8	-3.2	6.2	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS346	KAO351	Detrital Waste	Detrital	Immature Detrital	2	4	2	8.1	769	0.01		0.3	10.9	-10.6	35.6	9.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS347	KAO369	Detrital Waste	Detrital	Immature Detrital	2	4	2	7.9	482	0.01		0.3	5.6	-5.3	18.3	6.6	<0.1	0.8				Non-Acid Forming (Barren)
RGS348	KAO607	Low Grade Detrital	Detrital	Mature Detritals	38	40	2	7.6	93	0.05	0.01	0.2	5.9	-5.7	24.1	6.9	<0.1	0.4				Non-Acid Forming (Barren)
RGS354	KAW128	Low Grade Detrital	Detrital	Mature Detritals	8	10	2	7.2	430	0.15	0.01	0.3	5.5	-5.2	16.3	5.7	<0.1	2.9				Non-Acid Forming
RGS357	KBA863	Detrital Waste	Detrital	Immature Detrital	0	2	2	8	269	0.06	<0.005	0.1	8.1	-8.0	105.8	8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS359	KBG666	Detrital Waste	Detrital	Immature Detrital	42	44	2	5.4	383	0.19	0.01	0.2	5.7	-5.5	23.3	4.4	0.2	1.9				Non-Acid Forming
RGS368	KBL818	Detrital Waste	Detrital	Immature Detrital	2	4	2	7.2	1430	0.02		0.6	2.7	-2.1	4.4	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS371	KBO349	Detrital Waste	Detrital	Immature Detrital	0	2	2	8	388	0.02		0.6	14	-13.4	22.9	10.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS372	KBO817	Low Grade Detrital	Detrital	Mature Detritals	62	64	2	6.8	269	0.02		0.6	7	-6.4	11.4	6.9	<0.1	0.4				Non-Acid Forming (Barren)
RGS381	KCJ187	Low Grade Detrital	Detrital	Mature Detritals	12	14	2	5.5	353	0.09	0.01	0.4	2	-1.6	5.4	5.8	<0.1	0.9				Non-Acid Forming (Barren)
RGS385	KCJ374	Detrital Waste	Detrital	Immature Detrital	8	10	2	7.1	218	0.08	0.01	0.4	3.3	-2.9	9.0	6.3	<0.1	1				Non-Acid Forming (Barren)
RGS386	KCJ440	Low Grade Detrital	Detrital	Mature Detritals	24	26	2	7	139	0.04		1.2	3	-1.8	2.4	6.4	<0.1	0.6				Non-Acid Forming (Barren)
RGS387	KCJ549	Low Grade Detrital	Detrital	Mature Detritals	30	32	2	4.8	106	0.18	0.02	0.5	1.2	-0.7	2.6	4.6	<0.1	1.1				Uncertain

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC: MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t					
Dales Gorge Member																						
RGS022	IPP456	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	76	78	2	6.4	612	<0.01		0.2	<0.5	-0.1	1.6	6.7	<0.1	0.9				Non-Acid Forming (Barren)
RGS065	IRK629	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	84	86	2	7.2	925	<0.01		0.2	6	-5.8	39.2	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS071	IRM663	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	108	110	2	7.4	426	<0.01		0.2	1.4	-1.2	9.1	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS077	IRR624	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	56	58	2	5.5	807	0.04		1.2	<0.5	1.0	0.2	5.3	<0.1	1.2				Non-Acid Forming (Barren)
RGS078	IRR628	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	64	66	2	5.3	713	0.05	0.01	0.2	<0.5	0.0	1.0	5.5	<0.1	0.8				Non-Acid Forming (Barren)
RGS079	IRR651	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	106	108	2	6.7	299	<0.01		0.2	0.5	-0.3	3.3	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS080	IRR653	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	110	112	2	6.6	380	0.01		0.3	<0.5	0.1	0.8	6.4	<0.1	0.8				Non-Acid Forming (Barren)
RGS085	IRU451	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	76	78	2	7.3	822	0.02		0.6	11.5	-10.9	18.8	7.7	<0.1	<0.1	0.11	0.16	0.05	Non-Acid Forming (Barren)
RGS105	ISJ277	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	50	52	2	5.2	967	0.06	0.01	0.2	<0.5	0.0	1.2	5.1	<0.1	1				Non-Acid Forming (Barren)
RGS110	ITC180	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	74	76	2	7.3	443	<0.01		0.2	0.9	-0.7	5.9	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS111	ITC740	High Grade	Dales Gorge Member	Dales Gorge 2	40	42	2	7.4	465	<0.01		0.2	2.3	-2.1	15.0	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS112	ITC748	High Grade	Dales Gorge Member	Dales Gorge 2	56	58	2	7.8	197	<0.01		0.2	0.7	-0.5	4.6	5.9	<0.1	3.7				Non-Acid Forming (Barren)
RGS116	ITD726	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	118	120	2	7.8	287	<0.01		0.2	0.9	-0.7	5.9	6.3	<0.1	1.7				Non-Acid Forming (Barren)
RGS117	ITD748	Hydrated	Dales Gorge Member	Dales Gorge 3	28	30	2	7.7	480	<0.01		0.2	17.9	-17.7	116.9	9	<0.1	<0.1	0.15	0.3	0.15	Non-Acid Forming (Barren)
RGS119	ITD887	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	40	42	2	7.6	270	<0.01		0.2	1.7	-1.5	11.1	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS130	ITI713	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	40	42	2	7.5	752	<0.01		0.2	2.5	-2.3	16.3	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS152	ITQ041	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	108	110	2	7.4	835	<0.01		0.2	7.5	-7.3	49.0	8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS168	ITV914	Hydrated	Dales Gorge Member	Dales Gorge 2	26	28	2	7.3	1100	<0.01		0.2	29.8	-29.6	194.6	9.5	<0.1	<0.1	0.11	0.39	0.28	Non-Acid Forming (Barren)
RGS169	ITV916	Hydrated	Dales Gorge Member	Dales Gorge 2	30	32	2	7.5	1020	<0.01		0.2	25.2	-25.0	164.6	8.6	<0.1	<0.1	0.12	0.32	0.2	Non-Acid Forming (Barren)
RGS170	ITV995	Hydrated	Dales Gorge Member	Dales Gorge 2	38	40	2	7.4	508	<0.01		0.2	7.1	-6.9	46.4	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS181	IUI533	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	36	38	2	7.8	1300	<0.01		0.2	9.9	-9.7	64.7	8.5	<0.1	<0.1	0.07	0.1	0.03	Non-Acid Forming (Barren)
RGS184	IUK935	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	66	68	2	7.7	198	<0.01		0.2	2.7	-2.5	17.6	6.8	<0.1	0.4				Non-Acid Forming (Barren)
RGS196	IUP204	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	24	26	2	6.5	2450	0.04		1.2	4.6	-3.4	3.8	5.9	<0.1	1.2				Non-Acid Forming (Barren)
RGS197	IUP212	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	38	40	2	6	1920	0.04		1.2	3	-1.8	2.4	5.3	<0.1	0.8				Non-Acid Forming (Barren)
RGS198	IUP217	Shale	Dales Gorge Member	Dales Gorge 2	48	50	2	7.6	749	<0.01		0.2	4.7	-4.5	30.7	6.7	<0.1	0.5				Non-Acid Forming (Barren)
RGS199	IUP669	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	36	38	2	7.8	865	<0.01		0.2	7.8	-7.6	50.9	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS200	IUP864	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	64	66	2	7.8	239	<0.01		0.2	4.4	-4.2	28.7	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS202	IVA003	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	52	54	2	7.8	442	<0.01		0.2	7.1	-6.9	46.4	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS203	IVA087	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	90	92	2	7.3	752	<0.01		0.2	5.3	-5.1	34.6	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS205	IVA220	Hydrated Waste	Dales Gorge Member	Dales Gorge 1	30	32	2	7.4	760	<0.01		0.2	<0.5	-0.1	1.6	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS206	IVA275	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	48	50	2	7.2	671	<0.01		0.2	<0.5	-0.1	1.6	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS218	IVC092	Hydrated	Dales Gorge Member	Dales Gorge 2	12	14	2	7.2	429	0.03		0.9	<0.5	0.7	0.3	6.4	<0.1	0.8				Non-Acid Forming (Barren)
RGS224	IVM058	Hydrated	Dales Gorge Member	Dales Gorge 1	12	14	2	7.5	760	0.05	0.01	0.3	5.9	-5.6	21.4	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS228	IVN356	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	82	84	2	5.6	552	0.06	0.01	0.3	1.5	-1.2	4.5	5.2	<0.1	0.9				Non-Acid Forming (Barren)
RGS230	IVN838	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	30	32	2	6	323	0.02		0.6	1.9	-1.3	3.1	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS234	IWQ128	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	30	32	2	5.7	474	0.02		0.6	<0.5	0.4	0.4	5.3	<0.1	3.8				Non-Acid Forming (Barren)
RGS235	IWQ166	Shale	Dales Gorge Member	Dales Gorge 2	4	6	2	6.6	187	0.06	0.01	0.2	1.8	-1.6	7.3	6.2	<0.1	1				Non-Acid Forming (Barren)
RGS236	IWQ167	Shale	Dales Gorge Member	Dales Gorge 2	6	8	2	7.3	143	0.03		0.9	0.7	0.2	0.8	6.7	<0.1	0.9				Non-Acid Forming (Barren)
RGS241	IWS568	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	10	12	2	8	407	0.03		0.9	6.3	-5.4	6.9	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS242	IWS573	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	16	18	2	7.6	353	0.04		1.2	1.4	-0.2	1.1	6.6	<0.1	0.6				Non-Acid Forming (Barren)
RGS243	IWS575	Low Grade Aluminous	Dales Gorge Member	Dales Gorge 2	20	22	2	7.3	1370	0.02		0.6	<0.5	0.4	0.4	6.9	<0.1	0.1				Non-Acid Forming (Barren)
RGS244	IWT018	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	20	22	2	7.3	184	0.01		0.3	<0.5	0.1	0.8	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS245	IWT029	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	40	42	2	5.7	442	0.02		0.6	<0.5	0.4	0.4	6.6	<0.1	0.3				Non-Acid Forming (Barren)
RGS246	IWT048	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	34	36	2	6.3	323	<0.01		0.2	0.8	-0.6	5.2	6.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS249	IXA209	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	86	88	2	7.4	244	<0.01		0.2	<0.5	-0.1	1.6	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS269	IYR078	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	82	84	2	7.6	427	<0.01		0.2	0.8	-0.6	5.2	6.7	<0.1	0.7				Non-Acid Forming (Barren)
RGS275	IYU618	Banded Iron Formation	Dales Gorge Member	Dales Gorge 2	30	32	2	5.3	112	0.1	0.01	0.2	2.1	-1.9	8.6	5.8	<0.1	1				Non-Acid Forming (Barren)
RGS276	IYU629	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	52	54	2	6	124	0.01		0.3	0.9	-0.6	2.9	6.1	<0.1	1				Non-Acid Forming (Barren)
RGS277	IYU671	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	12	14	2	6.5	86	0.06	<0.005	0.1	2.1	-2.0	27.4	6.9	<0.1	0.4				Non-Acid Forming (Barren)
RGS351	KAS712	High Phos High grade	Dales Gorge Member	Dales Gorge 2	48	50	2	7	259	0.02		0.6	6.2	-5.6	10.1	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS352	KAS713	High Phos High grade	Dales Gorge Member	Dales Gorge 2	50	52	2	6.9	389	0.06	0.01	0.2	2.3	-2.1	9.4	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS353	KAS731	High Phos High grade	Dales Gorge Member	Dales Gorge 1	84	86	2	7.1	230	<0.01		0.2	1.3	-1.1	8.5	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS355	KAW711	Shale	Dales Gorge Member	Dales Gorge 2	20	22	2	7.3	230	0.02		0.6	6.2	-5.6	10.1	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS356	KAW714	Shale	Dales Gorge Member	Dales Gorge 2	26	28	2	7.5	361	0.01		0.3	5.2	-4.9	17.0	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS363	KBJ611	High Grade	Dales Gorge Member	Dales Gorge 3	86	88	2	7	379	0.01		0.3	2.6	-2.3	8.5	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS373	KBR002	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	86	88	2	7.2	318	0.01		0.3	9	-8.7	29.4	6.5	<0.1	1.9	0.03	0.05	0.02	Non-Acid Forming (Barren)
RGS374	KBR003	Banded Iron Formation	Dales Gorge Member	Dales Gorge 3	88	90	2	7	417	<0.01		0.2	2.3	-2.1	15.0	6.1	<0.1	3.7				Non-Acid Forming (Barren)
RGS377	KCI118	High Grade	Dales Gorge Member	Dales Gorge 2	48	50	2	6.2	259	0.01		0.3	2.1	-1.8	6.9	5.6	<0.1	1.2				Non-Acid Forming (Barren)
RGS388	KDD600	Banded Iron Formation	Dales Gorge Member	Dales Gorge 1	24	26	2	5.4	166	0.01		0.3	2.5	-2.2	8.2	5	<0.1	0.9				Non-Acid Forming (Barren)
RGS390	KDR479	Hydrated	Dales Gorge Member	Dales Gorge 3	4	6	2	8	214	0.03		0.9	6.2	-5.3	6.7	7.6	<0.1	<0.1				Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t						
Dolerite																						
RGS030	IPY877	Dolerite	Dolerite	Dolerite	152	154	2	7.6	423	<0.01		0.2	6.6	-6.4	43.1	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS067	IRL014	Dolerite	Dolerite	Dolerite	56	58	2	7.5	431	<0.01		0.2	8.9	-8.7	58.1	7.7	<0.1	<0.1	0.26	0.29	0.03	Non-Acid Forming (Barren)
RGS180	IUI522	Dolerite	Dolerite	Dolerite	16	18	2	7.6	1610	0.01		0.3	38.6	-38.3	126.0	8.9	<0.1	<0.1	0.19	0.58	0.39	Non-Acid Forming (Barren)
RGS364	KBL717	Dolerite	Dolerite	Dolerite	50	52	2	6.8	453	<0.01		0.2	2.8	-2.6	18.3	6.9	<0.1	0.7				Non-Acid Forming (Barren)
RGS365	KBL765	Dolerite	Dolerite	Dolerite	30	32	2	6.7	776	0.03		0.9	2.2	-1.3	2.4	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS366	KBL768	Dolerite	Dolerite	Dolerite	36	38	2	7.1	333	<0.01		0.2	3	-2.8	19.6	6.4	<0.1	1				Non-Acid Forming (Barren)
RGS367	KBL774	Dolerite	Dolerite	Dolerite	46	48	2	7.4	310	<0.01		0.2	2.8	-2.6	18.3	6.4	<0.1	1.2				Non-Acid Forming (Barren)
Joffre Member																						
RGS023	IPP783	Banded Iron Formation	Joffre Member	Joffre 2	72	74	2	5.9	426	0.01		0.3	<0.5	0.1	0.8	6.3	<0.1	1.4				Non-Acid Forming (Barren)
RGS024	IPP791	High Phos High grade	Joffre Member	Joffre 1	86	88	2	5.4	504	0.03		0.9	<0.5	0.7	0.3	5.7	<0.1	1.1				Non-Acid Forming (Barren)
RGS074	IRQ201	Hydrated	Joffre Member	Joffre 3	24	26	2	7.5	984	0.03		0.9	4.1	-3.2	4.5	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS086	IRU776	Hydrated Waste	Joffre Member	Joffre 2	18	20	2	7.1	178	0.01		0.3	2.5	-2.2	8.2	6.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS101	ISI845	Low grade siliceous	Joffre Member	Joffre 2	40	42	2	7.4	404	0.03	0.01	0.2	2.1	-1.9	13.7	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS102	ISI859	Banded Iron Formation	Joffre Member	Joffre 2	66	68	2	6.6	452	<0.01		0.2	1	-0.8	6.5	6.6	<0.1	1				Non-Acid Forming (Barren)
RGS125	ITI334	Banded Iron Formation	Joffre Member	Joffre 4	52	54	2	7.2	186	<0.01		0.2	0.8	-0.6	5.2	6.8	<0.1	0.8				Non-Acid Forming (Barren)
RGS126	ITI426	Banded Iron Formation	Joffre Member	Joffre 4	46	48	2	7.2	229	<0.01		0.2	1.6	-1.4	10.4	6.4	<0.1	1.4				Non-Acid Forming (Barren)
RGS127	ITI461	Banded Iron Formation	Joffre Member	Joffre 3	50	52	2	7.1	411	0.01		0.3	2.1	-1.8	6.9	6.5	<0.1	0.5				Non-Acid Forming (Barren)
RGS128	ITI551	Hydrated	Joffre Member	Joffre 1	8	10	2	7.8	1880	0.01		0.3	5.3	-5.0	17.3	7.4	<0.1	<0.1	0.13	0.14	<0.02	Non-Acid Forming (Barren)
RGS132	ITI951	Hydrated	Joffre Member	Joffre 2	8	10	2	7.2	412	<0.01		0.2	3.1	-2.9	20.2	6.5	<0.1	0.9				Non-Acid Forming (Barren)
RGS141	ITL838	Shale	Joffre Member	Joffre 1	30	32	2	6.2	747	0.03		0.9	2.9	-2.0	3.2	6.9	<0.1	0.2				Non-Acid Forming (Barren)
RGS162	ITV160	Banded Iron Formation	Joffre Member	Joffre 3	34	36	2	6	559	0.02		0.6	1.6	-1.0	2.6	6.5	<0.1	0.2				Non-Acid Forming (Barren)
RGS163	ITV171	Banded Iron Formation	Joffre Member	Joffre 3	54	56	2	5.9	622	0.01		0.3	<0.5	0.1	0.8	6.3	<0.1	0.2				Non-Acid Forming (Barren)
RGS164	ITV178	Banded Iron Formation	Joffre Member	Joffre 2	68	70	2	6	826	0.01		0.3	<0.5	0.1	0.8	6.3	<0.1	0.2				Non-Acid Forming (Barren)
RGS165	ITV182	Banded Iron Formation	Joffre Member	Joffre 2	76	78	2	6.1	737	0.01		0.3	<0.5	0.1	0.8	6.3	<0.1	0.2				Non-Acid Forming (Barren)
RGS179	IUI061	High Phos High grade	Joffre Member	Joffre 3	30	32	2	6.6	195	0.02		0.6	4.8	-4.2	7.8	5.9	<0.1	1.2	0.08	0.09	<0.02	Non-Acid Forming (Barren)
RGS208	IVB053	Banded Iron Formation	Joffre Member	Joffre 2	82	84	2	7	179	<0.01		0.2	<0.5	-0.1	1.6	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS209	IVB275	Banded Iron Formation	Joffre Member	Joffre 3	64	66	2	7.6	126	0.01		0.3	1.5	-1.2	4.9	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS210	IVB278	Banded Iron Formation	Joffre Member	Joffre 3	70	72	2	7.6	75	<0.01		0.2	<0.5	-0.1	1.6	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS222	IVL209	Banded Iron Formation	Joffre Member	Joffre 2	86	88	2	5.9	622	0.01		0.3	<0.5	0.1	0.8	6	<0.1	1				Non-Acid Forming (Barren)
RGS223	IVL225	Banded Iron Formation	Joffre Member	Joffre 1	116	118	2	6.2	683	0.01		0.3	1.2	-0.9	3.9	6.6	<0.1	0.7				Non-Acid Forming (Barren)
RGS283	IYW225	Low Grade Aluminous	Joffre Member	Joffre 4	50	52	2	7.6	364	<0.01		0.2	2	-1.8	13.1	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS305	IZR189	Low grade siliceous	Joffre Member	Joffre 2	0	2	2	8.3	216	0.03	0.01	0.2	7.7	-7.5	31.4	7.8	<0.1	<0.1	0.08	0.18	0.1	Non-Acid Forming (Barren)
RGS306	IZR191	Low grade siliceous	Joffre Member	Joffre 2	2	4	2	8.5	176	0.03		0.9	3.3	-2.4	3.6	6.9	<0.1	0.5				Non-Acid Forming (Barren)
RGS307	IZR193	Low grade siliceous	Joffre Member	Joffre 2	6	8	2	8.6	267	0.04		1.2	4.1	-2.9	3.3	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS308	IZR194	Low grade siliceous	Joffre Member	Joffre 2	8	10	2	7.6	370	0.03		0.9	0.8	0.1	0.9	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS309	IZR195	Low grade siliceous	Joffre Member	Joffre 2	10	12	2	8.6	142	0.03		0.9	1.1	-0.2	1.2	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS310	IZR200	Banded Iron Formation	Joffre Member	Joffre 2	18	20	2	8	175	0.01		0.3	1.1	-0.8	3.6	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS311	IZR202	Banded Iron Formation	Joffre Member	Joffre 2	22	24	2	8.3	161	<0.01		0.2	0.6	-0.4	3.9	6.9	<0.1	0.6				Non-Acid Forming (Barren)
RGS312	IZR203	Banded Iron Formation	Joffre Member	Joffre 2	24	26	2	8.2	104	0.01		0.3	2	-1.7	6.5	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS313	IZR208	Banded Iron Formation	Joffre Member	Joffre 2	34	36	2	7.8	208	<0.01		0.2	1.4	-1.2	9.1	5.7	<0.1	2.8				Non-Acid Forming (Barren)
RGS314	IZR212	Banded Iron Formation	Joffre Member	Joffre 1	40	42	2	7	842	0.04		1.2	1.3	-0.1	1.1	6.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS315	IZR213	Banded Iron Formation	Joffre Member	Joffre 1	42	44	2	6.5	693	0.05	0.01	0.2	0.9	-0.7	4.2	6.9	<0.1	0.4				Non-Acid Forming (Barren)
RGS316	IZR214	Banded Iron Formation	Joffre Member	Joffre 1	44	46	2	5.9	546	0.04		1.2	0.6	0.6	0.5	6.5	<0.1	0.7				Non-Acid Forming (Barren)
RGS317	IZV196	Banded Iron Formation	Joffre Member	Joffre 3	40	42	2	7.5	393	0.01		0.3	1.9	-1.6	6.2	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS318	IZV226	Low grade siliceous	Joffre Member	Joffre 2	98	100	2	8	431	<0.01		0.2	3.5	-3.3	22.9	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS319	IZV353	Banded Iron Formation	Joffre Member	Joffre 3	36	38	2	8.5	235	<0.01		0.2	5.3	-5.1	34.6	8	<0.1	<0.1	0.04	0.14	0.1	Non-Acid Forming (Barren)
RGS321	KAC147	Hydrated	Joffre Member	Joffre 3	18	20	2	8.1	209	<0.01		0.2	1.8	-1.6	11.8	6	<0.1	2				Non-Acid Forming (Barren)
RGS322	KAC172	High Phos High grade	Joffre Member	Joffre 2	62	64	2	7.6	509	<0.01		0.2	3.8	-3.6	24.8	6.8	<0.1	0.5				Non-Acid Forming (Barren)
RGS340	KAM124	Banded Iron Formation	Joffre Member	Joffre 1	18	20	2	8.6	424	0.02		0.6	3.8	-3.2	6.2	8	<0.1	<0.1				Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t						
Mount McRae Shale																						
RGS021	IPP152	Shale	Mount McRae Shale	Mount McRae Shale	48	50	2	7.9	523	0.06	0.01	0.2	2.5	-2.3	11.7	6.7	<0.1	1				Non-Acid Forming (Barren)
RGS026	IPU900	Banded Iron Formation	Mount McRae Shale	Footwall Zone	94	96	2	6.9	156	<0.01		0.2	1.1	-0.9	7.2	6.4	<0.1	1.4				Non-Acid Forming (Barren)
RGS064	IRK083	Shale	Mount McRae Shale	Mount McRae Shale	22	24	2	8	1000	0.52	0.44	13.5	5.6	7.9	0.4	2.8	11.4	15.3				Potentially Acid Forming - Low Capacity
RGS072	IRO039	Low grade siliceous	Mount McRae Shale	Footwall Zone	90	92	2	7.6	521	<0.01		0.2	4.4	-4.2	28.7	8.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS081	IRR945	Shale	Mount McRae Shale	Mount McRae Shale	32	34	2	6.8	775	0.04		1.2	3.9	-2.7	3.2	5.8	<0.1	2.8				Non-Acid Forming (Barren)
RGS082	IRR948	Shale	Mount McRae Shale	Mount McRae Shale	36	38	2	7.5	654	0.28	0.25	7.6	2.6	5.0	0.3	3.4	4.8	11.4				Uncertain
RGS103	ISJ051	Low Grade Aluminous	Mount McRae Shale	Footwall Zone	58	60	2	7	730	<0.01		0.2	2.8	-2.6	18.3	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS104	ISJ062	Shale	Mount McRae Shale	Mount McRae Shale	80	82	2	6.8	472	<0.01		0.2	2.7	-2.5	17.6	6.9	<0.1	0.2				Non-Acid Forming (Barren)
RGS114	ITD460	Hydrated	Mount McRae Shale	Footwall Zone	50	52	2	7.1	711	0.01		0.3	3.1	-2.8	10.1	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS115	ITD582	High Grade	Mount McRae Shale	Footwall Zone	98	100	2	7.6	524	<0.01		0.2	1.5	-1.3	9.8	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS131	ITI787	Banded Iron Formation	Mount McRae Shale	Footwall Zone	82	84	2	7.4	456	<0.01		0.2	0.7	-0.5	4.6	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS137	ITL213	Carbonaceous Shale	Mount McRae Shale	Mount McRae Shale	40	42	2	7.5	1440	<0.01		0.2	6.6	-6.4	43.1	6.3	<0.1	2				Non-Acid Forming (Barren)
RGS167	ITV838	Shale	Mount McRae Shale	Mount McRae Shale	80	82	2	4.8	1830	1.08	1.09	33.4	5.7	27.7	0.2	2.6	33.7	41.2				Potentially Acid Forming
RGS201	IUV445	Shale	Mount McRae Shale	Footwall Zone	26	28	2	6.9	706	0.01		0.3	6.9	-6.6	22.5	6.8	<0.1	0.1				Non-Acid Forming (Barren)
RGS204	IVA196	Shale	Mount McRae Shale	Footwall Zone	28	30	2	7	1160	<0.01		0.2	6.7	-6.5	43.8	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS219	IVC161	Shale	Mount McRae Shale	Mount McRae Shale	140	142	2	7.8	684	0.15	0.12	3.6	3.6	0.0	1.0	3.4	2.3	8				Uncertain
RGS225	IVM080	Banded Iron Formation	Mount McRae Shale	Footwall Zone	52	54	2	5.3	586	0.02		0.6	<0.5	0.4	0.4	6.9	<0.1	0.8				Non-Acid Forming (Barren)
RGS231	IVN871	Low Grade Aluminous	Mount McRae Shale	Footwall Zone	92	94	2	5.2	549	0.1	0.01	0.3	1.8	-1.5	5.3	4.6	<0.1	2.6				Non-Acid Forming (Barren)
RGS232	IVN891	Shale	Mount McRae Shale	Mount McRae Shale	128	130	2	8.8	2080	0.76	0.01	0.4	12.8	-12.4	29.9	7	<0.1	<0.1	4.47	4.48	<0.02	Non-Acid Forming
RGS233	IWQ038	Shale	Mount McRae Shale	Mount McRae Shale	14	16	2	7.8	680	0.03		0.9	3.3	-2.4	3.6	6.6	<0.1	1.3				Non-Acid Forming (Barren)
RGS239	IWS032	Shale	Mount McRae Shale	Mount McRae Shale	14	16	2	6.2	716	0.17	0.01	0.2	2.4	-2.2	9.8	6.4	<0.1	1.8				Uncertain
RGS240	IWS038	Shale	Mount McRae Shale	Mount McRae Shale	4	6	2	5.1	3630	0.22	0.01	0.3	<0.5	0.1	0.7	4.4	0.2	5				Uncertain
RGS247	IWT424	Shale	Mount McRae Shale	Mount McRae Shale	50	52	2	6.9	834	0.01		0.3	<0.5	0.1	0.8	6.7	<0.1	0.3				Non-Acid Forming (Barren)
RGS251	IXW451	Banded Iron Formation	Mount McRae Shale	Footwall Zone	8	10	2	7	108	<0.01		0.2	<0.5	-0.1	1.6	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS270	IYU108	Banded Iron Formation	Mount McRae Shale	Footwall Zone	20	22	2	7.3	152	0.02		0.6	2.2	-1.6	3.6	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS271	IYU160	Banded Iron Formation	Mount McRae Shale	Footwall Zone	42	44	2	4.8	1210	0.08	0.01	0.2	<0.5	0.0	1.0	5	<0.1	1.7				Non-Acid Forming (Barren)
RGS272	IYU295	Banded Iron Formation	Mount McRae Shale	Footwall Zone	52	54	2	5.3	714	0.1	0.01	0.2	<0.5	0.0	1.0	4.8	<0.1	2.5				Non-Acid Forming (Barren)
RGS273	IYU298	Banded Iron Formation	Mount McRae Shale	Footwall Zone	58	60	2	5.2	631	0.06	0.01	0.3	<0.5	0.1	0.8	4.9	<0.1	2				Non-Acid Forming (Barren)
RGS274	IYU383	Banded Iron Formation	Mount McRae Shale	Footwall Zone	44	46	2	7.8	415	0.06	0.01	0.2	0.7	-0.5	3.3	5	<0.1	2.4				Non-Acid Forming (Barren)
RGS286	IYY952	Hydrated Waste	Mount McRae Shale	Mount McRae Shale	36	38	2	5.7	639	0.06	0.01	0.2	2.7	-2.5	17.6	6.3	<0.1	0.8				Non-Acid Forming (Barren)
RGS320	IZV668	Shale	Mount McRae Shale	Mount McRae Shale	108	110	2	8	1020	0.27	0.21	6.4	3	3.4	0.5	3.9	1.9	5.6				Uncertain
RGS323	KAC711	Shale	Mount McRae Shale	Mount McRae Shale	70	72	2	7.2	612	0.02		0.6	3.6	-3.0	5.9	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS331	KAJ336	Shale	Mount McRae Shale	Mount McRae Shale	74	76	2	8.7	635	<0.01		0.2	79.4	-79.2	518.5	8.2	<0.1	<0.1	1.35	2.15	0.8	Non-Acid Forming (Barren)
RGS360	KBH061	Low Grade Aluminous	Mount McRae Shale	Footwall Zone	4	6	2	7.9	183	0.03		0.9	7.7	-6.8	8.4	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS361	KBH109	Shale	Mount McRae Shale	Mount McRae Shale	68	70	2	8	333	<0.01		0.2	146	-145.8	953.5	8.7	<0.1	<0.1	0.09	2.28	2.19	Non-Acid Forming (Barren)
RGS378	KCI669	Shale	Mount McRae Shale	Mount McRae Shale	110	112	2	7.7	1220	0.03		0.9	26.9	-26.0	29.3	7.4	<0.1	<0.1	4.23	4.38	0.15	Non-Acid Forming (Barren)
RGS379	KCI918	Low Grade Aluminous	Mount McRae Shale	Footwall Zone	34	36	2	5.3	1270	0.1	0.01	0.2	1.8	-1.6	7.3	4.5	<0.1	2.8				Non-Acid Forming (Barren)
RGS389	KDR301	Chert	Mount McRae Shale	Footwall Zone	26	28	2	5.6	808	0.04		1.2	2	-0.8	1.6	5.9	<0.1	0.4				Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t					
Marra Mamba																						
RGS005	IKO939	Banded Iron Formation	Marra Mamba	Newman Upper	62	64	2	7.8	438	0.06	0.06	1.7	38.5	-36.8	22.1	8.7	<0.1	<0.1	0.12	0.81	0.69	Non-Acid Forming (Barren)
RGS009	ILA658	Banded Iron Formation	Marra Mamba	Newman Lower Lower	140	142	2	7.2	340	0.02		0.6	6.5	-5.9	10.6	6.6	<0.1	1				Non-Acid Forming (Barren)
RGS010	ILA964	Hydrated Waste	Marra Mamba	Newman Upper	62	64	2	6.7	306	<0.01		0.2	3.5	-3.3	22.9	4.4	0.4	4.1				Non-Acid Forming (Barren)
RGS011	ILA976	Shale	Marra Mamba	Newman Lower	84	86	2	7	544	<0.01		0.2	3.4	-3.2	22.2	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS012	ILB540	Banded Iron Formation	Marra Mamba	Newman Lower Lower	118	120	2	7.2	480	<0.01		0.2	12.2	-12.0	79.7	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS013	ILC560	Banded Iron Formation	Marra Mamba	MacLeod Member	24	26	2	7.1	272	0.02		0.6	1.3	-0.7	2.1	6.9	<0.1	0.2				Non-Acid Forming (Barren)
RGS015	ILD720	Hydrated	Marra Mamba	Newman Upper	56	58	2	7.2	157	<0.01		0.2	0.8	-0.6	5.2	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS031	IPY893	Shale	Marra Mamba	Newman Lower	182	184	2	6.6	686	<0.01		0.2	2.9	-2.7	18.9	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS032	IPY901	Shale	Marra Mamba	Newman Lower	196	198	2	7.4	340	<0.01		0.2	1.4	-1.2	9.1	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS033	IQP002	Banded Iron Formation	Marra Mamba	Nammuldi Member	38	40	2	5.8	854	0.04		1.2	0.7	0.5	0.6	5.5	<0.1	2				Non-Acid Forming (Barren)
RGS034	IQP120	Banded Iron Formation	Marra Mamba	MacLeod Member	34	36	2	4.6	769	0.14	0.01	0.2	<0.5	-0.1	1.4	4.8	<0.1	2.1				Uncertain
RGS043	IQS418	Banded Iron Formation	Marra Mamba	Newman Lower	334	336	2	6.6	302	<0.01		0.2	2.5	-2.3	16.3	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS049	IRA551	Hydrated	Marra Mamba	Newman Upper	54	56	2	7.6	409	<0.01		0.2	6.4	-6.2	41.8	8.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS050	IRA619	Banded Iron Formation	Marra Mamba	Newman Lower Lower	180	182	2	7.7	958	0.17	0.15	4.7	16	-11.3	3.4	7.6	<0.1	<0.1				Non-Acid Forming
RGS088	IRZ661	Banded Iron Formation	Marra Mamba	Newman Lower	96	98	2	6.9	384	<0.01		0.2	1.6	-1.4	10.4	6.7	<0.1	0.8				Non-Acid Forming (Barren)
RGS089	IRZ663	Banded Iron Formation	Marra Mamba	Newman Lower	100	102	2	7	319	<0.01		0.2	2.4	-2.2	15.7	6.8	<0.1	0.6				Non-Acid Forming (Barren)
RGS090	ISD283	Hydrated	Marra Mamba	Newman Upper	44	46	2	7.6	143	<0.01		0.2	4.1	-3.9	26.8	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS099	ISE515	Banded Iron Formation	Marra Mamba	Newman Lower	68	70	2	7.5	199	<0.01		0.2	1.6	-1.4	10.4	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS100	ISE864	High Grade	Marra Mamba	Newman Lower Lower	48	50	2	6.7	164	<0.01		0.2	0.8	-0.6	5.2	6.9	<0.1	0.3				Non-Acid Forming (Barren)
RGS120	ITE611	Banded Iron Formation	Marra Mamba	Nammuldi Member	12	14	2	7.4	402	0.02		0.6	1.6	-1.0	2.6	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS121	ITG282	Low grade siliceous	Marra Mamba	Newman Lower Lower	96	98	2	7.6	319	<0.01		0.2	2.4	-2.2	15.7	7.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS122	ITG526	Banded Iron Formation	Marra Mamba	Newman Lower Lower	96	98	2	7.2	142	<0.01		0.2	1.4	-1.2	9.1	6.8	<0.1	0.8				Non-Acid Forming (Barren)
RGS123	ITG535	Banded Iron Formation	Marra Mamba	Newman Lower Lower	112	114	2	7.2	270	0.02		0.6	<0.5	0.4	0.4	6.6	<0.1	1				Non-Acid Forming (Barren)
RGS124	ITH923	Low grade siliceous	Marra Mamba	MacLeod Member	34	36	2	7.3	626	<0.01		0.2	<0.5	-0.1	1.6	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS136	ITK609	Banded Iron Formation	Marra Mamba	Newman Lower Lower	62	64	2	7	186	0.02		0.6	0.9	-0.3	1.5	6.8	<0.1	0.3				Non-Acid Forming (Barren)
RGS147	ITN418	Banded Iron Formation	Marra Mamba	Newman Lower Lower	118	120	2	7.5	257	<0.01		0.2	1.1	-0.9	7.2	6.2	<0.1	2.4				Non-Acid Forming (Barren)
RGS148	ITN542	High Grade	Marra Mamba	Newman Lower Lower	110	112	2	7.5	199	<0.01		0.2	7.7	-7.5	50.3	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS149	ITN784	Banded Iron Formation	Marra Mamba	Newman Lower Lower	150	152	2	7.7	357	0.03	0.04	1.1	7.6	-6.5	7.1	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS150	ITN964	Shale	Marra Mamba	Newman Upper	80	82	2	6.9	196	<0.01		0.2	2.2	-2.0	14.4	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS157	ITU333	Low grade siliceous	Marra Mamba	Newman Upper	98	100	2	6.8	325	<0.01		0.2	0.7	-0.5	4.6	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS161	ITU783	Low grade siliceous	Marra Mamba	Newman Lower Lower	104	106	2	7.7	275	<0.01		0.2	6.6	-6.4	43.1	7.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS172	ITW348	Banded Iron Formation	Marra Mamba	Newman Lower Lower	118	120	2	7.6	81	0.02		0.6	<0.5	0.4	0.4	6	<0.1	0.3				Non-Acid Forming (Barren)
RGS177	ITY858	Banded Iron Formation	Marra Mamba	Newman Upper	58	60	2	7	101	<0.01		0.2	3.8	-3.6	24.8	6.6	<0.1	0.7				Non-Acid Forming (Barren)
RGS220	IVD337	High Grade	Marra Mamba	Newman Lower Lower	44	46	2	6.9	255	<0.01		0.2	<0.5	-0.1	1.6	6.8	<0.1	0.4				Non-Acid Forming (Barren)
RGS238	IWR632	Banded Iron Formation	Marra Mamba	MacLeod Member	52	54	2	7.6	433	<0.01		0.2	1	-0.8	6.5	6.9	<0.1	0.1				Non-Acid Forming (Barren)
RGS258	IYF285	Banded Iron Formation	Marra Mamba	Newman Lower	60	62	2	8.2	39	<0.01		0.2	<0.5	-0.1	1.6	6.2	<0.1	2.5				Non-Acid Forming (Barren)
RGS260	IYF442	Banded Iron Formation	Marra Mamba	MacLeod Member	44	46	2	8.6	441	0.05	0.06	1.8	61.8	-60.0	34.2	10.2	<0.1	<0.1	0.04	1.24	1.2	Non-Acid Forming (Barren)
RGS278	IYV032	Banded Iron Formation	Marra Mamba	Newman Lower	40	42	2	7.3	362	<0.01		0.2	3.1	-2.9	20.2	6.9	<0.1	0.1				Non-Acid Forming (Barren)
RGS297	IZA182	Banded Iron Formation	Marra Mamba	Newman Lower Lower	96	98	2	8.4	156	0.04		1.2	5.2	-4.0	4.2	8.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS336	KAL098	Banded Iron Formation	Marra Mamba	Newman Upper	40	42	2	8.6	188	<0.01		0.2	26	-25.8	169.8	9.4	<0.1	<0.1	0.07	0.43	0.36	Non-Acid Forming (Barren)
RGS337	KAL383	Banded Iron Formation	Marra Mamba	Nammuldi Member	58	60	2	8.1	206	<0.01		0.2	6.1	-5.9	39.8	7.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS339	KAL552	Banded Iron Formation	Marra Mamba	Nammuldi Member	56	58	2	8.8	230	0.12	0.12	3.6	35.4	-31.8	9.8	10.4	<0.1	<0.1	0.1	1.63	1.53	Non-Acid Forming
Mount Sylvia																						
RGS068	IRL163	Shale	Mount Sylvia	Mount Sylvia Formation	26	28	2	7.6	1140	<0.01		0.2	2.9	-2.7	18.9	6.4	<0.1	0.9	0.14	0.15	<0.02	Non-Acid Forming (Barren)
RGS229	IVN449	Shale	Mount Sylvia	Mount Sylvia Formation	80	82	2	7.8	744	0.08	0.03	0.8	66.4	-65.6	80.3	10.1	<0.1	<0.1	3.91	4.51	0.6	Non-Acid Forming (Barren)
RGS255	IYD745	Shale	Mount Sylvia	Mount Sylvia Formation	18	20	2	7.8	417	<0.01		0.2	1	-0.8	6.5	6.4	<0.1	1.2				Non-Acid Forming (Barren)
RGS376	KCH854	Shale	Mount Sylvia	Mount Sylvia Formation	34	36	2	7.3	384	0.02		0.6	0.5	0.1	0.8	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS380	KCJ122	Shale	Mount Sylvia	Mount Sylvia Formation	12	14	2	6.7	736	0.02		0.6	0.5	0.1	0.8	6.3	<0.1	1.4				Non-Acid Forming (Barren)
RGS382	KCJ214	Cherty Shale	Mount Sylvia	Mount Sylvia Formation	0	2	2	5.6	80	<0.01		0.2	0.2	0.0	1.3	6.3	<0.1	0.3				Non-Acid Forming (Barren)
RGS383	KCJ271	Shale	Mount Sylvia	Mount Sylvia Formation	16	18	2	6	153	0.05	0.01	0.3	0.2	0.1	0.6	5.5	<0.1	0.8				Non-Acid Forming (Barren)
RGS384	KCJ308	Shale	Mount Sylvia	Mount Sylvia Formation	26	28	2	6.6	362	0.02		0.6	0.3	0.3	0.5	5.8	<0.1	1.3				Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t					
Wittenoom Formation																						
RGS003	IKO454	Manganiferous Shale	Wittenoom Formation	West Angela Member	90	92	2	6.6	971	0.02		0.6	24.6	-24.0	40.2	8.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS004	IKO712	Shale	Wittenoom Formation	West Angela Member	134	136	2	7.5	722	<0.01		0.2	503	-502.8	3284.9	8.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS006	IKQ120	Banded Iron Formation	Wittenoom Formation	West Angela Member	82	84	2	6.8	496	<0.01		0.2	1	-0.8	6.5	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS016	IPM179	Shale	Wittenoom Formation	West Angela Member	48	50	2	7.7	516	<0.01		0.2	5.7	-5.5	37.2	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS018	IPO347	Low grade siliceous	Wittenoom Formation	West Angela Member	150	152	2	7.1	290	<0.01		0.2	2.5	-2.3	16.3	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS019	IPP003	Shale	Wittenoom Formation	Wittenoom Formation	24	26	2	7.8	734	<0.01		0.2	20.8	-20.6	135.8	10.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS028	IPY536	Shale	Wittenoom Formation	West Angela Member	102	104	2	7.6	441	<0.01		0.2	4.6	-4.4	30.0	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS035	IQS087	Shale	Wittenoom Formation	Wittenoom Formation	92	94	2	6	886	0.85	0.59	18.1	8.8	9.3	0.5	4.5	<0.1	23.6				Potentially Acid Forming - Low Capacity
RGS036	IQS139	Dolomite	Wittenoom Formation	Wittenoom Formation	188	190	2	7.8	267	<0.01		0.2	924	-923.8	6034.3	9.9	<0.1	<0.1	0.29	11.8	11.5	Non-Acid Forming (Barren)
RGS041	IQS377	Banded Iron Formation	Wittenoom Formation	West Angela Member	258	260	2	6.8	321	<0.01		0.2	2.4	-2.2	15.7	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS042	IQS406	Banded Iron Formation	Wittenoom Formation	West Angela Member	312	314	2	6.8	787	<0.01		0.2	8.2	-8.0	53.6	8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS045	IQS493	Cherty Shale	Wittenoom Formation	Wittenoom Formation	110	112	2	7.1	259	<0.01		0.2	5.9	-5.7	38.5	6.8	<0.1	0.7				Non-Acid Forming (Barren)
RGS051	IRI357	Shale	Wittenoom Formation	Wittenoom Formation	62	64	2	7.6	516	<0.01		0.2	7.5	-7.3	49.0	6.6	<0.1	1.3				Non-Acid Forming (Barren)
RGS052	IRI399	Shale	Wittenoom Formation	Wittenoom Formation	72	74	2	7	300	<0.01		0.2	3.6	-3.4	23.5	6.7	<0.1	0.6				Non-Acid Forming (Barren)
RGS053	IRI434	Shale	Wittenoom Formation	Wittenoom Formation	58	60	2	7.1	326	0.01		0.3	3.3	-3.0	10.8	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS054	IRI603	Shale	Wittenoom Formation	Wittenoom Formation	48	50	2	6.9	423	<0.01		0.2	3.8	-3.6	24.8	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS057	IRI843	Shale	Wittenoom Formation	Wittenoom Formation	34	36	2	7	394	0.02		0.6	2.6	-2.0	4.2	6.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS059	IRI877	Dolomite	Wittenoom Formation	Wittenoom Formation	48	50	2	8.1	388	<0.01		0.2	915	-914.8	5975.5	10.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS060	IRI883	Dolomite	Wittenoom Formation	Wittenoom Formation	60	62	2	8	786	<0.01		0.2	317	-316.8	2070.2	9.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS061	IRI885	Dolomite	Wittenoom Formation	Wittenoom Formation	64	66	2	8.2	840	0.01		0.3	294	-293.7	960.0	9.5	<0.1	<0.1	0.09	4.65	4.56	Non-Acid Forming (Barren)
RGS063	IRJ561	High Grade	Wittenoom Formation	West Angela Member	100	102	2	6.9	286	<0.01		0.2	2.8	-2.6	18.3	6.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS076	IRR109	Shale	Wittenoom Formation	West Angela Member	52	54	2	7.6	390	<0.01		0.2	2.8	-2.6	18.3	7.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS087	IRZ397	Low Grade Aluminous	Wittenoom Formation	West Angela Member	114	116	2	7.2	347	<0.01		0.2	2	-1.8	13.1	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS093	ISD892	Shale	Wittenoom Formation	Wittenoom Formation	74	76	2	8	756	<0.01		0.2	39.4	-39.2	257.3	9.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS094	ISD896	Shale	Wittenoom Formation	Wittenoom Formation	82	84	2	8	528	<0.01		0.2	78.4	-78.2	512.0	11	<0.1	<0.1				Non-Acid Forming (Barren)
RGS095	ISD900	Dolomite	Wittenoom Formation	Wittenoom Formation	90	92	2	7.8	1070	<0.01		0.2	124	-123.8	809.8	10.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS106	ISJ804	Shale	Wittenoom Formation	Wittenoom Formation	58	60	2	7	1110	<0.01		0.2	4.2	-4.0	27.4	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS108	ISL365	Banded Iron Formation	Wittenoom Formation	West Angela Member	106	108	2	7.1	1380	<0.01		0.2	16.1	-15.9	105.1	8.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS144	ITM309	Shale	Wittenoom Formation	Wittenoom Formation	88	90	2	7.4	363	0.04		1.2	7.7	-6.5	6.3	8.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS146	ITM815	Dolomite	Wittenoom Formation	Wittenoom Formation	120	122	2	7.8	500	<0.01		0.2	969	-968.8	6328.2	9.5	<0.1	<0.1	0.2	11.8	11.6	Non-Acid Forming (Barren)
RGS151	ITO839	Shale	Wittenoom Formation	West Angela Member	176	178	2	7.5	402	<0.01		0.2	7.8	-7.6	50.9	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS156	ITU268	Banded Iron Formation	Wittenoom Formation	West Angela Member	94	96	2	6.8	563	<0.01		0.2	6.9	-6.7	45.1	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS176	ITY333	Shale	Wittenoom Formation	West Angela Member	62	64	2	7.8	353	<0.01		0.2	7.5	-7.3	49.0	7.8	<0.1	<0.1				Non-Acid Forming (Barren)
RGS185	IUL147	Manganiferous Shale	Wittenoom Formation	West Angela Member	102	104	2	7.6	384	<0.01		0.2	6.1	-5.9	39.8	7.6	<0.1	<0.1				Non-Acid Forming (Barren)
RGS187	IUO164	Shale	Wittenoom Formation	Wittenoom Formation	50	52	2	7.7	816	<0.01		0.2	14.5	-14.3	94.7	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS188	IUO168	Shale	Wittenoom Formation	Wittenoom Formation	58	60	2	8.1	531	0.01		0.3	25.2	-24.9	82.3	8.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS189	IUO309	Cherty Shale	Wittenoom Formation	Wittenoom Formation	48	50	2	7.9	446	0.01		0.3	9.1	-8.8	29.7	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS191	IUO469	Shale	Wittenoom Formation	Wittenoom Formation	66	68	2	7.9	452	0.01		0.3	31.9	-31.6	104.2	9.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS212	IVB481	Manganiferous Shale	Wittenoom Formation	Wittenoom Formation	126	128	2	7	1260	<0.01		0.2	<0.5	-0.1	1.6	7.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS257	IYF074	Dolomite	Wittenoom Formation	Wittenoom Formation	76	78	2	8.2	577	<0.01		0.2	662	-661.8	4323.3	8.9	<0.1	<0.1				Non-Acid Forming (Barren)
RGS259	IYF389	Manganiferous Shale	Wittenoom Formation	Wittenoom Formation	86	88	2	8.7	268	<0.01		0.2	923	-922.8	6027.8	8.9	<0.1	<0.1	0.06	11.5	11.4	Non-Acid Forming (Barren)
RGS261	IYF784	Shale	Wittenoom Formation	Wittenoom Formation	82	84	2	7.9	1170	<0.01		0.2	3.2	-3.0	20.9	8.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS262	IYF868	Shale	Wittenoom Formation	Wittenoom Formation	76	78	2	8.2	809	<0.01		0.2	8.7	-8.5	56.8	8.4	<0.1	<0.1				Non-Acid Forming (Barren)
RGS263	IYF998	Dolomite	Wittenoom Formation	Wittenoom Formation	88	90	2	8.8	166	<0.01		0.2	993	-992.8	6484.9	10.9	<0.1	<0.1	0.21	12.6	12.4	Non-Acid Forming (Barren)
RGS293	IYZ822	Shale	Wittenoom Formation	Wittenoom Formation	74	76	2	7.9	735	<0.01		0.2	3	-3.0	19.6	7.7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS294	IYZ887	Shale	Wittenoom Formation	Wittenoom Formation	106	108	2	7.8	27	<0.01		0.2	2.8	-2.8	18.3	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS295	IYZ931	Dolomite	Wittenoom Formation	Wittenoom Formation	76	78	2	8.1	566	<0.01		0.2	996	-996.0	6504.5	10.4	<0.1	<0.1	0.08	12.7	12.6	Non-Acid Forming (Barren)
RGS300	IZB305	Carbonaceous Shale	Wittenoom Formation	Wittenoom Formation	12	14	2	7.9	650	<0.01		0.2	1.4	-1.4	9.1	6.6	<0.1	1				Non-Acid Forming (Barren)
RGS301	IZB311	Carbonaceous Shale	Wittenoom Formation	Wittenoom Formation	22	24	2	7.8	509	<0.01		0.2	1.4	-1.4	9.1	6.8	<0.1	1				Non-Acid Forming (Barren)
RGS338	KAL432	Shale	Wittenoom Formation	Wittenoom Formation	28	30	2	8.1	880	<0.01		0.2	9.2	-9.2	60.1	8.5	<0.1	1				Non-Acid Forming (Barren)
RGS342	KAN042	Shale	Wittenoom Formation	Wittenoom Formation	24	26	2	7.1	563	0.02		0.6	4.3	-3.7	7.0	6.8	<0.1	1				Non-Acid Forming (Barren)
RGS343	KAN056	Cherty Shale	Wittenoom Formation	Wittenoom Formation	14	16	2	7.3	478	0.01		0.3	3.8	-3.5	12.4	6.3	<0.1	1				Non-Acid Forming (Barren)
RGS344	KAN060	Shale	Wittenoom Formation	Wittenoom Formation	20	22	2	7.2	705	0.02		0.6	2.8	-2.2	4.6	6.7	<0.1	1				Non-Acid Forming (Barren)
RGS345	KAN075	Shale	Wittenoom Formation	Wittenoom Formation	22	24	2	6.9	534	<0.01		0.2	4.7	-4.7	30.7	6.9	<0.1	1				Non-Acid Forming (Barren)
RGS349	KAP645	Shale	Wittenoom Formation	Wittenoom Formation	56	58	2	7.8	216	0.01		0.3	2.2	-1.9	7.2	6	<0.1	1				Non-Acid Forming (Barren)
RGS350	KAP647	Shale	Wittenoom Formation	Wittenoom Formation	60	62	2	7.6	301	<0.01		0.2	2.6	-2.6	17.0	6.4	<0.1	1				Non-Acid Forming (Barren)
RGS358	KBG514	Shale	Wittenoom Formation	Wittenoom Formation	88	90	2	8.1	366	<0.01		0.2	2.9	-2.9	18.9	6.8	<0.1	1				Non-Acid Forming (Barren)
RGS369	KBO224	Shale	Wittenoom Formation	Wittenoom Formation	82	84	2	7	271	<0.01		0.2	2.3	-2.3	15.0	6.7	<0.1	1				Non-Acid Forming (Barren)
RGS370	KBO255	Shale	Wittenoom Formation	Wittenoom Formation	52	54	2	7.5	504	0.02		0.6	50.9	-50.3	83.1	8.9	<0.1	1				Non-Acid Forming (Barren)

Table B1: Acid Base Account (ABA) Test Results for Rio Tinto Brockman

RGS Sample No.	RT Sample ID	Sample Lithology	Stratigraphy	Strand Formations	From	To	Interval	pH[1]	EC[1]	Total S	Scr[2]	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	NAG_{pH}	NAG Capacity (pH 4.5)	NAG Capacity (pH 7)	Total Organic Carbon (TOC)	Total Carbon (TC)	Total inorganic Carbon (TIC)	Sample Classification[3]
					(m)				(µS/cm)	(%)	(%)	kg H_2SO_4/t					kg H_2SO_4/t						
Whaleback Shale Upper																						
RGS002	IKN707	Shale	Whaleback Shale	Whaleback Shale Upper	22	24	2	5.7	1400	0.11	0.01	0.2	1.8	1.6	8.4	4.9	<0.1	1.8				Uncertain
RGS066	IRK837	Low Grade Aluminous	Whaleback Shale	Whaleback Shale Lower	42	44	2	7.6	352	<0.01		0.2	3.3	-3.3	21.6	6.7	<0.1	1				Non-Acid Forming (Barren)
RGS073	IRQ039	Hydrated	Whaleback Shale	Whaleback Shale Lower	14	16	2	8.1	833	<0.01		0.2	16.17	-19.2	105.6	4.5	<0.1	<0.1	0.08	0.27	0.19	Non-Acid Forming (Barren)
RGS075	IRQ767	Low Grade Aluminous	Whaleback Shale	Whaleback Shale Lower	40	42	2	7.4	359	0.01		0.3	1.8	-1.5	5.9	7.5	<0.1	<0.1				Non-Acid Forming (Barren)
RGS083	IRU033	Low Grade Aluminous	Whaleback Shale	Whaleback Shale Lower	54	56	2	5.3	859	0.13	0.01	0.2	1	3.0	6.5	6.2	<0.1	2.7				Uncertain
RGS084	IRU100	Hydrated	Whaleback Shale	Whaleback Shale Upper	22	24	2	6.5	382	0.01		0.3	2.4	-2.1	7.8	6.9	<0.1	0.2				Non-Acid Forming (Barren)
RGS113	ITC933	Low grade siliceous	Whaleback Shale	Whaleback Shale Upper	74	76	2	7	148	<0.01		0.2	2.2	-2.2	14.4	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS129	ITI571	Shale	Whaleback Shale	Whaleback Shale Lower	44	46	2	7.6	861	<0.01		0.2	3.6	-3.6	23.5	7.2	<0.1	<0.1				Non-Acid Forming (Barren)
RGS133	ITI971	Shale	Whaleback Shale	Whaleback Shale Lower	44	46	2	7.6	326	<0.01		0.2	2.8	-2.8	18.3	7	<0.1	<0.1				Non-Acid Forming (Barren)
RGS138	ITL714	Shale	Whaleback Shale	Whaleback Shale Lower	80	82	2	7	716	<0.01		0.2	4	-4.0	26.1	6.9	<0.1	0.4				Non-Acid Forming (Barren)
RGS139	ITL727	Shale	Whaleback Shale	Whaleback Shale Lower	104	106	2	7.1	484	<0.01		0.2	2.1	-2.1	13.7	6.9	<0.1	0.6				Non-Acid Forming (Barren)
RGS140	ITL781	Manganese	Whaleback Shale	Whaleback Shale Lower	28	30	2	6.3	755	0.01	0.01	0.2	6.5	-6.2	42.4	7.3	<0.1	<0.1	0.08	0.09	<0.02	Non-Acid Forming (Barren)
RGS153	ITQ586	Shale	Whaleback Shale	Whaleback Shale Upper	28	30	2	7.5	609	0.01		0.3	2.2	-1.9	7.2	6.9	<0.1	0.1				Non-Acid Forming (Barren)
RGS183	IUK907	Shale	Whaleback Shale	Whaleback Shale Lower	14	16	2	7.4	283	<0.01		0.2	4.4	-4.4	28.7	6.7	<0.1	1				Non-Acid Forming (Barren)
RGS207	IVA504	Banded Iron Formation	Whaleback Shale	Whaleback Shale Lower	94	96	2	5.8	993	0.02		0.6	<0.5	0.6	0.4	6.9	<0.1	0.2				Non-Acid Forming (Barren)
RGS250	IXA258	Shale	Whaleback Shale	Whaleback Shale Upper	62	64	2	6.9	707	<0.01		0.2	<0.5	0.3	1.6	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS254	IYD139	Hydrated	Whaleback Shale	Whaleback Shale Lower	0	2	2	7.5	723	0.02		0.6	0.8	-0.2	1.3	6.6	<0.1	0.4				Non-Acid Forming (Barren)
RGS264	IYN249	Shale	Whaleback Shale	Whaleback Shale Lower	36	38	2	6.9	568	0.02		0.6	<0.5	0.6	0.4	7.3	<0.1	<0.1				Non-Acid Forming (Barren)
RGS265	IYN252	Shale	Whaleback Shale	Whaleback Shale Lower	40	42	2	6.3	286	<0.01		0.2	0.5	-0.5	3.3	6.3	<0.1	0.7				Non-Acid Forming (Barren)
RGS266	IYN256	Shale	Whaleback Shale	Whaleback Shale Lower	48	50	2	5.8	379	0.05	0.01	0.2	1.4	0.3	5.7	5.9	<0.1	0.6				Non-Acid Forming (Barren)
RGS267	IYN259	Shale	Whaleback Shale	Whaleback Shale Lower	54	56	2	6.2	312	0.06	<0.005	0.1	1.8	0.3	23.5	5.8	<0.1	0.6				Non-Acid Forming (Barren)
RGS268	IYN260	Shale	Whaleback Shale	Whaleback Shale Lower	56	58	2	6.2	333	0.06	0.01	0.2	0.8	1.0	4.4	5.7	<0.1	1				Non-Acid Forming (Barren)
RGS327	KAG209	High Phos High grade	Whaleback Shale	Whaleback Shale Upper	34	36	2	8	248	<0.01		0.2	1.2	-1.2	7.8	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS341	KAM176	Banded Iron Formation	Whaleback Shale	Whaleback Shale Upper	112	114	2	7.4	436	0.01		0.3	2.3	-2.0	7.5	7.1	<0.1	<0.1				Non-Acid Forming (Barren)
RGS362	KBJ443	Shale	Whaleback Shale	Whaleback Shale Upper	20	22	2	5.9	1640	0.28	0.01	0.2	2.7	5.9	17.6	6.2	<0.1	1.1				Potentially Acid Forming - Low Capacity
RGS375	KCH462	Low Grade Aluminous	Whaleback Shale	Whaleback Shale Upper	20	22	2	7.2	455	0.02		0.6	2.8	-2.2	4.6	6.7	<0.1	2				Non-Acid Forming (Barren)

1. Current pH, EC, Alkalinity and Acidity provided for saturated paste
2. Scr = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; and NAPP = Net Acid Producing Potential.
3. Sample classification criteria detail provided in report text.

* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used in Table C1.

Code	Classification	Total S	NAPP value	ANC:MPA Ratio
NAF (B)	Non-Acid Forming (Barren)	≤ 0.1	-	-
NAF	Non-Acid Forming	> 0.1	≤ -5	≥ 2
Uncertain	Uncertain	> 0.1	> -5 to ≤ +5	< 2
PAF (LC)	Potentially Acid Forming - Low Capacity	> 0.1	> 5 to ≤ 10	< 2
PAF	**Potentially Acid Forming**	> 0.1	> 10	< 2

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low Grade Detrital	Shale	Manganiferous Shale	Shale	Banded Iron Formation	Banded Iron Formation	Detrital Waste	Low Grade Detrital	Banded Iron Formation	Hydrated Waste	Shale	Banded Iron Formation
	Stratigraphy →		Detrital	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Detrital	Detrital	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba
	RGS Sample Number →		1	2	3	4	5	6	7	8	9	10	11	12
	ALS Laboratory ID →		EB2012964001	EB2012964002	EB2012964003	EB2012964004	EB2012964005	EB2012964006	EB2012964007	EB2012964008	EB2012964009	EB2012964010	EB2012964011	EB2012964012
	Client Sample ID →		IKN091	IKN707	IKO454	IKO712	IKO939	IKQ120	ILA414	ILA602	ILA658	ILA964	ILA976	ILB540
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	0.14	0.05	0.08	0.06	0.01	0.03	0.02	0.02	0.01	0.01	<0.01
Aluminium (Al)	0.01	-	4.01	7.63	1.29	3.61	0.12	0.50	7.69	3.94	1.15	12.65	10.95	8.28
Calcium (Ca)	0.01	-	0.15	0.02	0.33	5.42	0.86	0.02	0.08	0.04	0.04	0.04	0.04	0.14
Iron (Fe)	0.01	-	47.80	38.10	36.10	9.04	31.70	25.40	32.60	>50	37.20	14.00	23.20	19.40
Potassium (K)	0.01	-	0.05	0.02	0.62	0.92	0.04	0.01	0.03	0.01	0.07	0.02	0.11	0.28
Magnesium (Mg)	0.01	-	0.61	0.04	0.34	3.5	0.98	0.04	0.13	0.05	0.11	0.05	0.07	4.22
Sodium (Na)	0.01	-	0.02	0.03	0.15	0.08	0.12	0.01	0.03	0.01	0.01	0.02	0.02	0.02
Titanium (Ti)	0.005	-	0.393	0.404	0.04	0.159	0.007	0.022	0.311	0.35	0.047	1.155	0.934	0.752
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.76	5.56	0.3	1.73	0.18	0.52	7.33	5.38	1.23	0.83	0.69	0.22
Arsenic (As)	0.2	300	20	86.2	4.5	15.4	1.6	3.8	99.8	109	12.9	11.9	5	0.9
Barium (Ba)	10	-	40	10	10	50	20	10	20	20	10	10	10	30
Beryllium (Be)	0.05	90	1.1	4.1	0.55	0.67	0.5	0.4	0.59	0.65	0.61	0.51	0.75	0.39
Bismuth (Bi)	0.01	-	0.22	0.65	0.11	0.42	0.01	0.09	0.77	0.68	0.16	0.02	0.02	0.02
Boron (B)	10	20000	30	10	20	40	10	10	40	30	10	20	20	20
Cadmium (Cd)	0.02	90	0.04	0.02	0.52	1.96	<0.02	0.04	0.04	0.31	0.08	0.1	0.15	0.16
Caesium (Cs)	0.05	-	0.87	0.16	1.76	3.64	0.59	<0.05	0.2	0.19	0.33	0.35	0.15	1.3
Cerium (Ce)	0.01	-	24.6	50.4	46.2	68.5	2.58	7.29	98.1	14.05	11.05	3.44	11.5	5.03
Chromium (Cr)	1	300	86	71	13	69	6	11	142	94	23	143	139	119
Cobalt (Co)	0.1	300	15.5	8.7	26.3	50.8	1	6.4	13.7	13	7.7	5.8	21.4	76.8
Copper (Cu)	0.2	17000	10.1	59.6	7.9	37.1	2	7.7	38.3	22.1	15.7	72.5	224	166
Fluorine (F)	20	-	160	110	210	580	90	30	330	80	80	60	<20	170
Gallium (Ga)	0.05	-	13.55	18.6	7.63	10.9	1.16	1.97	24.3	18	3.52	31.4	27.3	20.9
Germanium (Ge)	0.05	-	3.18	1.54	0.95	0.1	0.41	0.36	2	2.49	0.27	1.36	1.06	0.65
Hafnium (Hf)	0.1	-	2.6	4.5	0.6	1.7	0.1	0.2	4.9	2.6	0.5	3.1	2.8	2.2
Indium (In)	0.005	-	0.084	0.088	0.014	0.038	<0.005	0.006	0.163	0.106	0.019	0.101	0.119	0.095
Lanthanum (La)	0.5	-	11.3	15.2	31	38.4	1.7	2.4	20.7	7	5.3	1.3	5.5	1.9
Lead (Pb)	0.5	600	15.3	19.6	4.3	17.5	0.7	2.8	20	16	6.5	3.1	1.7	4.9
Lithium (Li)	0.2	-	19	5.3	22	13.3	7.5	4.5	37.6	23.1	3.5	66.6	19.7	47.9
Manganese (Mn)	5	19000	231	1300	>100000	>100000	346	1020	384	210	480	106	491	1060
Mercury (Hg)	0.005	80	0.019	0.01	0.179	0.705	0.018	0.012	0.086	0.276	0.018	0.056	0.017	0.138
Molybdenum (Mo)	0.05	-	2.39	3.45	0.17	0.53	0.34	0.62	3.23	3.52	1.47	0.35	0.41	0.34
Nickel (Ni)	0.2	1200	39.8	45.4	70.9	90.5	2.7	7.9	49.4	25.7	19.6	31.4	108.5	101
Niobium (Nb)	0.1	-	9	11.7	0.9	3.5	0.3	0.7	9.1	9.5	1.3	5.6	4.4	3.6
Phosphorus (P)	10	-	160	1660	70	250	620	130	340	440	410	90	590	90
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	8.5	0.5	33.6	42.6	5.9	0.6	1.3	1	4.1	1.2	4.7	12.1
Scandium (Sc)	0.1	-	9.3	17.5	3.9	8.2	0.4	1.2	18.4	8.1	3.7	49.5	54.6	54.3
Selenium (Se)	1	700	1	1	<1	1	<1	<1	3	2	<1	1	<1	1
Silver (Ag)	0.01	-	0.01	<0.01	0.04	0.12	<0.01	0.04	0.16	0.17	0.02	0.07	0.01	0.05
Strontium (Sr)	0.2	-	15.6	58.5	388	8.9	8.8	0.7	10	5.9	2.3	2.3	2.6	7.3
Tantalum (Ta)	0.05	-	0.67	0.92	0.09	0.36	<0.05	0.05	0.82	0.73	0.11	0.38	0.3	0.24
Tellurium (Te)	0.05	-	0.34	0.45	0.25	0.08	0.18	0.16	0.73	1.45	0.07	0.1	0.19	0.16
Thallium (Tl)	0.02	-	0.07	0.02	2.45	0.24	0.02	0.02	0.05	0.12	0.04	<0.02	0.02	0.06
Thorium (Th)	0.01	-	6.77	13.45	2.17	7.58	0.19	0.8	11.75	7.79	2.45	0.54	0.41	0.25
Tin (Sn)	0.2	-	2.4	2.5	0.4	1.4	0.2	0.3	2.9	2.7	0.5	1.2	1	0.7
Tungsten (W)	0.1	-	1.9	3	1	1	3.2	0.9	2.4	2.7	3.2	1.1	0.8	1
Uranium (U)	0.1	-	1.5	3.5	1.2	2.2	<0.1	1	6.8	1.9	0.7	0.4	1	0.3
Vanadium (V)	1	-	88	124	25	69	3	8	153	126	25	250	338	411
Yttrium (Y)	0.1	-	15.3	27.9	56.3	47.2	4.6	3.4	9.3	8.4	9.6	5.9	14.9	21.3
Zinc (Zn)	2	30000	146	109	58	109	6	13	19	115	88	162	331	198
Zirconium (Zr)	0.5	-	98.4	158.5	18.5	60.8	2.3	7.4	170	90.6	20.4	95.6	90.9	72.3

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Banded Iron Formation	Detrital Waste	Hydrated	Shale	Detrital Waste	Low grade siliceous	Shale	Detrital Waste	Shale	Banded Iron Formation	Banded Iron Formation	High Phos High grade
	Stratigraphy →		Marra Mamba	Detrital	Marra Mamba	Wittenoom Formation	Detrital	Wittenoom Formation	Wittenoom Formation	Detrital	Mount McRae Shale	Dales Gorge Member	Joffre Member	Joffre Member
	RGS Sample Number →		13	14	15	16	17	18	19	20	21	22	23	24
	ALS Laboratory ID →		EB2012964013	EB2012964014	EB2012964015	EB2012964016	EB2012964017	EB2012964018	EB2012964019	EB2012964020	EB2012964021	EB2012964022	EB2012964023	EB2012964024
	Client Sample ID →		ILC560	ILD638	ILD720	IPM179	IPN302	IPO347	IPP003	IPP032	IPP152	IPP456	IPP783	IPP791
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.02	0.07	0.01	0.01	0.03
Aluminium (Al)	0.01	-	1.51	3.88	1.02	1.37	4.84	1.57	3.70	4.95	10.10	0.58	1.01	1.56
Calcium (Ca)	0.01	-	0.02	0.08	0.01	0.09	0.06	0.02	0.62	1.68	0.05	0.02	0.01	0.01
Iron (Fe)	0.01	-	29.20	41.70	>50	46.70	40.60	>50	49.80	46.20	18.65	45.70	36.60	48.90
Potassium (K)	0.01	-	0.01	0.08	0.02	0.01	0.13	0.01	0.01	0.01	0.33	0.01	0.02	0.01
Magnesium (Mg)	0.01	-	0.03	0.06	0.04	0.47	0.06	0.1	0.11	0.13	0.08	0.03	0.02	0.01
Sodium (Na)	0.01	-	0.01	0.03	0.01	0.02	0.05	0.01	0.02	0.03	0.04	0.01	0.01	0.01
Titanium (Ti)	0.005	-	0.09	0.398	0.06	0.148	0.419	0.054	0.18	0.289	0.564	0.013	0.02	0.034
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.95	2.54	0.68	0.65	3.61	1.27	1.19	1.32	14	0.68	0.45	0.7
Arsenic (As)	0.2	300	10.7	24	20.8	9.9	56.7	16.7	77.5	125	194.5	12.2	2.3	3.9
Barium (Ba)	10	-	10	50	10	20	50	10	10	10	130	10	40	30
Beryllium (Be)	0.05	90	1.24	0.38	1.04	2.95	0.66	1.55	2.52	1.17	0.67	1.01	1.36	1.73
Bismuth (Bi)	0.01	-	0.09	0.33	0.07	0.06	0.55	0.34	0.2	0.28	3.46	0.15	0.07	0.07
Boron (B)	10	20000	10	30	10	30	40	20	20	30	70	20	20	10
Cadmium (Cd)	0.02	90	0.11	0.02	0.24	0.04	0.04	0.38	<0.02	<0.02	0.03	0.03	<0.02	<0.02
Caesium (Cs)	0.05	-	0.07	0.7	0.22	0.4	1.27	<0.05	0.09	0.14	1.74	0.07	0.18	0.1
Cerium (Ce)	0.01	-	5.91	13	9.75	23.2	24.7	16.35	20.4	59.9	77.8	20	74.6	43.1
Chromium (Cr)	1	300	34	187	27	19	171	73	29	42	204	4	8	9
Cobalt (Co)	0.1	300	5.6	4.7	7.5	15.4	5.5	18.9	5.3	6.1	1.5	2.3	1.1	1.6
Copper (Cu)	0.2	17000	86.4	37.8	32.5	7.5	30	28	5.1	7.4	47	9.5	6.6	6.6
Fluorine (F)	20	-	80	50	50	240	50	40	230	300	390	20	20	20
Gallium (Ga)	0.05	-	4.18	17.85	2.45	5.19	20.2	3.74	8.63	10.55	25.2	1.57	1.78	3.06
Germanium (Ge)	0.05	-	0.88	1.58	3.23	3.73	1.49	7.61	4.32	5.33	1.1	0.37	0.42	0.64
Hafnium (Hf)	0.1	-	0.7	3.1	0.4	0.7	4.1	0.8	1.4	2.2	8.3	0.6	0.4	0.7
Indium (In)	0.005	-	0.019	0.143	0.012	0.022	0.131	0.017	0.059	0.072	0.307	0.008	0.006	0.008
Lanthanum (La)	0.5	-	3.1	5.2	6.8	15.5	10	5.4	8.3	29.2	48.3	19.2	40.2	22.3
Lead (Pb)	0.5	600	8.5	18.3	4.4	5.4	19.2	7.6	11.8	17.3	178.5	7.3	5.2	4.5
Lithium (Li)	0.2	-	2.3	2.8	2.2	2.2	6.9	2.4	18.4	19.8	57.6	2.3	1.5	0.4
Manganese (Mn)	5	19000	61	214	391	96	595	795	59	58	25	166	116	92
Mercury (Hg)	0.005	80	0.025	0.017	0.033	0.019	0.015	0.027	0.02	0.027	0.135	0.016	0.018	0.019
Molybdenum (Mo)	0.05	-	0.62	2.15	2.56	0.84	2.44	2.65	1.47	1.54	10.85	1.31	0.4	0.45
Nickel (Ni)	0.2	1200	21.3	19.9	28.5	47.1	25.4	51.5	19	20.6	32.8	5.7	3.8	4.9
Niobium (Nb)	0.1	-	2	8.1	1.4	3.6	10.3	1.8	5.5	8.3	20.1	1.3	0.9	1.5
Phosphorus (P)	10	-	150	300	400	80	380	860	290	410	340	810	1440	1890
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	1	8.6	0.9	2.2	14	0.3	0.4	0.8	23.7	0.8	2.1	0.3
Scandium (Sc)	0.1	-	6.3	15.2	2.6	3	17.6	3.9	5.2	8.5	27.8	0.7	1.2	1.5
Selenium (Se)	1	700	1	2	1	<1	3	<1	1	1	5	<1	<1	2
Silver (Ag)	0.01	-	0.06	0.13	0.05	<0.01	0.11	0.01	0.01	0.01	0.23	0.01	<0.01	<0.01
Strontium (Sr)	0.2	-	2.8	18.1	1.1	8.1	26.1	1.4	5.5	11.1	49.5	4.1	24.7	13.1
Tantalum (Ta)	0.05	-	0.16	0.58	0.13	0.29	0.77	0.18	0.39	0.61	1.72	0.1	0.07	0.11
Tellurium (Te)	0.05	-	0.26	0.47	0.39	0.32	0.63	0.45	0.43	0.44	1.31	0.35	0.28	0.37
Thallium (Tl)	0.02	-	0.04	0.13	0.04	<0.02	0.18	0.02	0.03	0.04	0.12	0.08	<0.02	<0.02
Thorium (Th)	0.01	-	1.88	9.73	1.17	1.65	15.3	3.14	4.16	6.38	38.5	1.79	1.24	2.32
Tin (Sn)	0.2	-	0.6	2.8	0.4	0.9	2.6	0.5	1.1	1.7	8.3	0.4	0.2	0.3
Tungsten (W)	0.1	-	1.1	1.4	1.2	1.2	2.1	0.8	2.3	2.9	6.7	1.7	1.7	1.7
Uranium (U)	0.1	-	0.4	1.8	1.9	2	2.1	3	2.2	2.2	5.3	0.8	1.5	0.7
Vanadium (V)	1	-	29	199	24	29	174	59	89	95	111	6	9	11
Yttrium (Y)	0.1	-	6.2	5.6	10.2	23	10.5	23.3	15	9.4	27.1	5.6	7.9	8.1
Zinc (Zn)	2	30000	260	20	250	463	33	456	5	11	22	16	5	13
Zirconium (Zr)	0.5	-	25.8	104	16.1	24.5	137.5	28.5	52.4	81.8	270	21.5	15.1	27.6

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low Grade Limonite	Banded Iron Formation	Detrital Waste	Shale	Detrital Waste	Dolerite	Shale	Shale	Banded Iron Formation	Banded Iron Formation	Shale	Dolomite
	Stratigraphy →		Detrital	Mount McRae Shale	Detrital	Wittenoom Formation	Detrital	Dolerite	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Wittenoom Formation	Wittenoom Formation
	RGS Sample Number →		25	26	27	28	29	30	31	32	33	34	36	37
	ALS Laboratory ID →		EB2012964025	EB2012964026	EB2012964027	EB2012964028	EB2012964029	EB2012964030	EB2012964031	EB2012964032	EB2012964033	EB2012964034	EB2012964035	EB2012964036
	Client Sample ID →		IPP981	IPU900	IPY508	IPY536	IPY819	IPY877	IPY893	IPY901	IQP002	IQP120	IQS087	IQS139
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	<0.01	0.02	0.01	0.07	0.01	0.01	0.01	0.04	0.16	0.42	0.04
Aluminium (Al)	0.01	-	0.34	0.18	3.19	8.20	5.15	11.65	5.37	1.12	0.47	1.92	1.88	0.35
Calcium (Ca)	0.01	-	<0.01	0.03	0.34	0.05	0.59	0.05	0.03	0.01	0.01	0.01	0.19	18.55
Iron (Fe)	0.01	-	8.26	32.20	36.80	32.50	46.80	20.30	27.20	39.20	26.60	43.90	5.90	3.32
Potassium (K)	0.01	-	<0.01	0.01	0.04	0.61	0.03	0.19	0.01	0.01	0.01	0.01	0.03	0.12
Magnesium (Mg)	0.01	-	<0.01	0.03	0.48	0.3	0.25	0.08	0.04	0.03	0.01	0.02	0.09	10.65
Sodium (Na)	0.01	-	<0.01	<0.01	0.03	0.02	0.04	0.04	0.01	0.01	0.02	0.01	0.25	0.07
Titanium (Ti)	0.005	-	0.017	0.007	0.523	0.343	0.552	1.025	0.929	0.078	0.022	0.09	0.132	0.019
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.23	0.16	1.82	5.32	2.9	0.63	0.58	0.31	0.36	0.91	1.44	0.43
Arsenic (As)	0.2	300	1.1	7.3	17.7	39.2	26.8	26.5	9.2	2.5	1.3	15.5	19.4	4
Barium (Ba)	10	-	10	10	80	50	50	10	<10	<10	10	10	20	10
Beryllium (Be)	0.05	90	0.33	1.47	0.27	3.91	0.31	0.77	0.68	0.55	0.93	2.68	0.72	0.24
Bismuth (Bi)	0.01	-	0.02	0.01	0.24	0.69	0.38	0.03	0.05	0.03	0.02	0.09	0.26	0.03
Boron (B)	10	20000	20	<10	40	20	50	20	10	10	10	10	30	10
Cadmium (Cd)	0.02	90	<0.02	0.02	0.04	0.34	<0.02	0.05	0.17	0.06	<0.02	0.06	0.04	0.02
Caesium (Cs)	0.05	-	0.11	<0.05	0.38	1.44	0.29	0.37	0.5	0.08	0.15	0.06	0.49	0.66
Cerium (Ce)	0.01	-	9.76	8.75	4.2	411	6.76	12.05	10.4	11.7	2.53	29.1	21.6	11.7
Chromium (Cr)	1	300	4	7	104	143	176	114	147	21	10	37	27	6
Cobalt (Co)	0.1	300	0.5	2.1	13.8	30.1	4.9	17.6	9.6	5	1.7	11.9	2.8	1.8
Copper (Cu)	0.2	17000	2.5	6.9	19.5	52.1	20.2	240	83.2	20.7	3.5	24.5	8.2	5.4
Fluorine (F)	20	-	<20	20	420	330	180	100	80	<20	<20	120	110	200
Gallium (Ga)	0.05	-	0.66	0.54	18.1	24.6	23.9	29.1	22.2	2.46	1.02	4.53	5.59	1.15
Germanium (Ge)	0.05	-	0.21	0.3	7.06	1.85	3.6	3.36	1.06	0.37	0.24	5.06	<0.05	<0.05
Hafnium (Hf)	0.1	-	0.3	0.1	2.9	3.6	4.1	2.5	2.6	0.3	0.2	0.8	0.8	0.1
Indium (In)	0.005	-	<0.005	<0.005	0.057	0.086	0.156	0.135	0.11	0.011	0.007	0.018	0.035	0.008
Lanthanum (La)	0.5	-	4.9	2.2	2.5	350	2.6	4.6	1.2	1.9	0.9	3	13.5	7.3
Lead (Pb)	0.5	600	1.2	1	9.5	21.7	23.6	2.9	4	1.9	2.4	10.7	11.2	1.4
Lithium (Li)	0.2	-	15.2	2.4	2.1	23.1	4.5	17.8	9.1	1.8	1.8	1.2	8.9	3.4
Manganese (Mn)	5	19000	48	123	67	2780	84	1520	117	855	37	306	943	4800
Mercury (Hg)	0.005	80	0.014	0.011	<0.005	0.044	0.009	0.027	0.075	0.011	0.015	0.011	0.271	0.015
Molybdenum (Mo)	0.05	-	0.32	1.52	2.55	1.43	3.61	0.54	0.58	0.66	0.44	0.71	2.15	0.4
Nickel (Ni)	0.2	1200	2.1	6	34.3	99.8	26.7	60	19.3	17	4.8	28.1	11.4	6.9
Niobium (Nb)	0.1	-	0.5	0.4	11.8	8.1	12.1	5.1	4.7	0.8	0.5	2.5	3.6	0.5
Phosphorus (P)	10	-	330	950	90	890	170	580	620	430	170	160	20	90
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.3	0.5	6.2	29.5	2.5	7.2	0.8	0.3	1.5	0.3	1.8	4.1
Scandium (Sc)	0.1	-	0.4	0.4	5.5	20.3	15.4	53.4	18.8	7.4	1.1	6.5	3	1.1
Selenium (Se)	1	700	<1	<1	1	1	1	1	1	<1	<1	<1	<1	1
Silver (Ag)	0.01	-	<0.01	0.01	<0.01	0.05	0.04	0.03	0.37	0.03	0.01	0.04	0.02	0.01
Strontium (Sr)	0.2	-	2.6	1.3	27.9	8.6	33.9	2.9	1.7	0.6	0.8	0.6	5.4	14.9
Tantalum (Ta)	0.05	-	<0.05	<0.05	0.92	0.72	0.89	0.33	0.32	0.06	<0.05	0.19	0.3	<0.05
Tellurium (Te)	0.05	-	0.07	0.26	0.33	0.45	0.51	0.18	0.29	0.28	0.21	0.4	0.07	<0.05
Thallium (Tl)	0.02	-	<0.02	0.02	0.02	0.17	0.03	0.06	<0.02	<0.02	<0.02	0.04	0.04	0.06
Thorium (Th)	0.01	-	0.95	0.17	5.31	12.9	9.13	0.42	0.3	0.59	0.51	2.45	3.27	0.7
Tin (Sn)	0.2	-	0.2	<0.2	3	2.4	3.9	1.2	2.1	0.2	0.2	0.6	1.2	0.4
Tungsten (W)	0.1	-	0.8	3.1	2.1	2.3	2.1	0.4	3.9	1.4	1.6	1	1.8	0.4
Uranium (U)	0.1	-	0.2	0.3	1.5	4.6	1.8	0.7	1.3	0.4	0.2	1.3	1.4	0.3
Vanadium (V)	1	-	3	5	117	111	186	517	451	47	8	30	34	7
Yttrium (Y)	0.1	-	2	8.9	5.2	99.5	4.3	15.5	4.7	6.4	2.9	11.1	7.8	10.2
Zinc (Zn)	2	30000	3	15	415	223	98	73	164	87	6	35	4	8
Zirconium (Zr)	0.5	-	9.8	3.9	103.5	119.5	139.5	82.9	83.8	12.4	6.6	29.6	33.4	5.1

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Lignite	Lignite	Silcrete	Silcrete	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Calcrete	Cherty Shale	Red Ochre Waste	Calcrete	Limonitic Waste
	Stratigraphy →		Detrital	Detrital	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Marra Mamba	Detrital	Wittenoom Formation	Detrital	Detrital	Detrital
	RGS Sample Number →		38	39	40	41	42	43	44	45	46	47	48	49
	ALS Laboratory ID →		EB2012964037	EB2012964038	EB2012964039	EB2012964040	EB2012964041	EB2012964042	EB2012964043	EB2012964044	EB2012964045	EB2012964046	EB2012964047	EB2012964048
	Client Sample ID →		IQS283	IQS289	IQS300	IQS307	IQS377	IQS406	IQS418	IQS454	IQS493	IQS554	IQS585	IQS975
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.36	1.68	0.56	0.03	<0.01	0.02	0.01	0.04	0.01	0.13	0.01	0.07
Aluminium (Al)	0.01	-	6.35	1.58	2.63	0.63	2.46	2.46	0.40	0.31	8.16	4.97	4.02	2.92
Calcium (Ca)	0.01	-	0.47	0.26	0.25	0.03	0.02	0.05	0.02	18.35	0.05	0.09	2.18	0.07
Iron (Fe)	0.01	-	5.54	10.10	8.99	3.06	24.10	38.30	44.10	5.29	12.45	46.10	37.90	35.50
Potassium (K)	0.01	-	0.50	0.14	0.30	0.08	0.07	0.29	0.01	0.01	2.24	0.52	0.06	0.04
Magnesium (Mg)	0.01	-	0.41	0.16	0.21	0.04	0.07	0.12	0.04	9.83	0.5	0.15	1.46	0.16
Sodium (Na)	0.01	-	0.15	0.01	0.28	0.01	0.02	<0.01	<0.01	0.06	0.02	0.01	0.02	0.02
Titanium (Ti)	0.005	-	0.451	0.065	0.127	0.026	0.074	0.09	0.015	0.026	0.323	0.251	0.393	0.936
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	5.19	1.84	2.9	0.82	1.45	2.21	0.3	0.18	4.43	17.6	2.09	4.86
Arsenic (As)	0.2	300	41.5	34.2	26.4	10.2	62.4	20.9	4.8	6.7	25.9	340	28.4	40.9
Barium (Ba)	10	-	50	10	50	10	10	1380	30	20	130	40	40	30
Beryllium (Be)	0.05	90	1.99	0.74	1.09	0.42	0.48	0.85	0.43	0.3	3.39	1.53	1.13	0.51
Bismuth (Bi)	0.01	-	0.73	0.17	0.29	0.06	0.14	0.3	0.03	0.02	0.62	1.52	0.24	1.23
Boron (B)	10	20000	40	20	20	10	120	10	10	10	60	40	20	40
Cadmium (Cd)	0.02	90	0.17	0.14	0.16	0.19	0.03	0.11	<0.02	0.06	0.25	0.13	0.03	0.15
Caesium (Cs)	0.05	-	6.62	2.32	5.92	1.27	0.21	0.12	<0.05	1.32	6.1	7.91	1.85	0.87
Cerium (Ce)	0.01	-	53.1	20.1	28.7	7.16	16.8	39.2	9.23	6.24	139.5	28.1	45.3	30.2
Chromium (Cr)	1	300	138	44	53	28	47	43	5	4	180	228	79	159
Cobalt (Co)	0.1	300	8.2	7.8	13.1	12.7	2.8	24.3	1.7	6.1	5.7	8.5	22.7	14.8
Copper (Cu)	0.2	17000	45.9	15.4	21.5	7.9	13.1	19.2	3.8	4.1	43.5	27.3	10.1	53.3
Fluorine (F)	20	-	470	90	200	<20	30	30	20	510	950	240	170	110
Gallium (Ga)	0.05	-	21.2	4.16	7.64	1.32	4.5	6.56	1.01	0.97	21.5	23.1	17	17.35
Germanium (Ge)	0.05	-	0.28	0.23	0.06	0.16	0.35	3.98	0.4	<0.05	0.57	2.92	3.49	2.68
Hafnium (Hf)	0.1	-	3.2	0.7	1	0.2	0.8	1.2	0.1	0.2	3.3	3.8	2.7	5.6
Indium (In)	0.005	-	0.12	0.024	0.042	0.012	0.022	0.027	<0.005	0.008	0.073	0.202	0.094	0.181
Lanthanum (La)	0.5	-	25.8	10.5	16.5	5.4	6.1	13.8	1.3	4.1	107.5	11.9	21.3	27.1
Lead (Pb)	0.5	600	36.7	9.9	14.8	3.6	6.1	9	1.2	1.7	30.5	42.2	21	26.7
Lithium (Li)	0.2	-	41.5	10.4	14.8	6	8.2	5	2.7	1.1	30.4	18.3	28.9	10.4
Manganese (Mn)	5	19000	440	1780	2060	950	252	36700	1500	272	116	196	421	220
Mercury (Hg)	0.005	80	0.246	0.087	0.095	0.386	0.014	0.117	0.005	0.005	0.085	0.136	0.018	0.066
Molybdenum (Mo)	0.05	-	4.67	1.82	1.94	0.82	1	0.91	0.5	0.3	0.96	15.2	3.72	7.91
Nickel (Ni)	0.2	1200	44.4	24.4	44.9	30.1	17.8	28.8	5.6	7	59.7	43.9	48.2	34.2
Niobium (Nb)	0.1	-	11.7	1.6	2.9	0.7	1.6	2.4	0.4	0.7	7.7	7.7	9.8	24.4
Phosphorus (P)	10	-	60	30	40	30	440	510	490	20	370	590	120	540
Rhenium (Re)	0.002	-	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002
Rubidium (Rb)	0.1	-	23.2	10.6	22	5.5	3.6	5.1	0.3	1.8	103	37.3	6.3	2.8
Scandium (Sc)	0.1	-	12.4	3.7	5.6	1.4	3.8	5.2	0.8	0.6	17.4	22	12.5	6.1
Selenium (Se)	1	700	2	1	<1	<1	<1	<1	<1	1	<1	8	<1	13
Silver (Ag)	0.01	-	0.13	0.05	0.06	0.11	0.02	0.1	0.02	0.01	0.44	0.05	0.04	0.21
Strontium (Sr)	0.2	-	14	3	5.1	3.7	2.2	106.5	1.6	91.5	16	6.6	18.3	21.8
Tantalum (Ta)	0.05	-	1.1	0.13	0.28	0.06	0.14	0.23	<0.05	0.05	0.72	0.64	0.77	1.75
Tellurium (Te)	0.05	-	0.26	0.15	0.1	0.06	0.25	0.35	0.36	<0.05	0.22	1.45	0.1	1.66
Thallium (Tl)	0.02	-	0.74	0.26	0.71	0.23	0.02	15.5	0.06	0.1	0.41	0.86	0.49	0.15
Thorium (Th)	0.01	-	9.82	2.79	5.21	1.07	2.87	4.29	0.46	0.45	13.6	17.5	8.3	7.97
Tin (Sn)	0.2	-	3.8	0.7	1.3	0.4	0.6	0.8	<0.2	0.3	2.6	3	2.6	6.5
Tungsten (W)	0.1	-	3.9	1.8	2.7	1.1	1.2	1.2	0.9	0.3	2.4	5	2.3	4.2
Uranium (U)	0.1	-	4.3	1.1	2.1	0.3	1	2	0.4	0.5	3.1	4.6	1.7	4
Vanadium (V)	1	-	123	27	44	12	28	38	5	7	106	147	96	209
Yttrium (Y)	0.1	-	18.3	8.7	15.3	5.3	9.3	15.3	3.9	4.4	70.7	13.5	18.4	14.2
Zinc (Zn)	2	30000	75	54	110	34	23	45	7	32	82	115	55	70
Zirconium (Zr)	0.5	-	105.5	24.3	37.6	8.2	29.4	41.6	5.2	5.4	108	123	91.8	180.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Hydrated	Banded Iron Formation	Shale	Shale	Shale	Shale	Calcrete	Low Grade Limonite	Shale	Pisolite Waste	Dolomite	Dolomite
	Stratigraphy →		Marra Mamba	Marra Mamba	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Wittenoom Formation	Detrital	Wittenoom Formation	Wittenoom Formation
	RGS Sample Number →		50	51	52	53	54	55	56	57	58	59	60	61
	ALS Laboratory ID →		EB2012964049	EB2012964050	EB2012964051	EB2012964052	EB2012964053	EB2012964054	EB2012964055	EB2012964056	EB2012964057	EB2012964058	EB2012964059	EB2012964060
	Client Sample ID →		IRA551	IRA619	IRI357	IRI399	IRI434	IRI603	IRI671	IRI781	IRI843	IRI876	IRI877	IRI883
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.19	0.01	0.01	0.03	0.03	0.04	0.02	0.04	0.01	0.03	0.06
Aluminium (Al)	0.01	-	1.86	1.17	9.49	10.00	4.96	4.95	3.04	4.91	5.79	4.14	0.66	4.67
Calcium (Ca)	0.01	-	0.09	0.26	0.05	0.02	0.04	0.06	11.00	0.10	0.03	4.26	19.55	5.98
Iron (Fe)	0.01	-	>50	26.40	7.17	1.55	45.80	48.50	17.25	>50	49.10	45.10	6.03	27.70
Potassium (K)	0.01	-	0.01	0.39	2.27	0.05	0.14	0.25	0.03	0.03	0.01	0.02	0.02	0.03
Magnesium (Mg)	0.01	-	0.08	1.77	0.31	0.07	0.1	0.12	7.63	0.18	0.05	1.7	9.67	3.98
Sodium (Na)	0.01	-	0.01	0.04	0.05	0.02	0.02	0.03	0.08	0.02	0.02	0.02	0.06	0.09
Titanium (Ti)	0.005	-	0.064	0.065	0.429	0.502	0.178	0.147	0.307	0.333	0.272	0.382	0.056	0.349
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.92	0.86	5.25	1.4	4.94	13.8	5.54	4.28	3.5	2.92	0.51	9.37
Arsenic (As)	0.2	300	19.7	8.1	34.2	14.4	120	486	39.2	68.9	64.9	43.8	7	68.5
Barium (Ba)	10	-	10	70	130	10	40	50	50	60	10	50	40	50
Beryllium (Be)	0.05	90	1.1	0.94	2.19	0.98	1.68	1	0.35	1.73	0.58	0.62	0.09	0.55
Bismuth (Bi)	0.01	-	0.14	0.1	1.24	0.07	0.74	1.03	0.67	0.73	0.43	0.36	0.06	0.61
Boron (B)	10	20000	10	20	100	10	40	50	30	20	20	40	20	40
Cadmium (Cd)	0.02	90	0.79	0.11	0.03	0.03	0.41	0.42	0.03	0.18	0.03	0.02	<0.02	0.02
Caesium (Cs)	0.05	-	0.12	7.1	6.19	0.45	1.44	2.2	1.52	1.15	0.1	0.89	0.27	1.45
Cerium (Ce)	0.01	-	15.95	12.6	3.97	4.59	43.9	22.6	4.92	34.1	7.69	22	4.76	6.98
Chromium (Cr)	1	300	19	21	241	1140	71	80	84	70	101	86	11	181
Cobalt (Co)	0.1	300	13	7.1	1.3	4	11.2	2.4	2.2	20.5	7.2	5.4	1.6	3.1
Copper (Cu)	0.2	17000	37	13.8	5.9	13.1	195	33	7.1	20.6	33	8.5	4.5	5.9
Fluorine (F)	20	-	40	190	1170	60	250	190	890	180	200	140	420	750
Gallium (Ga)	0.05	-	3.83	3.38	37.1	19.25	13.8	17.15	23.3	22	16.25	15.9	2.31	26.4
Germanium (Ge)	0.05	-	4.13	0.16	0.56	<0.05	2.27	4.71	0.09	2.77	2.04	2.13	<0.05	0.97
Hafnium (Hf)	0.1	-	0.6	0.6	5.3	1.2	2.7	2.8	2.2	3.1	2.6	2.4	0.4	2.2
Indium (In)	0.005	-	0.019	0.014	0.142	0.065	0.075	0.154	0.117	0.116	0.112	0.088	0.016	0.126
Lanthanum (La)	0.5	-	6	7	1.7	3.2	8.1	16.3	2.4	52.9	4	10.5	2.1	3.9
Lead (Pb)	0.5	600	8.9	6.1	37.1	6.4	38.4	47.4	9.5	25.2	13.5	20.4	3.1	14.8
Lithium (Li)	0.2	-	4.1	6.6	27.4	29.1	3.6	9.3	9.1	5	1.2	22.4	5.2	15.2
Manganese (Mn)	5	19000	197	1930	27	19	892	126	200	170	108	64	48	141
Mercury (Hg)	0.005	80	0.036	0.043	0.043	0.016	0.235	0.278	0.018	0.206	0.055	0.015	0.012	0.012
Molybdenum (Mo)	0.05	-	1.72	0.79	2.8	0.69	3.34	15.95	3.52	6.6	3.88	4.64	0.75	4.67
Nickel (Ni)	0.2	1200	30.6	19.8	26.2	105.5	52.6	43.5	7.3	30	19.4	21.9	4.7	11.2
Niobium (Nb)	0.1	-	1.7	1.8	12.3	2.2	6.4	5.2	8.6	11.3	5	9.7	1.4	8.8
Phosphorus (P)	10	-	720	490	60	70	600	470	110	510	630	140	30	180
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.6	48	86.6	2.7	10.2	17.5	4.3	3.1	0.6	3.1	1.4	4.7
Scandium (Sc)	0.1	-	6.2	3.3	15.5	29.5	18.4	14.4	3.1	7.4	13.7	8.5	1.4	4.1
Selenium (Se)	1	700	1	<1	<1	1	3	4	1	3	5	1	1	1
Silver (Ag)	0.01	-	0.08	0.05	0.01	0.06	0.82	0.21	0.01	0.06	0.02	0.03	0.01	<0.01
Strontium (Sr)	0.2	-	2.1	5.7	5.7	3.7	5.2	9.6	125.5	10.3	3.5	41.4	193.5	59.7
Tantalum (Ta)	0.05	-	0.15	0.15	1.2	0.16	0.52	0.42	0.73	0.91	0.4	0.78	0.11	0.8
Tellurium (Te)	0.05	-	0.05	<0.05	0.27	0.07	0.35	0.57	0.32	0.29	0.28	0.15	<0.05	0.26
Thallium (Tl)	0.02	-	0.03	0.08	0.55	0.02	0.55	0.12	0.08	0.21	0.02	0.04	0.09	0.08
Thorium (Th)	0.01	-	1.86	2.03	8.96	0.9	11.1	12.5	8.79	10.6	7.15	7.78	1.27	9.37
Tin (Sn)	0.2	-	0.6	0.6	5.4	0.7	2	2.2	3.4	3.1	1.5	2.6	0.5	3.7
Tungsten (W)	0.1	-	1.2	2.2	3.4	0.7	3.1	2.6	2.9	4.9	3.3	2.7	0.5	3.1
Uranium (U)	0.1	-	1.2	0.6	3.7	0.6	5.8	3.1	1.7	3.9	3.1	2.2	0.6	3.2
Vanadium (V)	1	-	26	20	150	227	72	85	111	106	165	92	14	182
Yttrium (Y)	0.1	-	11.8	9.6	5.7	4.1	10.8	9.8	3.4	38	3.4	7.9	1.6	3.7
Zinc (Zn)	2	30000	499	47	14	16	113	126	4	31	11	3	4	3
Zirconium (Zr)	0.5	-	21.7	21.2	171.5	44	93.2	99.6	78.5	113.5	94.7	83.9	13.5	79.3

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Dolomite	Detrital Waste	High Grade	Shale	Banded Iron Formation	Low Grade Aluminous	Dolerite	Shale	Low Grade Red Ochre Detrital	Calcrete	Banded Iron Formation	Low grade siliceous
	Stratigraphy →		Wittenoom Formation	Detrital	Wittenoom Formation	Mount McRae Shale	Dales Gorge Member	Whaleback Shale	Dolerite	Mount Sylvia	Detrital	Detrital	Dales Gorge Member	Mount McRae Shale
	RGS Sample Number →		62	63	64	65	66	67	68	69	70	71	72	73
	ALS Laboratory ID →		EB2012964061	EB2012964062	EB2012964063	EB2012964064	EB2012964065	EB2012964066	EB2012964067	EB2012964068	EB2012964069	EB2012965001	EB2012965002	EB2012965003
	Client Sample ID →		IRI885	IRJ297	IRJ561	IRK083	IRK629	IRK837	IRL014	IRL163	IRL691	IRM602	IRM663	IRO039
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.05	0.02	0.02	0.15	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01
Aluminium (Al)	0.01	-	11.90	6.92	3.37	9.82	0.95	2.18	12.05	8.53	1.72	8.58	3.09	1.58
Calcium (Ca)	0.01	-	7.50	0.16	0.03	0.06	0.07	0.04	0.12	0.03	0.03	0.05	0.04	0.03
Iron (Fe)	0.01	-	2.15	35.20	>50	3.42	38.30	>50	18.45	4.73	>50	10.60	40.40	36.10
Potassium (K)	0.01	-	0.04	0.23	0.01	1.72	0.01	0.01	0.43	0.86	0.01	2.00	0.01	0.03
Magnesium (Mg)	0.01	-	4.51	0.18	0.07	0.43	0.08	0.06	0.37	0.17	0.05	0.5	0.06	0.04
Sodium (Na)	0.01	-	0.1	0.04	0.01	0.17	0.01	0.01	0.03	0.05	0.01	0.05	0.01	0.01
Titanium (Ti)	0.005	-	0.332	0.636	0.114	0.4	0.038	0.043	0.419	0.26	0.053	0.31	0.073	0.041
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	2.9	2.95	1.66	7.09	0.9	1.13	6.02	4.11	2.05	3.98	1.25	1.04
Arsenic (As)	0.2	300	7.6	23.4	27.2	53.3	16.4	12.2	61.7	23.8	39.1	227	11.1	11.6
Barium (Ba)	10	-	190	90	10	160	10	10	80	100	20	110	60	20
Beryllium (Be)	0.05	90	0.5	0.52	1.36	0.94	1.67	2.08	3.41	1.56	1.53	2.97	2.4	1.69
Bismuth (Bi)	0.01	-	0.49	0.45	0.39	1.53	0.1	0.13	0.55	1.2	0.27	0.76	0.21	0.17
Boron (B)	10	20000	50	50	40	160	20	20	50	80	20	170	20	20
Cadmium (Cd)	0.02	90	<0.02	0.07	0.22	0.04	0.03	<0.02	0.04	<0.02	0.05	0.17	0.02	<0.02
Caesium (Cs)	0.05	-	0.76	1.91	<0.05	9.71	0.09	0.09	4.46	3.31	0.06	8.82	0.28	0.28
Cerium (Ce)	0.01	-	23.4	28.1	44.9	95.2	16.1	19.25	27.8	19.95	58.2	92.3	30.3	18.3
Chromium (Cr)	1	300	212	261	52	145	20	8	996	126	45	107	28	12
Cobalt (Co)	0.1	300	1.5	12.4	23	4.6	1.2	2.8	16.5	1.6	7.4	20.5	3.9	4.1
Copper (Cu)	0.2	17000	8.1	66.2	41.2	67.1	7.8	6.6	27.3	18.6	17.8	142.5	11.1	7.5
Fluorine (F)	20	-	340	80	50	1760	70	110	640	570	90	1850	40	40
Gallium (Ga)	0.05	-	21.2	24.9	9.95	21.9	2.76	3.5	25.1	22.6	4.83	22.5	6.33	3.83
Germanium (Ge)	0.05	-	0.1	1.06	1.94	0.12	0.56	2.83	0.87	0.08	0.79	0.3	0.91	0.29
Hafnium (Hf)	0.1	-	2.8	4.5	1.8	4.1	0.5	1	2.7	3.5	0.7	4	1.9	0.9
Indium (In)	0.005	-	0.089	0.211	0.045	0.141	0.01	0.009	0.096	0.117	0.03	0.097	0.022	0.013
Lanthanum (La)	0.5	-	15	14.8	16.6	55.9	2.3	1.7	15.7	11.6	9.4	47.8	8.4	4.1
Lead (Pb)	0.5	600	13.1	24.1	18.4	67.4	5	6.3	25.8	23.4	16.4	65.1	9.7	8.8
Lithium (Li)	0.2	-	82.7	7.1	9	31.3	1.4	3.4	28.3	15.6	7.6	35.3	4.8	3
Manganese (Mn)	5	19000	46	356	2080	35	178	271	184	23	840	244	851	558
Mercury (Hg)	0.005	80	0.11	0.008	0.069	1.855	0.015	0.008	0.066	0.007	0.02	0.03	0.044	0.013
Molybdenum (Mo)	0.05	-	0.66	2.24	1.62	3.73	1.02	0.99	2.93	3.38	2.65	2.41	1.46	0.9
Nickel (Ni)	0.2	1200	20.5	38.5	42.7	29.5	10.1	5.9	108.5	57.6	27.8	95.2	9.8	7.4
Niobium (Nb)	0.1	-	8.5	11.9	2.3	11.7	1.8	2.5	4.5	7.5	1.8	10.4	6.1	2.5
Phosphorus (P)	10	-	50	350	540	230	1540	1680	260	80	920	370	1190	980
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	0.009	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.8	28.1	0.3	122.5	1	0.3	22.8	59.3	0.4	144	1.3	3.1
Scandium (Sc)	0.1	-	7.7	24.6	8.4	19.9	2.3	2.6	29.3	15.6	4.7	20.6	3.3	2.3
Selenium (Se)	1	700	1	1	1	1	<1	<1	2	1	<1	<1	<1	<1
Silver (Ag)	0.01	-	0.06	0.17	0.07	0.25	0.02	<0.01	0.09	0.03	0.01	0.12	0.05	0.02
Strontium (Sr)	0.2	-	67.2	36.9	1.8	22.5	2.4	2.6	7.5	8.9	4.4	10.3	6.6	3.4
Tantalum (Ta)	0.05	-	0.86	0.93	0.2	1.1	0.12	0.19	0.43	0.69	0.14	0.95	0.44	0.2
Tellurium (Te)	0.05	-	<0.05	0.31	0.09	0.56	<0.05	<0.05	0.29	0.31	0.14	0.22	<0.05	<0.05
Thallium (Tl)	0.02	-	0.09	0.26	0.07	1.36	0.09	0.02	0.19	0.29	0.05	0.74	0.08	0.02
Thorium (Th)	0.01	-	9.49	13.8	5.15	17.6	1.97	4.09	7.91	17	3.3	17.05	8.19	3.62
Tin (Sn)	0.2	-	3.1	4	0.6	4	0.4	0.6	2	3.3	0.6	2.9	1.2	0.7
Tungsten (W)	0.1	-	2.5	1.8	1.5	6	1.5	1.4	1.2	2.3	1.2	5.8	2.3	2
Uranium (U)	0.1	-	1.4	2	1.9	4	1.3	1.6	3.2	2.8	2.1	3.8	1.7	1.2
Vanadium (V)	1	-	52	271	48	117	18	16	254	82	30	100	26	15
Yttrium (Y)	0.1	-	5	15.2	27.4	14.3	8.7	10.2	11.3	14.5	7.8	33.3	16	12.6
Zinc (Zn)	2	30000	3	73	191	57	26	18	35	16	51	215	20	20
Zirconium (Zr)	0.5	-	90	162.5	67.5	135	23.7	39.1	93.4	121	27.2	131	66.4	32.9

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Hydrated	Hydrated	Low Grade Aluminous	Shale	Low Grade Aluminous	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Shale	Shale	Low Grade Aluminous	Hydrated
	Stratigraphy →		Whaleback Shale	Joffre Member	Whaleback Shale	Wittenoom Formation	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Whaleback Shale	Whaleback Shale
	RGS Sample Number →		74	75	76	77	78	79	80	81	82	83	84	85
	ALS Laboratory ID →		EB2012965004	EB2012965005	EB2012965006	EB2012965007	EB2012965008	EB2012965009	EB2012965010	EB2012965011	EB2012965012	EB2012965013	EB2012965014	EB2012965015
	Client Sample ID →		IRQ039	IRQ201	IRQ767	IRR109	IRR624	IRR628	IRR651	IRR653	IRR945	IRR948	IRU033	IRU100
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.05	0.01	0.05	0.06	0.01	0.04	0.01	0.01	0.04	<0.01	0.01
Aluminium (Al)	0.01	-	0.97	2.42	10.65	5.81	2.90	6.85	0.43	0.59	1.10	0.88	0.24	8.75
Calcium (Ca)	0.01	-	0.02	0.01	0.18	16.55	0.11	0.09	17.30	0.02	0.07	0.13	0.02	0.05
Iron (Fe)	0.01	-	>50	39.30	16.70	12.15	24.20	19.95	3.68	34.60	43.60	31.30	35.70	22.50
Potassium (K)	0.01	-	0.02	0.01	0.22	0.11	0.06	0.56	0.02	0.01	0.01	0.01	0.01	0.95
Magnesium (Mg)	0.01	-	0.02	0.04	0.31	0.49	0.14	0.2	10.5	0.03	0.07	0.07	0.06	0.32
Sodium (Na)	0.01	-	<0.01	0.04	0.03	0.1	0.02	0.05	0.06	0.01	0.01	0.01	<0.01	0.02
Titanium (Ti)	0.005	-	0.035	0.044	0.797	0.446	0.933	0.453	0.024	0.025	0.04	0.032	0.012	0.341
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.99	0.8	1.88	1.29	4.85	3.5	0.3	0.31	0.81	0.26	0.42	6.32
Arsenic (As)	0.2	300	6.2	8	11.9	9.7	36.3	52.4	4.3	3.8	4.5	2.8	5.2	39.1
Barium (Ba)	10	-	160	20	80	70	10	170	10	10	<10	<10	<10	80
Beryllium (Be)	0.05	90	2.78	1.33	1.08	1.59	0.83	1.4	0.18	0.79	1.11	1.29	0.65	2.2
Bismuth (Bi)	0.01	-	0.08	0.2	0.37	0.2	0.37	0.57	0.04	0.03	0.05	0.05	0.02	1.08
Boron (B)	10	20000	20	20	50	40	50	50	10	10	10	10	10	40
Cadmium (Cd)	0.02	90	<0.02	0.02	0.04	0.12	0.04	0.13	0.1	0.05	0.27	0.53	0.04	0.12
Caesium (Cs)	0.05	-	0.08	0.07	4.45	4.52	1.1	3.82	0.13	0.15	0.08	0.15	0.08	2.07
Cerium (Ce)	0.01	-	194	16.7	56.3	58.1	19.9	61.1	11	18.15	7.66	13.9	6.44	60.5
Chromium (Cr)	1	300	10	33	150	60	79	145	6	14	13	19	6	99
Cobalt (Co)	0.1	300	6.8	2.7	16.6	16.5	11.3	16.2	2.5	2.8	7.9	11.8	2.4	53.5
Copper (Cu)	0.2	17000	3.8	24.8	61.3	31.6	6.4	47.2	2.7	3.9	7.3	6.3	3	65.2
Fluorine (F)	20	-	20	120	170	110	120	290	420	<20	<20	60	<20	400
Gallium (Ga)	0.05	-	3.32	3.44	28.1	15.9	12.1	19.2	1.33	1.43	2.44	1.88	0.97	23.5
Germanium (Ge)	0.05	-	1.75	1.66	0.84	0.14	0.23	0.38	<0.05	0.31	0.39	0.29	0.3	0.84
Hafnium (Hf)	0.1	-	0.5	1.2	5.3	2.9	3.2	3.9	0.2	0.2	0.4	0.3	0.1	4.7
Indium (In)	0.005	-	0.009	0.014	0.165	0.103	0.088	0.119	0.008	0.006	0.008	0.006	<0.005	0.098
Lanthanum (La)	0.5	-	9.7	3.2	18.1	43.5	15.6	26.7	7.3	10	2.2	8.2	3.8	22
Lead (Pb)	0.5	600	4	8.4	22.7	15.8	16.5	27.2	1.4	2	3.2	2.7	1.1	34.2
Lithium (Li)	0.2	-	0.3	3.9	21.1	35.8	26.4	13.9	5.8	3.4	4.6	4.1	2	18.7
Manganese (Mn)	5	19000	13600	317	976	464	3790	1160	4870	143	474	432	343	5950
Mercury (Hg)	0.005	80	0.035	0.055	0.007	0.014	0.056	0.011	0.02	0.035	0.026	0.042	0.012	0.045
Molybdenum (Mo)	0.05	-	0.68	1.07	2.1	1.34	4.18	2.79	0.35	1.28	0.71	2.17	0.68	1.98
Nickel (Ni)	0.2	1200	6	9	63	58.9	21.2	58.3	9.9	9.4	23.2	22.6	9.2	108.5
Niobium (Nb)	0.1	-	1.7	2.6	17	9.1	18.3	10.7	0.6	0.7	1.1	0.9	0.3	8.8
Phosphorus (P)	10	-	1400	760	350	170	150	400	120	530	880	710	320	770
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.8	0.4	24.7	20.3	3.3	49.2	1	1.2	0.5	0.8	0.8	46
Scandium (Sc)	0.1	-	2	3	31	17.2	6.2	19.7	1.1	1.7	2	1.9	0.7	21.2
Selenium (Se)	1	700	<1	2	1	1	3	1	1	<1	<1	<1	<1	<1
Silver (Ag)	0.01	-	0.01	0.02	0.05	0.03	0.07	0.05	0.01	0.01	<0.01	0.01	0.02	0.06
Strontium (Sr)	0.2	-	8.1	2.9	15.7	25.6	43.7	20.2	14.9	12	1.1	2.5	0.7	6.8
Tantalum (Ta)	0.05	-	0.12	0.22	1.35	0.8	1.41	0.82	0.05	0.05	0.1	0.08	<0.05	0.77
Tellurium (Te)	0.05	-	0.07	0.06	0.15	0.08	0.16	0.23	<0.05	0.05	0.06	0.05	0.06	0.19
Thallium (Tl)	0.02	-	0.44	0.03	0.35	0.23	1.65	0.6	0.04	0.04	<0.02	0.04	0.02	0.19
Thorium (Th)	0.01	-	1.86	4.07	12.05	8.36	4.55	12.2	0.8	0.65	1.37	1.04	0.34	15
Tin (Sn)	0.2	-	0.4	0.6	4	2.5	5.1	2.8	0.2	0.2	0.3	0.3	<0.2	2.9
Tungsten (W)	0.1	-	1.4	2.3	2.2	1.6	5.7	2.2	0.3	3.2	1.1	2.5	0.8	2.7
Uranium (U)	0.1	-	1	1.3	1.8	1.2	1.4	2.3	0.3	0.4	0.8	0.4	0.5	4.3
Vanadium (V)	1	-	18	18	178	92	124	139	9	9	14	10	7	127
Yttrium (Y)	0.1	-	10.6	8.1	18.5	38.4	11.9	18.9	8.6	4.6	5.1	18.1	9.7	47.8
Zinc (Zn)	2	30000	11	14	83	63	60	78	8	85	428	720	24	239
Zirconium (Zr)	0.5	-	23.7	41.2	175.5	96.7	110	131.5	6.1	7.7	14.2	11.1	3.6	157.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Banded Iron Formation	Hydrated Waste	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Hydrated	Limonitic Waste	Low Grade Limonite	Shale	Shale	Dolomite	Calcrete
	Stratigraphy →		Dales Gorge Member	Joffre Member	Wittenoom Formation	Marra Mamba	Marra Mamba	Marra Mamba	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital
	RGS Sample Number →		86	87	88	89	90	91	92	93	94	95	96	97
	ALS Laboratory ID →		EB2012965016	EB2012965017	EB2012965018	EB2012965019	EB2012965020	EB2012965021	EB2012965022	EB2012965023	EB2012965024	EB2012965025	EB2012965026	EB2012965027
	Client Sample ID →		IRU451	IRU776	IRZ397	IRZ661	IRZ663	ISD283	ISD467	ISD761	ISD892	ISD896	ISD900	ISD936
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	0.02	0.03	0.04	0.01	<0.01	0.01	0.01	0.02	0.01	0.03	0.02
Aluminium (Al)	0.01	-	2.38	3.30	2.78	3.69	1.02	0.40	2.79	1.11	3.82	1.22	0.97	0.68
Calcium (Ca)	0.01	-	0.07	0.03	0.06	0.06	0.02	0.02	0.06	1.15	0.04	0.03	0.01	0.01
Iron (Fe)	0.01	-	39.10	24.20	46.10	22.20	32.50	>50	>50	>50	>50	>50	43.50	35.50
Potassium (K)	0.01	-	0.05	0.04	0.06	0.28	0.02	0.02	0.01	0.14	0.01	0.01	0.03	0.02
Magnesium (Mg)	0.01	-	0.08	0.06	0.06	0.09	0.07	0.04	0.11	0.64	0.08	0.07	0.02	0.02
Sodium (Na)	0.01	-	<0.01	0.02	0.02	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Titanium (Ti)	0.005	-	0.075	0.108	0.214	0.229	0.035	0.015	0.18	0.041	0.267	0.05	0.036	0.012
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.91	0.85	3	1.65	0.9	0.21	1	1.97	1.77	0.87	0.76	0.57
Arsenic (As)	0.2	300	37.9	5.3	67.8	43.1	11.5	6.7	38.9	29.6	52.2	11.9	5.7	3.1
Barium (Ba)	10	-	1560	40	110	140	80	20	10	40	10	10	50	40
Beryllium (Be)	0.05	90	2.52	1.64	0.56	1.38	0.56	0.34	1.86	1.99	1.2	0.61	1.26	1.37
Bismuth (Bi)	0.01	-	0.16	0.12	0.35	0.32	0.12	0.03	0.13	0.09	0.24	0.07	0.25	0.05
Boron (B)	10	20000	20	10	30	30	20	10	20	10	20	30	20	20
Cadmium (Cd)	0.02	90	0.37	<0.02	0.06	0.05	0.02	0.02	0.05	0.24	0.11	0.33	0.02	<0.02
Caesium (Cs)	0.05	-	0.17	0.33	0.56	1.82	0.08	0.08	0.57	0.48	0.37	0.05	0.3	0.19
Cerium (Ce)	0.01	-	78.7	82.1	17.2	36.8	9.55	6.12	24.8	44.3	23.4	21.5	17.2	22.1
Chromium (Cr)	1	300	20	19	73	97	18	7	41	27	68	11	6	4
Cobalt (Co)	0.1	300	35	2.7	5.2	7	2.9	1.4	46.2	21.3	17.7	13.4	1	0.9
Copper (Cu)	0.2	17000	12.5	4.8	9.8	28.2	7.8	4.2	16.9	14.9	19.8	12	9.3	4
Fluorine (F)	20	-	80	60	60	160	40	<20	50	100	120	<20	<20	<20
Gallium (Ga)	0.05	-	6.16	7.31	11.35	10.25	2.75	1.18	7.77	4.12	11.3	2.83	2.3	1.49
Germanium (Ge)	0.05	-	1.32	0.36	0.6	0.34	0.35	0.53	4.16	1	4.32	2.59	0.45	0.43
Hafnium (Hf)	0.1	-	1.2	1	2.3	2.3	0.5	0.1	1.2	0.5	2	0.4	0.7	0.3
Indium (In)	0.005	-	0.021	0.02	0.062	0.066	0.01	<0.005	0.045	0.012	0.068	0.01	0.023	<0.005
Lanthanum (La)	0.5	-	11.9	75.6	7.1	14.6	2.9	1.8	11.8	27.3	9.7	3.1	7.5	10.9
Lead (Pb)	0.5	600	8.8	7.8	15.6	18.2	3.7	1.3	12.8	5.7	19	3.6	3.8	1.8
Lithium (Li)	0.2	-	5	22.6	6.7	11.4	5.8	1.9	15	1.8	12.2	2.8	0.4	0.4
Manganese (Mn)	5	19000	12900	192	359	656	4330	840	287	2130	216	1100	148	43
Mercury (Hg)	0.005	80	0.136	0.03	0.02	0.016	0.013	0.01	0.019	0.049	0.038	0.032	0.01	0.007
Molybdenum (Mo)	0.05	-	1.46	0.48	2.76	1.77	1.05	1.27	1.9	1.83	3.1	0.93	0.4	0.25
Nickel (Ni)	0.2	1200	20.4	10.1	14.6	23.4	13.3	4.9	79.1	56	47.2	18	2.1	3.3
Niobium (Nb)	0.1	-	4	3.8	5.8	5.6	1.1	0.4	4.4	1	6.5	1.2	1.4	0.7
Phosphorus (P)	10	-	1730	590	220	360	190	500	160	370	210	740	1370	930
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.1	2.5	4.8	23.2	1	1	1.7	6	1.2	0.4	3.3	1.7
Scandium (Sc)	0.1	-	3.7	2.8	8	8.8	1.9	0.8	5.7	4	7.2	2.4	1.8	1.1
Selenium (Se)	1	700	<1	<1	2	1	<1	<1	1	1	1	<1	<1	<1
Silver (Ag)	0.01	-	0.1	0.03	0.03	0.09	0.02	<0.01	0.04	0.03	0.04	<0.01	<0.01	<0.01
Strontium (Sr)	0.2	-	11.4	28.9	14.6	17.1	12.9	3.9	3.8	6.3	3.6	1.7	12.3	13.5
Tantalum (Ta)	0.05	-	0.29	0.29	0.42	0.44	0.12	<0.05	0.35	0.1	0.5	0.11	0.1	0.05
Tellurium (Te)	0.05	-	0.11	<0.05	0.24	0.18	0.07	0.13	0.19	0.15	0.25	0.15	0.12	0.1
Thallium (Tl)	0.02	-	6.3	0.02	0.12	0.32	0.85	0.09	0.07	0.11	0.04	0.07	0.03	0.02
Thorium (Th)	0.01	-	5.65	2.94	8.09	8.61	1.82	0.49	3.01	1.94	5.1	1.36	1.85	0.88
Tin (Sn)	0.2	-	0.8	0.9	1.7	1.5	0.4	<0.2	1.1	0.4	1.8	0.3	0.4	0.2
Tungsten (W)	0.1	-	2.6	3.3	1.8	2	0.8	0.5	1	0.5	1.7	1.4	1.6	1
Uranium (U)	0.1	-	1.8	0.8	1.8	1.3	1.4	0.4	1.6	2.4	2.1	0.9	0.9	0.3
Vanadium (V)	1	-	31	15	79	95	15	7	61	34	82	16	11	7
Yttrium (Y)	0.1	-	20.7	14.9	7.8	9.7	6.6	4.9	12.7	51.3	15.1	5.7	5.2	5.6
Zinc (Zn)	2	30000	43	11	12	53	24	7	451	111	646	396	15	5
Zirconium (Zr)	0.5	-	47.7	40	79.2	78.4	17.6	5.2	46.2	17.6	63	14.4	27	11.6

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low Grade Red Ochre Detrital	Low Grade Red Ochre Detrital	Banded Iron Formation	High Grade	Low grade siliceous	Banded Iron Formation	Low Grade Aluminous	Shale	Low Grade Aluminous	Shale	Calcrete	Banded Iron Formation
	Stratigraphy →		Detrital	Detrital	Marra Mamba	Marra Mamba	Joffre Member	Joffre Member	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Wittenoom Formation	Detrital	Wittenoom Formation
	RGS Sample Number →		98	99	100	101	104	105	106	107	108	109	110	111
	ALS Laboratory ID →		EB2012965028	EB2012965029	EB2012965030	EB2012965031	EB2012965032	EB2012965033	EB2012965034	EB2012965035	EB2012965036	EB2012965037	EB2012965038	EB2012965039
	Client Sample ID →		ISE024	ISE033	ISE515	ISE864	ISI845	ISI859	ISJ051	ISJ062	ISJ277	ISJ804	ISL158	ISL365
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.01	0.05	0.17	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02
Aluminium (Al)	0.01	-	0.43	0.45	0.13	9.20	2.66	4.99	5.48	8.22	0.14	4.22	8.45	3.42
Calcium (Ca)	0.01	-	0.01	0.01	17.95	0.07	0.57	0.44	0.05	0.11	0.04	0.06	0.11	0.05
Iron (Fe)	0.01	-	36.00	32.20	2.31	2.53	46.70	42.60	45.20	31.50	31.90	>50	19.20	>50
Potassium (K)	0.01	-	0.02	0.02	0.02	1.57	0.01	0.01	0.01	0.12	0.01	0.01	0.41	0.01
Magnesium (Mg)	0.01	-	0.02	0.02	7.53	0.39	0.58	0.38	0.06	0.13	0.04	0.11	0.11	0.07
Sodium (Na)	0.01	-	0.01	0.01	0.09	0.2	0.03	0.03	0.01	0.04	<0.01	0.01	0.04	0.01
Titanium (Ti)	0.005	-	0.011	0.013	0.009	0.483	0.128	0.182	0.179	0.657	0.007	0.272	0.613	0.187
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.54	0.65	0.24	5.99	1.53	2.55	3.08	2.75	0.22	1.33	2.57	0.9
Arsenic (As)	0.2	300	3	2.6	8.4	56.9	24.2	23.8	54.8	28	1	39.4	31.4	38
Barium (Ba)	10	-	20	20	40	130	20	10	10	80	10	10	150	10
Beryllium (Be)	0.05	90	1.07	1	0.18	1.43	3.44	3.02	2.87	1.03	0.44	1.69	1.23	1.92
Bismuth (Bi)	0.01	-	0.03	0.03	0.01	1.91	0.1	0.36	0.84	0.44	0.01	0.2	0.52	0.18
Boron (B)	10	20000	20	10	10	160	30	30	30	50	10	40	40	30
Cadmium (Cd)	0.02	90	<0.02	<0.02	0.03	0.03	<0.02	<0.02	0.03	0.1	0.03	0.04	0.07	0.08
Caesium (Cs)	0.05	-	0.24	0.2	1.38	12.8	0.36	0.28	0.24	2.85	0.61	0.3	3.97	0.28
Cerium (Ce)	0.01	-	6.75	8.58	3.92	72.7	21.1	34.8	33.2	56.6	2.17	19.75	60.8	23.1
Chromium (Cr)	1	300	4	5	5	154	21	38	40	181	13	55	216	45
Cobalt (Co)	0.1	300	1.3	0.7	2.6	8.8	10.8	3.5	1.8	29.1	1.6	20.9	13.5	32.3
Copper (Cu)	0.2	17000	3.3	3.3	4.1	65.1	5.5	11	19.2	38.1	2.1	20.2	72.3	20.5
Fluorine (F)	20	-	<20	<20	340	2150	310	270	90	110	40	120	180	110
Gallium (Ga)	0.05	-	1.13	1.25	0.39	25.3	7.82	14.4	12.9	25.1	0.69	10.15	25.8	6.59
Germanium (Ge)	0.05	-	0.49	0.45	<0.05	0.1	4.39	8.28	3.82	1.18	0.85	3.98	0.68	3.07
Hafnium (Hf)	0.1	-	0.2	0.2	0.1	5.1	1.1	2.9	3.9	4.9	0.1	1.9	5.1	1.4
Indium (In)	0.005	-	<0.005	<0.005	<0.005	0.162	0.027	0.065	0.149	0.154	<0.005	0.066	0.167	0.048
Lanthanum (La)	0.5	-	3.2	4.4	2.9	33.6	9.1	15.4	10.3	17.3	1.4	7.9	25.3	7.3
Lead (Pb)	0.5	600	1.4	1.4	0.7	60.3	9.3	16.1	30.9	25.2	0.6	17.4	28	13.5
Lithium (Li)	0.2	-	0.3	0.5	1.7	44.7	6.7	33.6	16	21.6	2.1	31.4	15.9	7.2
Manganese (Mn)	5	19000	109	44	46	19	99	107	179	841	122	443	950	393
Mercury (Hg)	0.005	80	0.006	0.01	0.013	0.597	0.026	0.022	0.023	0.012	0.011	0.017	0.014	0.035
Molybdenum (Mo)	0.05	-	0.23	0.29	0.24	4.51	1.11	1.29	2.02	2.97	1.76	2.4	2.22	1.71
Nickel (Ni)	0.2	1200	2.7	2	4.1	32.7	28.8	13.4	11.5	70.3	3.9	50.6	41.7	47.5
Niobium (Nb)	0.1	-	0.5	0.6	0.2	13.6	4.5	8.8	10.4	14.4	0.3	6.8	13.6	4.4
Phosphorus (P)	10	-	870	680	20	160	260	770	1320	250	390	250	470	290
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.3	2	1.9	107.5	1.1	0.8	0.7	16.7	1.7	1.1	43.5	1.3
Scandium (Sc)	0.1	-	0.8	0.9	0.2	21.4	3.8	7.2	8.6	25.7	0.6	9.1	26.1	7.4
Selenium (Se)	1	700	<1	<1	1	1	<1	1	<1	1	<1	1	1	1
Silver (Ag)	0.01	-	<0.01	<0.01	0.01	0.25	0.01	0.01	0.01	0.04	<0.01	0.03	0.07	0.04
Strontium (Sr)	0.2	-	2.9	3.4	167	15.8	14.1	13.6	5.6	11.7	1.1	4	28.4	3.4
Tantalum (Ta)	0.05	-	<0.05	<0.05	<0.05	1.28	0.32	0.66	0.79	1.08	<0.05	0.52	1.06	0.35
Tellurium (Te)	0.05	-	0.13	0.11	<0.05	0.81	0.16	0.25	0.64	0.25	0.09	0.27	0.31	0.25
Thallium (Tl)	0.02	-	<0.02	<0.02	0.04	1.81	<0.02	<0.02	0.02	0.25	0.04	0.03	0.54	0.05
Thorium (Th)	0.01	-	0.59	0.64	0.17	16.8	2.95	7.66	11.55	13.1	0.19	4.78	15.25	3.44
Tin (Sn)	0.2	-	0.2	0.2	<0.2	4.9	1.1	2.2	2.9	3.7	<0.2	1.7	3.8	1
Tungsten (W)	0.1	-	1.6	1.8	0.5	7.1	2.4	3.3	2.4	2.4	4.8	1.4	2.1	0.9
Uranium (U)	0.1	-	0.2	0.2	0.5	5	1.1	1.6	1.9	2.6	0.1	3.2	2.8	1.7
Vanadium (V)	1	-	6	6	9	121	36	46	54	194	3	72	238	59
Yttrium (Y)	0.1	-	3.6	3.4	2.7	16.2	17.3	22.6	20	17.1	3.9	11.1	16.7	12.5
Zinc (Zn)	2	30000	5	4	3	11	22	33	87	61	21	374	90	269
Zirconium (Zr)	0.5	-	8.7	9.8	2.2	161	42.7	103	136.5	168.5	2.4	70	167.5	46.9

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Detrital Waste	Banded Iron Formation	High Grade	High Grade	Low grade siliceous	Hydrated	High Grade	Banded Iron Formation	Hydrated	Detrital Waste	Banded Iron Formation	Banded Iron Formation
	Stratigraphy →		Detrital	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Whaleback Shale	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Detrital	Dales Gorge Member	Marra Mamba
	RGS Sample Number →		112	113	114	115	116	117	118	119	120	121	122	123
	ALS Laboratory ID →		EB2012965040	EB2012965041	EB2012965042	EB2012965043	EB2012965044	EB2012965046	EB2012965047	EB2012965048	EB2012965049	EB2012965050	EB2012965051	EB2012965052
	Client Sample ID →		ISL976	ITC180	ITC740	ITC748	ITC933	ITD460	ITD582	ITD726	ITD748	ITD802	ITD887	ITE611
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	<0.01	0.01	0.04	0.02	0.01	0.02	0.01	<0.01	0.01	0.01	0.02
Aluminium (Al)	0.01	-	8.81	0.28	4.27	1.86	7.56	8.29	3.64	2.19	0.11	3.52	8.21	5.41
Calcium (Ca)	0.01	-	0.06	0.01	0.10	0.01	0.52	0.11	0.07	0.02	0.02	0.04	0.12	0.24
Iron (Fe)	0.01	-	15.30	28.60	49.30	>50	24.80	16.80	49.90	38.60	37.30	45.60	23.40	41.90
Potassium (K)	0.01	-	1.14	0.01	0.02	0.01	0.09	0.45	0.01	0.04	0.02	0.36	0.19	0.03
Magnesium (Mg)	0.01	-	0.31	0.04	0.22	0.02	0.48	0.11	0.18	0.05	0.03	0.08	0.11	0.46
Sodium (Na)	0.01	-	0.02	0.01	0.01	<0.01	0.05	0.04	0.01	0.02	<0.01	0.04	0.03	0.03
Titanium (Ti)	0.005	-	0.393	0.013	0.289	0.037	0.852	0.992	0.239	0.052	<0.005	0.164	0.669	0.27
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	5.93	0.26	1.47	1.16	2.05	0.34	1.2	1.37	0.24	3.02	2.16	5.4
Arsenic (As)	0.2	300	46.1	4.1	41.9	6.1	37.9	29.7	54.6	5.8	2.2	13.9	20.4	79.5
Barium (Ba)	10	-	90	10	20	10	70	50	10	30	20	20	80	40
Beryllium (Be)	0.05	90	1.98	0.32	1.67	2.12	1.2	0.7	1.57	2.42	0.89	2.9	0.57	1.28
Bismuth (Bi)	0.01	-	0.96	0.02	0.26	0.1	0.03	0.02	0.22	0.16	0.01	0.32	0.43	0.7
Boron (B)	10	20000	30	10	40	20	40	50	30	20	20	20	50	60
Cadmium (Cd)	0.02	90	0.06	0.06	0.06	0.02	0.08	0.06	0.09	0.02	<0.02	0.45	0.03	<0.02
Caesium (Cs)	0.05	-	2.76	0.11	0.44	0.11	0.22	0.18	0.29	0.25	0.24	0.8	2.97	1.68
Cerium (Ce)	0.01	-	93.6	3.3	32.7	17.85	6.68	16.2	15.25	18.45	5.97	61	27	9.43
Chromium (Cr)	1	300	85	8	61	14	130	93	62	16	5	59	214	223
Cobalt (Co)	0.1	300	14.6	4.1	17.9	1.8	9.4	6.7	24.4	2.8	1.5	35.5	9.7	4.4
Copper (Cu)	0.2	17000	56.8	6.1	19.5	9.1	99.6	145	19.6	8.5	3	51.7	50.7	4.7
Fluorine (F)	20	-	530	30	150	40	170	80	150	70	20	140	100	580
Gallium (Ga)	0.05	-	20.9	0.7	11	3.04	21.2	24.1	8.08	3.97	0.44	9.04	23.6	19.5
Germanium (Ge)	0.05	-	0.38	0.19	3.48	2.38	1.15	0.63	2.56	1.23	0.37	1.54	1.02	2.5
Hafnium (Hf)	0.1	-	5.2	0.1	2	0.7	2.7	3.1	1.3	1.1	<0.1	1.5	5	2.9
Indium (In)	0.005	-	0.096	<0.005	0.069	0.01	0.112	0.118	0.062	0.013	<0.005	0.04	0.162	0.123
Lanthanum (La)	0.5	-	47.8	2.2	11.4	8.3	2.2	1.4	8.1	8.7	4.3	45.6	15.5	3.5
Lead (Pb)	0.5	600	29.3	0.9	17.6	5.8	8.5	1.6	14.2	8.8	0.9	10.6	21.4	27.9
Lithium (Li)	0.2	-	19.5	6.8	22.4	0.4	29.2	16.1	18.1	1.5	1.1	14.4	10.9	6.3
Manganese (Mn)	5	19000	4340	419	304	113	780	878	330	177	200	34200	290	91
Mercury (Hg)	0.005	80	0.01	0.022	0.015	0.009	0.062	0.018	0.026	0.009	0.022	0.013	0.007	0.008
Molybdenum (Mo)	0.05	-	1.08	0.57	2.18	0.38	0.31	0.44	1.9	0.7	0.84	0.89	2.12	4.98
Nickel (Ni)	0.2	1200	57.9	10.1	52.1	5.6	32.4	32.4	61.3	7.4	5.2	79.8	43.3	20.3
Niobium (Nb)	0.1	-	11.1	0.4	6.7	2.3	4.8	5.2	5.3	2.6	0.2	3.3	13.9	7.9
Phosphorus (P)	10	-	650	280	230	2060	280	450	250	1110	630	530	310	140
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	50.5	1	2.3	0.4	1	12.3	1.3	3.3	2.4	11.7	23.9	4.1
Scandium (Sc)	0.1	-	17.1	0.6	10.7	3.8	38.7	40.9	6.1	3.6	0.4	13.2	24.7	9.5
Selenium (Se)	1	700	<1	<1	1	1	1	<1	1	1	<1	<1	1	1
Silver (Ag)	0.01	-	0.02	0.01	0.02	<0.01	0.03	0.01	0.07	<0.01	0.01	0.02	0.08	<0.01
Strontium (Sr)	0.2	-	4.4	0.8	5.5	3.5	14.7	5.4	3.3	4	2.1	85.8	16.2	13.9
Tantalum (Ta)	0.05	-	0.99	<0.05	0.53	0.15	0.33	0.35	0.42	0.2	<0.05	0.28	1.05	0.62
Tellurium (Te)	0.05	-	0.21	0.09	0.3	0.31	0.14	0.11	0.33	0.18	0.19	0.26	0.29	0.43
Thallium (Tl)	0.02	-	0.27	0.03	0.04	0.02	0.13	0.15	0.03	0.02	0.04	0.49	0.27	0.06
Thorium (Th)	0.01	-	16.4	0.34	5.8	2.53	0.52	0.42	3.11	4.27	0.21	4.96	13.55	11.75
Tin (Sn)	0.2	-	2.9	0.2	1.8	0.5	1.1	1.1	1.4	0.6	0.2	0.9	3.4	2.5
Tungsten (W)	0.1	-	3	3.6	1.5	1.1	3.5	0.5	1.1	2.7	4.5	1.7	1.9	3
Uranium (U)	0.1	-	4.3	0.3	2.7	0.8	0.6	0.4	1.8	2	0.1	3.1	2.2	2.3
Vanadium (V)	1	-	114	6	86	19	389	377	90	19	2	80	225	111
Yttrium (Y)	0.1	-	52.8	4.5	15.5	9	6.9	2.5	9.8	9.6	5	85.6	15.2	5.9
Zinc (Zn)	2	30000	111	68	219	14	52	44	539	17	12	88	59	2
Zirconium (Zr)	0.5	-	169.5	3.6	73	31.1	88.4	101	47.3	40.1	2.7	50.2	172.5	97.9

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Hydrated	Shale	Low Grade Aluminous	Banded Iron Formation	Hydrated
	Stratigraphy →		Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Whaleback Shale	Dales Gorge Member	Mount McRae Shale	Joffre Member
	RGS Sample Number →		124	125	126	127	128	129	130	131	132	133	134	135
	ALS Laboratory ID →		EB2012965053	EB2012965054	EB2012965055	EB2012965056	EB2012965057	EB2012965058	EB2012965059	EB2012965060	EB2012965061	EB2012965062	EB2012965063	EB2012965064
	Client Sample ID →		ITG282	ITG526	ITG535	ITH923	ITI334	ITI426	ITI461	ITI551	ITI571	ITI713	ITI787	ITI951
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.03	0.03	0.01	0.02	0.02	0.05	0.03	0.03	0.07	0.04	0.01	0.01
Aluminium (Al)	0.01	-	4.20	5.12	5.21	4.35	2.93	4.37	2.90	1.55	4.07	0.77	10.80	10.15
Calcium (Ca)	0.01	-	0.43	0.18	1.39	0.45	0.12	0.05	0.06	0.02	0.02	0.01	0.02	0.03
Iron (Fe)	0.01	-	48.30	40.20	44.90	43.00	36.00	48.20	>50	35.70	40.10	28.70	6.92	14.80
Potassium (K)	0.01	-	0.02	0.04	0.02	0.11	0.17	0.23	0.04	0.17	0.01	0.01	0.02	0.03
Magnesium (Mg)	0.01	-	0.53	0.47	0.93	0.34	0.13	0.09	0.06	0.06	0.03	0.02	0.03	0.13
Sodium (Na)	0.01	-	0.02	0.03	0.03	0.03	0.04	0.03	0.03	0.02	0.04	0.02	0.03	0.04
Titanium (Ti)	0.005	-	0.499	0.35	1.105	0.331	0.233	0.192	0.213	0.084	0.174	0.011	0.394	0.35
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	13	5.56	18.15	10.1	1.87	7.83	1.68	1.33	2.4	0.85	2.4	1.74
Arsenic (As)	0.2	300	198.5	70.3	102	110	37.4	204	32.2	41.1	62.6	2.7	12.3	10.6
Barium (Ba)	10	-	30	50	20	20	150	50	40	50	10	10	30	80
Beryllium (Be)	0.05	90	0.67	1.61	0.98	0.85	1.33	0.96	0.46	1.15	1.25	0.49	0.8	0.82
Bismuth (Bi)	0.01	-	1.53	0.69	2.19	1.23	0.31	0.9	0.24	0.17	0.47	0.02	1.54	1.72
Boron (B)	10	20000	80	70	60	30	30	30	40	20	20	10	20	30
Cadmium (Cd)	0.02	90	0.02	<0.02	0.02	0.02	0.09	0.02	0.03	0.03	0.02	<0.02	0.02	0.03
Caesium (Cs)	0.05	-	0.76	1.52	1.41	1.22	1.25	1.88	0.23	0.95	0.14	0.08	0.11	0.2
Cerium (Ce)	0.01	-	10.35	12.25	9.75	8.3	38	17.6	10.7	20.3	10.6	43.8	97.6	210
Chromium (Cr)	1	300	110	174	200	153	69	68	44	34	46	8	83	48
Cobalt (Co)	0.1	300	2.4	8.3	3	2.4	6.4	3.7	5	3.7	2.1	6.8	2.5	7.6
Copper (Cu)	0.2	17000	10.6	8.2	12.9	15.3	26.4	17.2	6.4	15.1	17.9	5.2	21	16.6
Fluorine (F)	20	-	820	780	390	370	170	300	100	80	130	<20	60	190
Gallium (Ga)	0.05	-	31.7	22.3	80.3	28	10.05	12.95	9.23	4.44	11.45	1.14	29.6	24.6
Germanium (Ge)	0.05	-	3.84	2.31	4.84	3.68	0.55	2.83	0.96	0.38	2.82	0.41	0.35	0.64
Hafnium (Hf)	0.1	-	4	3	5.4	3.6	2	2.7	2	0.9	3.3	0.2	13.2	11.7
Indium (In)	0.005	-	0.16	0.127	0.27	0.182	0.068	0.104	0.051	0.031	0.054	<0.005	0.324	0.382
Lanthanum (La)	0.5	-	5.7	5.9	3.8	4.2	17.1	12.8	3.7	11.8	11.2	38.8	63	120.5
Lead (Pb)	0.5	600	18.8	36.1	28.1	26.1	14.3	29.4	9.9	10.5	18.5	13.7	62.6	103.5
Lithium (Li)	0.2	-	4.1	12.5	12.7	6.8	9.8	5.8	2.2	4.6	1.1	0.8	3.7	10.6
Manganese (Mn)	5	19000	121	61	57	21	581	137	178	274	233	91	160	668
Mercury (Hg)	0.005	80	0.088	0.015	0.031	0.133	0.02	0.035	<0.005	0.018	0.013	<0.005	0.011	0.016
Molybdenum (Mo)	0.05	-	12.95	5.68	15.45	6.89	2	7.31	3.59	1.74	2.88	0.41	1.54	1.78
Nickel (Ni)	0.2	1200	8.2	31.4	21.2	15.9	23.7	11.3	12.7	15.4	11.4	7.4	24.5	40.2
Niobium (Nb)	0.1	-	17.8	10.5	36	10.9	6.4	6.8	6.3	2.4	9.1	0.6	28.8	25.8
Phosphorus (P)	10	-	360	110	290	300	600	310	320	570	640	400	470	630
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.2	3.9	3.5	3.8	15.2	16.2	2.8	14.2	0.7	1.5	0.6	0.9
Scandium (Sc)	0.1	-	7	7.6	12.4	6.9	7.8	8.6	5.1	3.8	8.1	1.4	15.5	9.9
Selenium (Se)	1	700	3	1	2	4	1	3	2	1	1	1	1	1
Silver (Ag)	0.01	-	0.09	<0.01	0.01	0.13	0.04	0.03	0.01	0.04	0.01	0.01	<0.01	<0.01
Strontium (Sr)	0.2	-	12.9	13	13.3	6.8	23.2	6.3	15.5	10.8	7.4	5.6	30.2	26
Tantalum (Ta)	0.05	-	1.42	0.83	2.92	0.93	0.47	0.53	0.46	0.18	0.68	<0.05	2.19	2.06
Tellurium (Te)	0.05	-	0.94	0.43	0.94	0.83	0.26	0.68	0.35	0.27	0.47	0.19	0.47	0.45
Thallium (Tl)	0.02	-	0.02	0.05	0.03	0.03	0.53	0.18	0.07	0.24	0.02	<0.02	<0.02	0.78
Thorium (Th)	0.01	-	13.1	10.1	16.95	9.71	7.37	9.89	5.8	3.28	10.4	0.84	28.4	23.7
Tin (Sn)	0.2	-	5.6	3.1	12.3	4	1.6	2.3	1.6	0.7	1.8	0.2	7	5.7
Tungsten (W)	0.1	-	6.2	3.2	12.1	3.8	2	3.1	2.2	1.3	2.1	1.3	4.3	4.6
Uranium (U)	0.1	-	2.9	2.7	3.5	4.5	1.4	2.6	1.1	0.9	1.5	0.2	5.5	5.7
Vanadium (V)	1	-	227	128	258	172	80	84	54	38	61	8	93	65
Yttrium (Y)	0.1	-	9.4	7.8	8.5	5	12.2	10.6	4.2	7.2	13.3	2.3	33.6	44.3
Zinc (Zn)	2	30000	8	<2	2	12	40	21	6	28	70	11	83	69
Zirconium (Zr)	0.5	-	135	102.5	179.5	127.5	79	89.2	68.1	34.7	114	11.8	436	411

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Shale	Detrital Waste	Calcrete	Banded Iron Formation	Carbonaceous Shale	Shale	Shale	Manganese	Shale	Detrital Waste	Detrital Waste	Shale
	Stratigraphy →		Whaleback Shale	Detrital	Detrital	Marra Mamba	Mount McRae Shale	Whaleback Shale	Whaleback Shale	Whaleback Shale	Joffre Member	Detrital	Detrital	Wittenoom Formation
	RGS Sample Number →		136	137	138	139	140	141	142	143	144	145	146	147
	ALS Laboratory ID →		EB2012965065	EB2012965066	EB2012965067	EB2012965068	EB2012967001	EB2012967002	EB2012967003	EB2012967004	EB2012967005	EB2012967006	EB2012967007	EB2012967008
	Client Sample ID →		ITI971	ITJ305	ITJ709	ITK609	ITL213	ITL714	ITL727	ITL781	ITL838	ITM231	ITM284	ITM309
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	<0.01	0.02	0.01	<0.01	0.01	0.01	0.01	0.02	<0.01	0.01	<0.01	0.01
Aluminium (Al)	0.01	-	0.25	3.57	12.20	0.43	6.53	5.44	6.57	1.03	0.48	1.69	0.76	1.13
Calcium (Ca)	0.01	-	0.03	0.07	0.06	0.08	0.11	0.13	0.04	0.02	0.01	0.07	0.04	0.03
Iron (Fe)	0.01	-	34.50	45.60	20.40	35.00	33.50	14.55	40.10	30.20	37.70	29.60	31.30	>50
Potassium (K)	0.01	-	0.03	0.02	0.01	0.03	0.02	0.03	<0.01	0.25	0.02	0.06	0.02	0.02
Magnesium (Mg)	0.01	-	0.03	0.18	0.06	0.03	0.23	0.18	0.04	0.11	0.03	0.05	0.03	0.03
Sodium (Na)	0.01	-	0.01	0.02	0.02	0.01	0.04	0.03	0.02	0.02	0.01	0.01	<0.01	0.01
Titanium (Ti)	0.005	-	0.005	0.102	0.394	0.009	0.505	0.637	0.202	0.029	0.016	0.082	0.017	0.178
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.25	2.09	6.82	0.27	2.78	2.28	5.41	1.23	0.55	0.74	0.67	1.36
Arsenic (As)	0.2	300	4.7	117	71.8	5.5	131.5	33.3	59.3	4.4	2.5	5.1	3.7	19.1
Barium (Ba)	10	-	30	20	30	20	30	90	20	120	20	40	20	20
Beryllium (Be)	0.05	90	0.78	1.18	2.98	1.02	3.54	1.08	2.62	2.88	0.72	1.26	1.4	0.38
Bismuth (Bi)	0.01	-	0.02	0.2	1.96	0.04	0.44	0.49	0.86	0.19	0.04	0.17	0.06	0.28
Boron (B)	10	20000	10	30	20	20	220	190	60	70	<20	70	20	20
Cadmium (Cd)	0.02	90	0.02	0.02	0.04	0.02	0.12	0.02	0.09	0.06	<0.02	0.05	0.02	0.02
Caesium (Cs)	0.05	-	0.27	0.24	0.21	0.25	0.39	0.4	0.14	12.5	0.22	1.02	0.2	0.19
Cerium (Ce)	0.01	-	6.49	16.2	31.6	21.8	38.2	58.7	33	31	6.99	24.9	8.36	7.6
Chromium (Cr)	1	300	5	32	76	6	64	65	39	8	4	74	12	37
Cobalt (Co)	0.1	300	1.5	2.6	4.6	1.4	9.1	3.4	6.2	5.5	0.6	2.3	2.6	0.9
Copper (Cu)	0.2	17000	2.8	8.5	40.2	3.4	29.9	10.4	25.2	4.6	5.3	22.9	11.8	10.2
Fluorine (F)	20	-	20	260	120	90	40	40	10	10	10	10	10	10
Gallium (Ga)	0.05	-	0.68	6.15	33.2	1.08	19.2	18.45	17.55	3.33	1.4	4.87	1.9	7.9
Germanium (Ge)	0.05	-	0.38	3.58	1.57	0.45	6.58	0.75	1.58	0.18	0.18	0.13	0.11	2.22
Hafnium (Hf)	0.1	-	0.2	1.4	16.6	0.3	3	3	6.6	0.7	0.3	1.2	0.5	1.5
Indium (In)	0.005	-	<0.005	0.039	0.48	0.006	0.091	0.075	0.212	0.01	0.005	0.023	0.007	0.068
Lanthanum (La)	0.5	-	3	9.2	9.9	5.5	17	29.3	8.4	8.3	2.7	10.8	3.4	3.3
Lead (Pb)	0.5	600	1.1	18.4	57.5	1.5	34.7	19	29.6	8.4	1.5	7.3	3.5	4.6
Lithium (Li)	0.2	-	2.9	12.8	58.4	4.8	43.9	52.5	22	3.3	1.2	3.5	2	0.6
Manganese (Mn)	5	19000	238	104	328	86	179	53	203	5170	84	249	248	194
Mercury (Hg)	0.005	80	0.02	0.05	0.019	<0.005	0.055	0.076	0.025	0.029	0.013	0.016	0.008	0.059
Molybdenum (Mo)	0.05	-	0.42	2.34	6.61	1.25	2.56	2.3	3.17	0.73	0.24	0.55	0.47	1.3
Nickel (Ni)	0.2	1200	3.2	19.9	37.5	3.5	61	19.5	30.4	10	2.4	9.2	5.2	2.8
Niobium (Nb)	0.1	-	0.4	3.7	34.3	0.8	13.4	15.7	14.2	1.8	0.7	2.5	1.3	4.1
Phosphorus (P)	10	-	730	500	1100	960	460	530	1620	480	590	1410	1200	530
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.9	1	0.5	4.2	2.3	1.9	0.6	94.3	1.9	10.1	2.1	1.4
Scandium (Sc)	0.1	-	0.5	7.2	12.1	0.7	13.3	7.6	10	1.8	1.1	6.5	1.1	7.1
Selenium (Se)	1	700	<1	1	1	<1	1	<1	<1	<1	<1	<1	<1	2
Silver (Ag)	0.01	-	<0.01	0.02	<0.01	0.01	0.04	0.07	<0.01	0.02	<0.01	<0.01	<0.01	0.04
Strontium (Sr)	0.2	-	2.2	10.8	5.2	5.6	13.8	23.7	4	4.6	2.7	8.6	2.4	4.1
Tantalum (Ta)	0.05	-	<0.05	0.3	2.65	0.05	1.1	1.18	1.16	0.16	0.06	0.19	0.1	0.29
Tellurium (Te)	0.05	-	0.17	0.33	0.55	0.2	0.13	0.09	0.24	<0.05	<0.05	<0.05	<0.05	0.54
Thallium (Tl)	0.02	-	0.09	<0.02	0.04	0.04	0.03	0.09	0.03	0.85	0.02	0.06	0.02	0.02
Thorium (Th)	0.01	-	0.47	5.62	31.8	1.03	6.28	4.07	17.3	3.37	1.02	3.06	1.78	3.87
Tin (Sn)	0.2	-	0.2	0.9	8.4	0.2	3.2	3.6	3.7	0.6	0.2	0.6	0.3	1.1
Tungsten (W)	0.1	-	2.2	2.4	3.6	3.4	5.2	7.7	3.4	3.2	0.7	2	1.5	1.9
Uranium (U)	0.1	-	0.3	1.7	7.4	0.4	2.1	1.2	3.1	1.3	0.4	1.5	0.9	1
Vanadium (V)	1	-	4	46	89	7	105	90	54	9	6	30	7	79
Yttrium (Y)	0.1	-	5.2	9	36.1	6.7	22.4	11.8	29	15	3.4	9.7	6.3	2.9
Zinc (Zn)	2	30000	9	21	174	8	97	15	101	24	4	22	17	8
Zirconium (Zr)	0.5	-	7	52.1	>500	15.8	111.5	117	219	25.8	14.6	55.9	19.7	57.8

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Detrital Waste	Dolomite	Banded Iron Formation	High Grade	Banded Iron Formation	Shale	Shale	Banded Iron Formation	Shale	Detrital Waste	Detrital Waste	Banded Iron Formation
	Stratigraphy →		Detrital	Wittenoom Formation	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Wittenoom Formation	Dales Gorge Member	Whaleback Shale	Detrital	Detrital	Wittenoom Formation
	RGS Sample Number →		148	149	150	151	152	153	154	155	156	157	158	159
	ALS Laboratory ID →		EB2012967009	EB2012967010	EB2012967011	EB2012967012	EB2012967013	EB2012967014	EB2012967015	EB2012967016	EB2012967017	EB2012967018	EB2012967019	EB2012967020
	Client Sample ID →		ITM458	ITM815	ITN418	ITN542	ITN784	ITN964	ITO839	ITQ041	ITQ586	ITS268	ITS739	ITU268
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.02	0.03	0.02	0.02	0.02	0.04	0.16	0.01	0.03	0.02	0.01
Aluminium (Al)	0.01	-	7.83	2.42	2.28	9.16	8.66	3.70	5.62	7.90	0.58	2.60	1.23	0.46
Calcium (Ca)	0.01	-	0.13	0.14	0.27	0.01	0.01	0.01	0.02	0.04	0.02	0.06	0.01	0.01
Iron (Fe)	0.01	-	25.30	30.00	27.20	19.70	11.15	>50	42.70	17.15	>50	33.90	29.70	33.60
Potassium (K)	0.01	-	0.95	0.23	0.28	1.03	1.43	0.11	0.03	1.46	0.03	0.09	0.03	0.03
Magnesium (Mg)	0.01	-	0.43	0.11	0.13	0.15	0.16	0.03	0.02	0.38	0.02	0.06	0.02	0.02
Sodium (Na)	0.01	-	0.03	0.04	0.05	0.05	0.07	0.01	0.03	0.04	0.01	0.03	0.01	0.01
Titanium (Ti)	0.005	-	0.286	0.127	0.103	0.211	0.291	0.14	0.187	0.276	0.009	0.138	0.036	0.013
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	3.66	1.92	1.91	7.14	8.64	6.68	4.21	3.34	0.25	2.1	0.62	0.42
Arsenic (As)	0.2	300	34.8	59.9	61.5	145	112	256	36.8	69.2	7.2	41	2.2	2.7
Barium (Ba)	10	-	350	110	130	100	120	20	30	90	40	170	10	60
Beryllium (Be)	0.05	90	8.86	1.15	1.23	1.77	1.92	0.33	0.68	1.66	1.16	0.66	1.56	1.27
Bismuth (Bi)	0.01	-	0.62	0.26	0.25	1.72	2.13	0.69	0.63	0.72	0.02	0.27	0.09	0.03
Boron (B)	10	20000	480	170	200	770	1140	180	140	1370	20	100	<20	<20
Cadmium (Cd)	0.02	90	1.99	0.07	0.05	0.03	<0.02	0.02	0.03	0.08	0.12	0.03	<0.02	0.03
Caesium (Cs)	0.05	-	1.87	1.31	1.53	3.12	3.74	0.39	0.14	10.9	<0.05	0.82	0.24	0.29
Cerium (Ce)	0.01	-	114	23.1	28.9	7.89	4.29	15.8	18.8	82	53	8.52	11.65	8.09
Chromium (Cr)	1	300	68	56	45	101	217	78	55	102	2	53	16	6
Cobalt (Co)	0.1	300	38.4	6.3	7.5	3.2	2.4	1.2	3.4	4.3	31.1	3.6	1.1	3.5
Copper (Cu)	0.2	17000	72.5	26.8	28.5	43.5	39.8	13	11.3	64.6	4.3	14.8	4.1	3.9
Fluorine (F)	20	-	80	30	30	140	220	30	10	110	10	30	10	10
Gallium (Ga)	0.05	-	22.9	7.31	7.43	36.4	44.5	14.8	17.25	19.6	0.89	8.64	3.08	0.9
Germanium (Ge)	0.05	-	1.74	0.13	0.12	0.98	1.01	1.71	2.74	0.34	0.71	0.25	0.1	0.12
Hafnium (Hf)	0.1	-	3.7	1.4	1.2	6.1	7.1	2.5	6.9	3.9	0.1	1.6	0.7	0.2
Indium (In)	0.005	-	0.084	0.05	0.055	0.197	0.287	0.115	0.119	0.084	<0.005	0.053	0.01	<0.005
Lanthanum (La)	0.5	-	154.5	12.6	13.5	2.5	1.8	3.5	7	48.7	10.9	4.8	3.1	5
Lead (Pb)	0.5	600	20	14	14.5	32.8	36.6	33.2	16.7	37.7	1.4	14.7	3.6	1.3
Lithium (Li)	0.2	-	59.3	6.7	7.9	16.3	26.3	2.9	3.3	36.3	8.1	4.4	0.9	0.7
Manganese (Mn)	5	19000	68200	345	449	92	37	504	220	84	4820	241	302	326
Mercury (Hg)	0.005	80	0.189	0.018	0.012	0.028	0.109	0.018	0.034	0.321	0.032	0.012	0.005	<0.005
Molybdenum (Mo)	0.05	-	0.58	1.8	2.18	9.59	11	6.72	3.68	5.52	0.2	1.95	0.44	0.37
Nickel (Ni)	0.2	1200	265	23.6	24.3	62.1	81.2	7.4	19.3	27.9	40.4	12.5	3.9	5.4
Niobium (Nb)	0.1	-	6.9	3.4	3	7.5	9.3	5	14.5	10	0.3	3.5	2.4	0.6
Phosphorus (P)	10	-	1150	450	330	250	130	200	480	320	770	360	620	880
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.006	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	27.6	20.8	23.6	70.2	74.9	7.6	2.3	122	0.8	8.5	3.8	3.2
Scandium (Sc)	0.1	-	19.4	6.6	6.2	24	24.2	8.9	9.8	14.5	1.6	6.8	2	0.8
Selenium (Se)	1	700	<1	1	1	1	1	1	1	2	<1	3	<1	<1
Silver (Ag)	0.01	-	0.15	0.08	0.08	0.05	0.52	0.06	0.03	0.16	0.01	0.04	<0.01	<0.01
Strontium (Sr)	0.2	-	42.2	18.9	19.6	12.6	12.5	2.4	6.9	9.4	9.5	15.9	1.9	5.6
Tantalum (Ta)	0.05	-	0.64	0.31	0.26	0.72	0.92	0.44	1.11	0.97	<0.05	0.29	0.16	<0.05
Tellurium (Te)	0.05	-	0.14	0.13	0.12	0.7	1.04	0.52	0.24	0.23	<0.05	0.12	0.06	<0.05
Thallium (Tl)	0.02	-	1.47	0.26	0.44	0.43	0.74	0.1	0.05	0.66	0.09	0.22	0.03	0.3
Thorium (Th)	0.01	-	10.85	5.43	4.75	12.1	9.07	10.4	15	15.5	0.23	5.83	2.52	0.61
Tin (Sn)	0.2	-	2.5	1	1	5	6.3	2	3.3	2.7	<0.2	1.2	0.5	0.2
Tungsten (W)	0.1	-	2.7	1.7	1.5	3.7	3.2	2.5	3.6	4.6	2.2	1.7	1.9	4.1
Uranium (U)	0.1	-	3.7	1.2	1.1	4.2	4.3	2	2.4	3.9	0.6	1	0.4	0.4
Vanadium (V)	1	-	113	59	50	135	183	78	76	88	4	52	17	5
Yttrium (Y)	0.1	-	298	11	10.3	8.7	5.8	6.1	15.9	22.3	43.6	4.3	5.7	3.7
Zinc (Zn)	2	30000	452	58	50	99	55	21	29	47	27	19	8	9
Zirconium (Zr)	0.5	-	121.5	51.7	41.7	194	224	86.5	226	131.5	3.3	54.1	30.6	8

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low grade siliceous	Low Grade Limonite	Low Grade Limonite	Low Grade Limonite	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Calcrete	Shale	Hydrated
	Stratigraphy →		Marra Mamba	Detrital	Detrital	Detrital	Marra Mamba	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Detrital	Mount McRae Shale	Dales Gorge Member
	RGS Sample Number →		160	161	162	163	164	165	166	167	168	169	170	171
	ALS Laboratory ID →		EB2012967021	EB2012967022	EB2012967023	EB2012967024	EB2012967025	EB2012967026	EB2012967027	EB2012967028	EB2012967029	EB2012967030	EB2012967031	EB2012967033
	Client Sample ID →		ITU333	ITU361	ITU378	ITU558	ITU783	ITV160	ITV171	ITV178	ITV182	ITV767	ITV838	ITV914
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.04	0.02	0.22	0.03	0.07	0.08	0.02	0.11	0.79	0.02	0.02	0.08
Aluminium (Al)	0.01	-	2.57	3.98	2.95	3.15	2.84	6.92	0.27	2.64	10.10	4.95	0.31	5.19
Calcium (Ca)	0.01	-	0.12	0.01	0.01	0.04	0.01	1.76	0.02	0.01	0.13	0.03	0.01	0.04
Iron (Fe)	0.01	-	>50	>50	>50	39.80	41.20	3.16	37.00	>50	1.83	38.90	38.30	35.10
Potassium (K)	0.01	-	0.05	0.01	0.01	0.09	0.01	1.33	0.02	0.01	3.67	0.04	0.02	0.11
Magnesium (Mg)	0.01	-	0.11	0.03	0.02	0.06	0.02	0.73	0.02	0.02	0.9	0.06	0.02	0.03
Sodium (Na)	0.01	-	0.03	0.02	0.01	0.05	0.01	0.04	0.01	0.01	0.13	0.07	0.01	0.05
Titanium (Ti)	0.005	-	0.127	0.212	0.186	0.147	0.089	0.27	0.006	0.076	0.394	0.102	0.012	0.301
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.17	2.18	5.8	2.51	0.93	3.9	0.41	1.6	10.05	3.89	0.23	6.22
Arsenic (As)	0.2	300	14.8	32.8	117.5	51.2	29.3	35.6	4.5	63.2	137.5	316	2.1	50.7
Barium (Ba)	10	-	40	270	10	30	10	100	20	10	420	60	30	270
Beryllium (Be)	0.05	90	1.38	1.67	0.37	0.38	1.3	1.72	0.83	1.38	1.73	0.95	0.86	0.77
Bismuth (Bi)	0.01	-	0.17	0.3	0.64	0.3	0.15	1.03	0.01	0.2	1.02	0.57	0.02	0.97
Boron (B)	10	20000	140	80	70	90	20	920	<20	70	2830	110	<20	50
Cadmium (Cd)	0.02	90	0.02	0.03	<0.02	<0.02	0.02	0.33	<0.02	0.04	0.03	0.02	<0.02	0.03
Caesium (Cs)	0.05	-	0.53	<0.05	0.08	0.69	0.16	5.52	0.26	0.05	12.15	0.14	0.22	0.35
Cerium (Ce)	0.01	-	19.65	29.3	8.14	7.84	7.64	52.1	10.2	16.1	81.4	13.55	11.2	14.35
Chromium (Cr)	1	300	31	42	81	52	27	86	3	29	153	51	3	55
Cobalt (Co)	0.1	300	4.5	3	1.8	1.4	3.9	14.5	1.5	16.6	4.6	7.3	0.8	3.5
Copper (Cu)	0.2	17000	16.2	21.9	18.4	11.2	11.5	140.5	3.9	18.6	80.3	54.8	4.2	14
Fluorine (F)	20	-	20	70	20	20	10	90	10	20	130	30	20	20
Gallium (Ga)	0.05	-	6.77	11.1	15	9.33	5.64	21.3	0.49	5.83	20.2	10.1	0.69	24.9
Germanium (Ge)	0.05	-	2.87	3.4	3.51	0.26	0.79	<0.05	0.15	2.9	0.08	3	0.15	1.84
Hafnium (Hf)	0.1	-	1.4	2.4	2.2	1.7	1.1	3.5	0.1	1.2	3.7	1.7	0.2	7.3
Indium (In)	0.005	-	0.03	0.058	0.115	0.049	0.022	0.157	<0.005	0.025	0.13	0.089	<0.005	0.187
Lanthanum (La)	0.5	-	10.8	12.8	3.2	3.3	2.2	31.6	9.1	5.6	38.3	5.6	7.3	14.4
Lead (Pb)	0.5	600	8.9	13.6	13.4	15.1	6.6	28.7	1.6	8.5	76.9	18.1	2.2	22
Lithium (Li)	0.2	-	2.8	1.1	0.4	3.6	0.5	25.6	0.7	0.3	40.6	2.1	0.9	3.9
Manganese (Mn)	5	19000	325	2650	46	122	247	107	136	806	21	107	289	184
Mercury (Hg)	0.005	80	0.019	0.04	0.041	<0.005	0.007	4.67	0.017	0.034	0.583	0.028	0.017	0.027
Molybdenum (Mo)	0.05	-	1.19	2.79	3.95	2.65	1.13	2.58	0.46	2.7	7.25	4.19	0.31	3.17
Nickel (Ni)	0.2	1200	13.3	8.9	5	7	11	58	4.8	21.1	30.2	29.6	2	16.6
Niobium (Nb)	0.1	-	4.1	6.1	5.4	4.2	3.7	7.9	0.4	3.3	10.6	3.6	0.5	17.1
Phosphorus (P)	10	-	1300	1780	280	260	1220	70	840	1920	360	320	570	520
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.021	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	4.8	0.6	1	7.6	0.9	105	5.6	0.4	205	2.2	4.1	6.2
Scandium (Sc)	0.1	-	6	8.7	5.3	6.5	3.6	13.5	0.7	4.8	20.9	12.9	1.1	10.8
Selenium (Se)	1	700	<1	<1	7	2	1	8	<1	<1	3	1	<1	2
Silver (Ag)	0.01	-	0.03	0.01	0.01	0.01	<0.01	0.26	0.03	<0.01	0.37	0.02	<0.01	<0.01
Strontium (Sr)	0.2	-	18.6	21.2	2.2	11.1	2	27.4	6.9	1	57.2	10.3	6.8	12.6
Tantalum (Ta)	0.05	-	0.36	0.52	0.46	0.34	0.25	0.7	<0.05	0.3	0.9	0.31	<0.05	1.39
Tellurium (Te)	0.05	-	0.09	0.19	0.55	0.16	0.09	1.04	<0.05	0.11	0.36	0.55	<0.05	0.33
Thallium (Tl)	0.02	-	0.05	0.26	0.04	0.11	0.02	0.75	0.04	0.09	1.71	0.08	0.03	0.11
Thorium (Th)	0.01	-	5.29	7.18	8.34	6.44	4.15	13.6	0.33	4.94	13.95	7.88	0.57	19.1
Tin (Sn)	0.2	-	1	1.3	2	1.4	0.8	3.1	<0.2	0.7	3.1	1.7	<0.2	4.6
Tungsten (W)	0.1	-	3.4	3.2	3.1	4	1.3	3.1	1.5	2.9	5.1	2.2	0.8	3.8
Uranium (U)	0.1	-	1.4	1.7	1.3	1.1	1.1	3.1	0.5	1.6	3	1.7	0.2	3.1
Vanadium (V)	1	-	38	50	118	51	36	68	5	31	131	48	6	97
Yttrium (Y)	0.1	-	8.6	17.7	3.6	4	8.9	12.7	6.6	17.5	18.7	8.8	4.3	19.9
Zinc (Zn)	2	30000	20	43	12	5	23	24	9	86	30	141	6	70
Zirconium (Zr)	0.5	-	50.1	90	78.3	60.3	46.3	122.5	7.9	43.3	132	65.3	8.7	247

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Hydrated	Hydrated	Clay	Banded Iron Formation	Detrital Waste	Detrital Waste	Low Grade Limonite	Shale	Banded Iron Formation	Detrital Waste	High Phos High grade	Dolerite
	Stratigraphy →		Dales Gorge Member	Dales Gorge Member	Detrital	Marra Mamba	Detrital	Detrital	Detrital	Wittenoom Formation	Marra Mamba	Detrital	Joffre Member	Dolerite
	RGS Sample Number →		172	173	174	175	177	178	179	180	181	182	183	184
	ALS Laboratory ID →		EB2012967034	EB2012967035	EB2012967036	EB2012967037	EB2012967039	EB2012967040	EB2012967041	EB2012967042	EB2012967043	EB2012967044	EB2012967045	EB2012967046
	Client Sample ID →		ITV916	ITV995	ITW108	ITW348	ITW556	ITW668	ITW975	ITY333	ITY858	ITY943	IUI061	IUI522
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.04	<0.01	<0.01	0.18	0.24	0.03	0.04	0.03	0.01	0.02	0.01	0.02
Aluminium (Al)	0.01	-	7.02	1.45	2.52	6.96	4.58	1.86	3.88	3.40	0.27	0.91	0.29	7.99
Calcium (Ca)	0.01	-	0.03	0.01	0.02	0.01	0.05	0.12	0.03	0.04	0.03	0.01	0.01	0.03
Iron (Fe)	0.01	-	25.90	13.25	16.95	4.29	45.70	>50	49.50	>50	34.80	40.90	35.10	8.55
Potassium (K)	0.01	-	0.07	0.01	0.02	2.20	0.03	0.04	0.02	0.01	0.03	0.01	0.03	1.59
Magnesium (Mg)	0.01	-	0.02	0.02	0.03	0.48	0.03	0.09	0.02	0.05	0.02	0.02	0.02	0.38
Sodium (Na)	0.01	-	0.06	0.01	0.01	0.04	0.09	0.04	0.05	0.05	<0.01	0.01	0.01	0.04
Titanium (Ti)	0.005	-	0.29	0.045	0.134	0.353	0.113	0.079	0.098	0.076	0.009	0.032	0.024	0.313
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	4.77	0.26	0.87	19.2	2.62	1.73	4.05	2.23	0.23	0.46	0.21	14.85
Arsenic (As)	0.2	300	28.2	1.3	6.1	365	320	23.4	24	33.6	2.2	12.5	4.6	253
Barium (Ba)	10	-	130	60	20	320	20	40	140	40	40	100	160	110
Beryllium (Be)	0.05	90	0.54	0.29	1.8	1.42	0.8	1.31	1.49	1.63	1.03	1.34	1.12	1.17
Bismuth (Bi)	0.01	-	1	0.05	0.33	4.25	0.36	0.27	1.57	0.27	0.01	0.07	0.01	1.14
Boron (B)	10	20000	20	<20	<20	1690	90	170	40	70	<20	<20	<20	870
Cadmium (Cd)	0.02	90	0.02	<0.02	0.2	0.03	0.31	0.02	0.03	0.03	<0.02	0.03	<0.02	0.16
Caesium (Cs)	0.05	-	0.13	0.14	0.38	5.51	0.51	0.22	0.11	0.1	0.34	0.18	0.29	5.12
Cerium (Ce)	0.01	-	15.6	3.19	27.3	101.5	14.15	16.5	35.8	13.95	18.1	15.8	11.85	74.7
Chromium (Cr)	1	300	51	24	47	101	51	19	31	30	4	11	4	130
Cobalt (Co)	0.1	300	2.8	0.9	5.5	2.5	12.4	1.7	2.4	2.2	1.2	3.9	2.8	26
Copper (Cu)	0.2	17000	11.2	4.7	37.8	43.3	56.5	9.1	11.2	11.6	5.6	8.4	7.6	48.2
Fluorine (F)	20	-	20	20	10	100	10	30	20	20	30	10	10	80
Gallium (Ga)	0.05	-	23	3.89	7.12	24.8	9.98	5.48	7.18	6.06	0.73	2.32	0.91	22.5
Germanium (Ge)	0.05	-	0.6	<0.05	0.32	0.31	1.62	1.2	3.3	4.24	0.56	0.61	0.54	0.5
Hafnium (Hf)	0.1	-	7.9	0.3	1.5	6.1	2.2	1.5	2	1.8	0.1	0.4	0.2	4.2
Indium (In)	0.005	-	0.174	0.009	0.034	0.286	0.05	0.071	0.127	0.03	<0.005	0.009	0.005	0.106
Lanthanum (La)	0.5	-	13	1.9	6	49	8	8.4	23	10.4	9.5	8.9	5.9	62.1
Lead (Pb)	0.5	600	17.8	2.3	8.2	180.5	9.9	9.2	20.1	8.7	2	4	0.8	112
Lithium (Li)	0.2	-	6.9	20.9	19.2	28.3	4.8	2	6.3	2.5	0.6	1.4	1.1	16.8
Manganese (Mn)	5	19000	131	34	166	30	164	210	142	232	91	1270	2210	554
Mercury (Hg)	0.005	80	0.019	0.047	0.029	0.02	0.016	0.018	0.012	0.009	0.008	0.015	0.01	0.011
Molybdenum (Mo)	0.05	-	2.29	0.53	0.99	22	12.15	1.54	1.11	1.28	0.57	0.8	0.52	2.36
Nickel (Ni)	0.2	1200	22.9	6.8	25.3	12	84.7	5.7	11.4	10.3	3.6	8.8	3.1	131
Niobium (Nb)	0.1	-	17.1	1.2	3.6	14.1	5	3.2	3.7	3.9	0.4	1.2	0.5	10.2
Phosphorus (P)	10	-	330	60	240	270	380	880	670	880	910	980	810	440
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.3	1	2.6	118	1.5	2.5	0.7	0.7	6.3	1.6	5.4	95.5
Scandium (Sc)	0.1	-	9.2	1.4	7.8	25	19.1	2.8	8.4	6.6	0.9	2	1	23
Selenium (Se)	1	700	1	<1	<1	3	4	2	1	1	<1	<1	<1	1
Silver (Ag)	0.01	-	<0.01	0.03	0.11	0.08	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.08
Strontium (Sr)	0.2	-	10.2	3	2.1	83.8	4.3	20.3	17.2	14.2	19.5	6.2	7.3	11
Tantalum (Ta)	0.05	-	1.47	0.09	0.34	1.34	0.48	0.25	0.33	0.34	<0.05	0.11	<0.05	1
Tellurium (Te)	0.05	-	0.27	<0.05	0.1	0.77	0.2	0.18	0.33	0.19	0.09	0.13	0.11	0.24
Thallium (Tl)	0.02	-	0.07	<0.02	0.38	1.22	0.03	0.07	0.03	0.06	0.02	0.32	0.33	0.4
Thorium (Th)	0.01	-	15.6	0.89	4.57	21.3	9.23	3.87	6.83	6.75	0.34	1.66	0.31	18.05
Tin (Sn)	0.2	-	4.7	0.5	1	8.2	1.3	0.9	1.9	0.9	<0.2	0.3	<0.2	3.2
Tungsten (W)	0.1	-	5.2	2.5	1.6	10.3	2.1	10	3.5	1.7	2.7	3.9	1.4	5.7
Uranium (U)	0.1	-	3	0.1	1	4.7	1.3	0.7	1	1.1	0.3	0.6	0.2	4.3
Vanadium (V)	1	-	68	4	38	99	56	35	56	34	5	11	8	129
Yttrium (Y)	0.1	-	18.2	2.8	12.8	23.6	7.6	6	7.2	7.8	3.1	7.4	5.2	18.2
Zinc (Zn)	2	30000	62	27	101	17	443	28	22	25	7	19	6	687
Zirconium (Zr)	0.5	-	267	12.7	50	189.5	78	54.2	70.2	67.1	7.1	15.8	8.5	124.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Banded Iron Formation	Hydrated Waste	Shale	Banded Iron Formation	Manganiferous Shale	Detrital Waste	Shale	Shale	Cherty Shale	Limonitic Waste	Shale	Detrital Waste
	Stratigraphy →		Dales Gorge Member	Detrital	Whaleback Shale	Dales Gorge Member	Wittenoom Formation	Detrital	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Wittenoom Formation	Detrital
	RGS Sample Number →		185	186	187	188	189	190	191	192	193	194	195	196
	ALS Laboratory ID →		EB2012967047	EB2012967048	EB2012967049	EB2012967050	EB2012967051	EB2012967052	EB2012967053	EB2012967054	EB2012967055	EB2012967056	EB2012967057	EB2012967058
	Client Sample ID →		IUI533	IUJ616	IUK907	IUK935	IUL147	IUL857	IUO164	IUO168	IUO309	IUO422	IUO469	IUO484
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	<0.01	0.01	0.01	0.02	0.03	0.04	0.01	0.02	0.01	0.09	0.01
Aluminium (Al)	0.01	-	1.91	0.35	7.55	0.65	4.27	2.68	1.43	0.56	3.47	5.40	1.81	0.09
Calcium (Ca)	0.01	-	0.12	0.02	0.03	0.02	0.03	0.09	0.03	0.01	0.04	0.16	12.45	0.05
Iron (Fe)	0.01	-	30.20	35.20	37.00	37.40	48.50	43.60	>50	>50	31.80	25.50	9.44	28.80
Potassium (K)	0.01	-	0.24	0.02	0.02	0.01	0.01	0.08	0.02	0.04	0.10	0.13	0.84	0.01
Magnesium (Mg)	0.01	-	0.07	0.03	0.03	0.02	0.08	0.05	0.03	0.03	0.05	1.09	7.91	0.03
Sodium (Na)	0.01	-	0.02	0.01	0.02	0.01	0.01	0.04	0.01	0.01	0.04	0.03	0.07	<0.01
Titanium (Ti)	0.005	-	0.107	0.006	0.438	0.022	0.244	0.19	0.059	0.019	0.221	0.534	0.094	0.006
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.74	0.23	5.2	0.44	2.96	2.83	1.58	1	2.57	1.48	2.96	0.17
Arsenic (As)	0.2	300	44.9	4.7	84.4	13.1	38.3	61.8	11.5	37.4	49.3	17.2	49.2	1.5
Barium (Ba)	10	-	90	30	200	10	20	80	40	10	50	10	790	10
Beryllium (Be)	0.05	90	1.4	1.07	12.85	1.23	1.29	0.54	2.64	1.29	0.43	1.83	0.89	0.46
Bismuth (Bi)	0.01	-	0.18	0.03	0.63	0.03	0.46	0.34	0.18	0.17	0.35	0.07	0.17	0.01
Boron (B)	10	20000	100	<20	40	30	100	40	20	20	40	260	520	<20
Cadmium (Cd)	0.02	90	0.05	<0.02	0.28	0.08	1.52	0.02	0.09	0.09	<0.02	0.31	0.18	0.02
Caesium (Cs)	0.05	-	1.13	0.26	0.21	0.11	0.22	0.6	0.16	0.18	1.01	5.43	2.04	0.12
Cerium (Ce)	0.01	-	23.7	11.1	31.6	11.65	47.2	8.46	12	10.6	6.72	18.85	25.4	1.77
Chromium (Cr)	1	300	40	2	99	8	64	69	15	6	85	43	24	6
Cobalt (Co)	0.1	300	6.9	0.9	26.7	12.6	13.5	2.5	3.6	5.1	2.3	129	29.3	1.5
Copper (Cu)	0.2	17000	28.7	4.6	92.5	11.4	19.2	12.4	9.4	26	15.7	128	18.3	2.3
Fluorine (F)	20	-	20	10	30	10	10	30	10	10	20	20	20	10
Gallium (Ga)	0.05	-	6.12	0.88	21.3	1.68	11.75	10	4.6	2.46	11.45	16.35	5.78	0.72
Germanium (Ge)	0.05	-	0.55	0.58	1.73	0.55	3.05	0.8	3.28	4.37	0.86	1.5	0.08	0.73
Hafnium (Hf)	0.1	-	1.1	0.2	4.3	0.2	2.3	2	1.3	0.4	2.2	2.1	0.8	<0.1
Indium (In)	0.005	-	0.039	<0.005	0.078	0.006	0.083	0.056	0.019	0.066	0.063	0.073	0.021	<0.005
Lanthanum (La)	0.5	-	12.8	6.1	45	5.7	12.8	3.8	3.9	5.4	4	10.4	18.6	1.3
Lead (Pb)	0.5	600	13.9	1.5	26.6	2.2	9.9	15.5	8.2	13.3	16.3	4.4	7.8	0.6
Lithium (Li)	0.2	-	6.6	2.2	25	2.4	11.2	5.9	1.6	1.8	4.7	76.5	9.2	3.7
Manganese (Mn)	5	19000	457	218	1420	148	124	153	538	122	139	11400	35400	128
Mercury (Hg)	0.005	80	0.01	0.009	0.088	0.009	0.157	0.012	0.024	0.009	0.008	0.01	0.042	0.016
Molybdenum (Mo)	0.05	-	1.89	0.29	3.59	1.14	2.25	2.67	1.32	0.63	2.34	1.49	1.76	0.76
Nickel (Ni)	0.2	1200	20	3.8	83.6	17.9	58.8	11	11.1	21.1	11.7	128	48.4	4.5
Niobium (Nb)	0.1	-	2.5	0.4	10.5	0.7	6.9	4.8	2.9	0.5	5.2	3.6	2.5	0.2
Phosphorus (P)	10	-	460	690	840	670	370	270	1330	110	240	280	250	370
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	17.7	2.4	1.5	0.8	1.2	5.7	1.6	3.1	8.6	4.2	31.4	0.8
Scandium (Sc)	0.1	-	7.5	0.5	22.7	1.6	12.8	8.2	5.8	4.2	10.1	28.3	5	0.4
Selenium (Se)	1	700	1	<1	1	<1	2	3	1	1	3	<1	1	<1
Silver (Ag)	0.01	-	0.06	0.01	0.05	0.02	0.13	0.03	0.05	0.01	0.03	0.09	0.05	0.01
Strontium (Sr)	0.2	-	17.8	4.7	13	2.1	3.9	18.6	6.8	12.7	10.8	28.6	83.6	1.3
Tantalum (Ta)	0.05	-	0.21	<0.05	0.99	<0.05	0.55	0.39	0.25	0.06	0.43	0.3	0.2	<0.05
Tellurium (Te)	0.05	-	0.14	0.12	0.31	0.13	0.59	0.24	0.21	0.41	0.21	0.14	0.06	0.12
Thallium (Tl)	0.02	-	0.28	0.08	0.03	0.02	0.03	0.15	0.04	0.09	0.15	0.25	1.77	<0.02
Thorium (Th)	0.01	-	3.89	0.83	11.7	0.68	7.16	7.08	5.53	1.62	7.78	1.2	3.14	0.13
Tin (Sn)	0.2	-	0.7	<0.2	2.7	0.2	1.8	1.5	0.7	0.4	1.6	1.1	0.7	0.2
Tungsten (W)	0.1	-	1.4	3	3.9	2.3	2.8	1.8	3	0.7	1.8	1.8	1	4.8
Uranium (U)	0.1	-	1	0.4	5.1	0.5	3.3	1.2	1.4	0.6	1	1.1	1.1	0.1
Vanadium (V)	1	-	61	5	130	9	82	76	22	12	88	174	31	2
Yttrium (Y)	0.1	-	9.1	4.2	47.2	9.5	21	4.9	11.4	6.7	3.8	37.4	26.9	4.2
Zinc (Zn)	2	30000	37	9	169	44	465	12	36	116	15	192	84	19
Zirconium (Zr)	0.5	-	38.1	6.7	138.5	9.9	78.9	68.8	44.9	15.8	73.2	69.4	30.4	1.7

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Detrital Waste	Low Grade Pisolite	Detrital Waste	Banded Iron Formation	Banded Iron Formation	Shale	Low Grade Aluminous	Banded Iron Formation	Shale	Low Grade Aluminous	Banded Iron Formation	Shale
	Stratigraphy →		Detrital	Detrital	Detrital	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale
	RGS Sample Number →		197	198	199	200	201	202	203	204	206	207	208	209
	ALS Laboratory ID →		EB2012967059	EB2012967060	EB2012967061	EB2012967062	EB2012967063	EB2012967064	EB2012967065	EB2012967066	EB2012967067	EB2012967068	EB2012967069	EB2012968001
	Client Sample ID →		IUO694	IUO927	IUO947	IUP204	IUP212	IUP217	IUP669	IUP864	IUV445	IVA003	IVA087	IVA196
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.05	0.06	0.01	0.07	0.03	0.04	0.07	0.09	0.08	0.01	0.03	0.10
Aluminium (Al)	0.01	-	0.75	0.35	9.23	0.30	4.54	1.53	3.34	0.83	1.20	0.69	0.97	2.46
Calcium (Ca)	0.01	-	18.20	1.67	0.35	20.00	0.05	0.01	0.01	<0.01	<0.01	0.03	0.05	0.02
Iron (Fe)	0.01	-	2.97	26.60	15.95	1.41	26.80	41.80	39.10	48.50	46.00	33.90	36.90	33.90
Potassium (K)	0.01	-	0.27	0.22	0.09	0.05	0.02	0.01	0.01	<0.01	<0.01	0.02	0.01	0.01
Magnesium (Mg)	0.01	-	11.45	0.78	1.14	12.1	0.04	0.02	0.02	0.01	0.01	0.03	0.05	0.03
Sodium (Na)	0.01	-	0.04	0.02	0.06	0.08	0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.02
Titanium (Ti)	0.005	-	0.034	0.021	0.879	0.016	0.072	0.043	0.089	0.045	0.045	0.023	0.033	0.076
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.53	0.8	0.25	0.23	2.79	1.57	1.61	1.36	1.39	0.43	0.9	1.06
Arsenic (As)	0.2	300	9.6	3.6	2.9	2.9	2.8	10.1	22.1	15.7	23.3	7.3	28.8	47.7
Barium (Ba)	10	-	180	30	20	10	20	20	60	10	10	20	60	10
Beryllium (Be)	0.05	90	0.38	1.09	0.79	0.14	2.49	2.67	2.49	3.57	3.34	1.15	1.58	1.53
Bismuth (Bi)	0.01	-	0.08	0.04	0.02	0.03	0.2	0.12	0.29	0.11	0.14	0.06	0.06	0.17
Boron (B)	10	20000	520	50	70	260	<20	<20	80	20	<20	<20	40	60
Cadmium (Cd)	0.02	90	0.18	0.02	0.13	<0.02	<0.02	0.03	0.03	<0.02	0.02	<0.02	<0.02	0.06
Caesium (Cs)	0.05	-	0.7	2.27	17.2	0.11	0.2	0.15	0.19	0.07	0.1	0.31	0.49	0.07
Cerium (Ce)	0.01	-	14.65	7.07	28.5	6.36	33.1	9.75	48	15.25	17.3	12.95	6.5	35.5
Chromium (Cr)	1	300	10	10	62	8	20	12	24	13	11	8	7	34
Cobalt (Co)	0.1	300	7.6	2.7	172	1.5	1.5	3.2	3.8	1.4	2.2	1.2	4.1	8.2
Copper (Cu)	0.2	17000	7.9	5.3	186	2.3	5.6	9.2	9.5	8	7.2	4.5	16.6	20.9
Fluorine (F)	20	-	10	30	20	10	20	10	20	10	20	30	20	30
Gallium (Ga)	0.05	-	2.39	1.34	24	0.92	6.2	3.62	8.2	3.5	4.58	2.06	2.44	5.59
Germanium (Ge)	0.05	-	<0.05	0.61	0.83	<0.05	0.71	1.17	2.45	2.96	3.25	0.85	2	1.58
Hafnium (Hf)	0.1	-	0.4	0.2	2.8	0.1	1.8	1	2.5	0.8	1.2	0.5	0.3	0.9
Indium (In)	0.005	-	0.01	0.005	0.105	<0.005	0.014	0.011	0.028	0.009	0.013	0.006	0.014	0.033
Lanthanum (La)	0.5	-	10.4	4	15.9	4.4	17.6	4.5	38.4	9.1	3.6	7.2	3.1	12.3
Lead (Pb)	0.5	600	2.9	2.3	0.9	0.5	16.9	10.7	17.2	6.1	6.2	4.1	4.6	8.2
Lithium (Li)	0.2	-	9.1	4.1	83	4.1	2.1	0.8	1.4	0.4	0.5	3	2.6	0.9
Manganese (Mn)	5	19000	7460	392	1860	2960	126	198	195	300	505	185	94	1340
Mercury (Hg)	0.005	80	0.014	0.042	0.015	0.025	<0.005	<0.005	0.006	0.005	0.009	0.021	0.008	0.013
Molybdenum (Mo)	0.05	-	0.81	0.39	0.25	0.24	0.64	0.98	1.2	0.9	0.65	1.27	2.98	2.35
Nickel (Ni)	0.2	1200	30	6.4	257	8.8	6.7	12.4	10.9	10.4	10.3	4.7	11.2	31.3
Niobium (Nb)	0.1	-	1	0.6	4.2	0.4	4.2	2.5	5.8	2	3.4	1.4	1	2.6
Phosphorus (P)	10	-	140	390	650	80	850	1240	910	900	920	730	790	1490
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	9.5	25.5	8.2	1.5	2.1	1.2	0.6	0.4	0.5	3.8	1.3	0.4
Scandium (Sc)	0.1	-	2.2	1.3	59.3	0.8	5.2	2.5	4.4	2.5	2.3	1.2	3.8	4.9
Selenium (Se)	1	700	<1	<1	<1	<1	1	1	1	<1	<1	<1	<1	<1
Silver (Ag)	0.01	-	0.02	0.01	0.03	0.01	0.01	0.03	0.02	0.01	0.01	0.02	0.01	0.01
Strontium (Sr)	0.2	-	29.2	36.6	10.1	19.8	3.7	1.9	22.8	5	1.3	4.6	2.3	31.7
Tantalum (Ta)	0.05	-	0.08	0.05	0.32	<0.05	0.35	0.21	0.5	0.17	0.28	0.13	0.08	0.25
Tellurium (Te)	0.05	-	<0.05	0.11	0.07	<0.05	0.11	0.18	0.18	0.26	0.25	0.19	0.2	0.23
Thallium (Tl)	0.02	-	0.78	0.13	0.16	0.09	<0.02	<0.02	0.02	<0.02	<0.02	0.1	0.02	0.11
Thorium (Th)	0.01	-	1.6	0.57	0.31	0.56	7.08	3.51	9	2.71	4.84	2.43	1.29	3.82
Tin (Sn)	0.2	-	0.3	0.2	1	0.2	0.8	0.5	1.4	0.5	0.7	0.5	0.3	0.6
Tungsten (W)	0.1	-	0.4	1.5	0.5	0.3	1.7	1.8	1.3	1.6	1.2	1.8	1.7	2.4
Uranium (U)	0.1	-	0.5	0.2	0.9	0.2	1.5	1.1	2.1	1.3	1.2	0.9	0.9	3.7
Vanadium (V)	1	-	13	7	254	4	24	15	28	20	16	9	14	26
Yttrium (Y)	0.1	-	15.6	7	44.9	5.4	10.3	8.5	13.7	8.8	9.5	5.5	7.3	13.1
Zinc (Zn)	2	30000	20	6	261	3	17	21	16	23	23	10	27	61
Zirconium (Zr)	0.5	-	15.8	7.1	83.5	4.5	61.9	37.1	77.2	27.4	39.7	17.5	13.6	31.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Hydrated Waste	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Red Ochre High Grade	Manganiferous Shale	Detrital Waste	Detrital Waste	Detrital Waste	Detrital Waste
	Stratigraphy →		Dales Gorge Member	Dales Gorge Member	Whaleback Shale	Joffre Member	Joffre Member	Joffre Member	Detrital	Wittenoom Formation	Detrital	Detrital	Detrital	Detrital
	RGS Sample Number →		210	211	212	214	215	216	217	218	219	220	221	222
	ALS Laboratory ID →		EB2012968002	EB2012968003	EB2012968004	EB2012968005	EB2012968006	EB2012968007	EB2012968008	EB2012968009	EB2012968011	EB2012968010	EB2012968012	EB2012968013
	Client Sample ID →		IVA220	IVA275	IVA504	IVB053	IVB275	IVB278	IVB424	IVB481	IVB619	IVB621	IVB839	IVB842
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.12	0.06	0.06	0.10	0.02	0.06	<0.01	0.01	0.08	0.07	0.03	<0.01
Aluminium (Al)	0.01	-	3.23	2.07	2.65	1.47	1.23	0.75	0.98	2.97	2.21	0.87	3.45	1.09
Calcium (Ca)	0.01	-	0.02	0.01	0.01	<0.01	0.01	0.01	0.02	2.22	21.10	32.00	0.05	0.02
Iron (Fe)	0.01	-	27.80	26.70	36.20	49.40	19.65	36.10	33.30	45.00	8.22	2.46	49.50	>50
Potassium (K)	0.01	-	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.09	0.06	0.60	0.01	0.01
Magnesium (Mg)	0.01	-	0.03	0.02	0.02	0.01	0.02	0.01	0.04	0.48	3.52	0.48	0.09	0.03
Sodium (Na)	0.01	-	0.02	0.02	0.02	0.01	<0.01	0.01	0.01	0.01	0.08	0.06	0.01	0.01
Titanium (Ti)	0.005	-	0.083	0.071	0.124	0.105	0.065	0.111	0.05	0.212	0.173	0.046	0.187	0.014
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.3	1.53	1.26	1.13	0.46	0.51	0.92	2.49	1.18	0.36	1.1	0.87
Arsenic (As)	0.2	300	10.5	23.6	25.9	13	2.6	7.7	10.4	58	8.2	7.4	44.7	8.5
Barium (Ba)	10	-	90	30	10	10	10	10	10	30	60	70	10	120
Beryllium (Be)	0.05	90	1.3	1.47	2.01	0.54	0.56	0.2	1.78	0.9	1.16	0.27	1.3	3.07
Bismuth (Bi)	0.01	-	0.2	0.17	0.17	0.28	0.08	0.13	0.07	0.32	0.26	0.06	0.22	0.05
Boron (B)	10	20000	30	30	50	10	10	10	20	30	20	10	20	20
Cadmium (Cd)	0.02	90	0.02	0.03	0.03	<0.02	<0.02	<0.02	0.03	0.03	0.03	0.1	0.06	<0.02
Caesium (Cs)	0.05	-	0.08	0.1	0.09	0.08	0.37	0.1	0.11	2.79	5.21	1.75	0.12	0.16
Cerium (Ce)	0.01	-	240	63.4	13.75	14	20.4	3.8	11.85	10.8	19.05	15.1	9.17	73.3
Chromium (Cr)	1	300	35	34	28	24	10	11	24	53	35	11	59	6
Cobalt (Co)	0.1	300	5.7	6.6	9.4	2	0.8	0.8	7.5	4.9	6.9	2.8	12.8	3.5
Copper (Cu)	0.2	17000	16	18.5	38.9	4.3	5.8	4.1	17.6	19.6	8.6	7.2	18.8	26.4
Fluorine (F)	20	-	50	20	20	20	<20	90	<20	110	320	210	130	<20
Gallium (Ga)	0.05	-	6.93	5.46	6.57	4.95	2.87	2.57	3.08	8.45	6.51	2.64	8.74	1.52
Germanium (Ge)	0.05	-	1.71	0.55	0.68	2.16	0.35	0.57	0.6	3.08	<0.05	<0.05	3.19	0.47
Hafnium (Hf)	0.1	-	1.3	1	1.3	1.2	0.7	1	0.4	1.6	1.2	0.4	1.2	0.2
Indium (In)	0.005	-	0.03	0.024	0.027	0.043	0.013	0.022	0.008	0.047	0.044	0.009	0.057	0.006
Lanthanum (La)	0.5	-	139	55.8	6.8	8.3	16.7	1.4	9	7.4	11.5	8.9	4.4	24.1
Lead (Pb)	0.5	600	13.1	11.8	7	5	5.1	1.6	3.9	11.7	17.6	1.9	11.4	5.3
Lithium (Li)	0.2	-	2.6	3.5	0.7	0.6	1.4	1.3	8.7	15.7	15.3	3.7	9.9	7.2
Manganese (Mn)	5	19000	296	307	192	40	58	25	433	264	593	3890	280	418
Mercury (Hg)	0.005	80	0.013	0.012	0.006	0.021	0.023	0.028	0.019	0.021	0.026	0.01	0.012	0.005
Molybdenum (Mo)	0.05	-	1.45	2.23	1.64	1.79	0.37	1.04	1.19	1.59	0.66	0.52	2.31	0.43
Nickel (Ni)	0.2	1200	15.2	15.7	15.9	5.4	3.6	1.4	20.2	21	18.9	10.8	37.5	6.5
Niobium (Nb)	0.1	-	3.3	2.8	3.3	4	1.9	4.5	1.3	6.1	5	1.2	4.4	0.8
Phosphorus (P)	10	-	2040	1530	1400	520	640	320	470	260	40	100	310	1550
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.4	1.1	0.3	1.4	8.6	1.9	0.7	9.6	9.1	20.4	0.6	1.3
Scandium (Sc)	0.1	-	7.8	4.9	5.5	2.9	2.3	1.4	3.1	9.2	5.5	2.4	8.4	9
Selenium (Se)	1	700	<1	1	<1	6	<1	10	<1	1	<1	<1	1	<1
Silver (Ag)	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.05	0.01
Strontium (Sr)	0.2	-	330	87	6.8	6.1	5.2	2.3	1.2	9.2	59.3	34.7	2.8	13.5
Tantalum (Ta)	0.05	-	0.3	0.22	0.28	0.3	0.12	0.32	0.11	0.51	0.41	0.1	0.35	0.06
Tellurium (Te)	0.05	-	0.23	0.18	0.24	0.32	0.09	0.23	0.14	0.24	0.07	<0.05	0.27	0.15
Thallium (Tl)	0.02	-	0.04	0.05	0.05	0.02	0.02	<0.02	0.03	0.05	0.07	0.31	0.02	0.15
Thorium (Th)	0.01	-	5.77	3.91	3.84	3.33	1.65	1.69	1.48	5.03	4.28	1.56	3.17	0.69
Tin (Sn)	0.2	-	0.7	0.6	0.7	0.8	0.4	0.6	0.4	1.3	1.2	0.3	1.1	0.2
Tungsten (W)	0.1	-	3.8	2	2	2.4	1.5	2.5	1.5	2.2	1.5	0.4	1.1	1.5
Uranium (U)	0.1	-	4	3.6	1.4	0.7	0.6	0.4	0.8	1.2	0.8	0.3	3.2	0.5
Vanadium (V)	1	-	27	22	35	25	18	14	29	51	31	12	80	9
Yttrium (Y)	0.1	-	9.5	12.8	12	3.3	4.2	2.7	16.4	11.2	12.6	15.6	8.2	9.9
Zinc (Zn)	2	30000	40	54	70	5	6	<2	28	25	13	13	657	16
Zirconium (Zr)	0.5	-	45.6	37.5	50	52.7	31.1	41.8	17	60.9	44.3	12.7	46.8	10.1

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low Grade Detrital	Hydrated	Shale	High Grade	Detrital Waste	Banded Iron Formation	Banded Iron Formation	Hydrated	Banded Iron Formation	Low Grade Detrital	Detrital Waste	Banded Iron Formation
	Stratigraphy →		Detrital	Dales Gorge Member	Mount McRae Shale	Marra Mamba	Detrital	Joffre Member	Joffre Member	Dales Gorge Member	Mount McRae Shale	Detrital	Detrital	Dales Gorge Member
	RGS Sample Number →		223	224	225	226	227	228	229	230	231	232	233	234
	ALS Laboratory ID →		EB2012968014	EB2012968015	EB2012968016	EB2012968017	EB2012968018	EB2012968019	EB2012968020	EB2012968021	EB2012968022	EB2012968023	EB2012968024	EB2012968025
	Client Sample ID →		IVB921	IVC092	IVC161	IVD337	IVK485	IVL209	IVL225	IVM058	IVM080	IVM112	IVM713	IVN356
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	<0.01	0.07	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.06
Aluminium (Al)	0.01	-	3.81	5.47	7.14	6.27	1.46	6.14	3.51	2.90	4.91	13.25	10.55	0.38
Calcium (Ca)	0.01	-	0.05	0.23	0.04	0.05	0.03	0.04	0.07	0.07	0.06	0.06	0.06	20.10
Iron (Fe)	0.01	-	48.70	32.50	30.80	47.30	>50	43.40	17.80	34.40	37.60	10.10	19.60	1.50
Potassium (K)	0.01	-	0.02	0.36	0.27	0.02	0.02	0.31	0.24	0.21	0.06	2.72	2.36	0.17
Magnesium (Mg)	0.01	-	0.07	0.15	0.13	0.1	0.05	0.1	0.09	0.09	0.09	0.41	0.53	11.75
Sodium (Na)	0.01	-	0.03	0.02	0.06	0.02	0.01	0.02	0.04	0.03	0.03	0.05	0.03	0.06
Titanium (Ti)	0.005	-	0.482	0.371	0.315	0.328	0.048	0.22	0.221	0.156	0.299	0.552	0.417	0.02
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	4.11	4.88	9.53	5.04	1.23	6.88	1.66	3.4	2.88	14.95	12.25	0.43
Arsenic (As)	0.2	300	39.6	76.1	138	85.7	56.8	145.5	38.2	78.7	66	27	77.7	3.6
Barium (Ba)	10	-	30	40	30	20	10	50	120	80	30	180	140	20
Beryllium (Be)	0.05	90	1.73	2.11	0.73	1.23	0.43	0.71	1.38	0.85	0.58	1.65	3.94	0.18
Bismuth (Bi)	0.01	-	0.37	0.74	1.26	0.57	0.17	1.02	0.35	0.44	0.4	1.52	1	0.03
Boron (B)	10	20000	10	50	40	40	20	50	40	30	40	90	80	10
Cadmium (Cd)	0.02	90	0.08	0.02	<0.02	0.05	0.02	0.04	0.06	0.05	0.02	<0.02	0.07	<0.02
Caesium (Cs)	0.05	-	0.13	10.5	5.41	0.7	0.34	1.23	1.88	1.54	0.93	4.69	5.76	0.38
Cerium (Ce)	0.01	-	14.45	15.45	8.57	22.4	8.23	13.2	34.9	19.3	16.95	4.62	71.7	6.46
Chromium (Cr)	1	300	58	75	131	114	16	116	98	73	93	280	163	12
Cobalt (Co)	0.1	300	7.2	3.3	1.6	11.2	3.7	2.5	8.5	4.7	5.1	12.4	54.4	1.8
Copper (Cu)	0.2	17000	7.9	17.7	13.4	3.7	10.1	29	31.7	20.9	14.9	55.2	74.5	3.4
Fluorine (F)	20	-	200	310	500	280	70	250	140	160	110	790	910	210
Gallium (Ga)	0.05	-	21.7	18.1	24.5	24.1	3.75	20	11.45	10	15.75	39	32.9	1.1
Germanium (Ge)	0.05	-	3.32	3.07	1.18	1.87	2.7	1.67	0.33	0.44	0.88	0.53	0.84	<0.05
Hafnium (Hf)	0.1	-	2.6	3.3	4.2	2.8	0.7	3.5	2.5	1.9	2.6	6.8	4.7	0.2
Indium (In)	0.005	-	0.079	0.091	0.15	0.122	0.024	0.131	0.065	0.068	0.094	0.129	0.097	<0.005
Lanthanum (La)	0.5	-	6.9	9.4	3.9	8.2	3	7.3	16.7	10.7	7	1.2	13	4.2
Lead (Pb)	0.5	600	18.5	24.2	35.4	24.4	15.9	26.6	19.4	20.4	22.1	39.7	53.8	1.2
Lithium (Li)	0.2	-	2.6	31.3	8.6	18.3	2.1	26.8	10.5	5	23.6	44.9	39	3.2
Manganese (Mn)	5	19000	91	53	31	137	225	142	378	271	98	1600	4550	2900
Mercury (Hg)	0.005	80	0.014	0.1	0.009	0.018	0.112	0.351	0.012	0.014	<0.005	0.008	0.029	0.007
Molybdenum (Mo)	0.05	-	4.62	2.27	6.2	3.69	1.23	4.23	1.63	2.46	3.86	5.13	3.74	0.36
Nickel (Ni)	0.2	1200	18.5	20.2	14.4	33.1	6.1	17.1	24.3	17.6	25.2	57.1	118.5	11.5
Niobium (Nb)	0.1	-	16.9	9.9	8.9	9.8	1.9	7.2	6.2	4.2	7.4	14.3	11.2	0.5
Phosphorus (P)	10	-	450	120	160	230	200	240	360	400	200	270	710	70
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	1.1	34.1	36.2	2.2	1.4	21.5	24.8	19.5	5.8	93.3	86.7	5.1
Scandium (Sc)	0.1	-	7.1	15.1	21.5	8.3	4.3	14	10.6	8.5	14.8	25.5	25.6	1
Selenium (Se)	1	700	1	<1	2	1	3	4	2	2	2	<1	1	<1
Silver (Ag)	0.01	-	0.01	0.02	0.01	0.02	0.06	0.05	0.09	0.06	0.07	0.02	0.07	<0.01
Strontium (Sr)	0.2	-	12.2	5.6	3.5	6.6	1.6	5.1	24.1	18.1	8.9	9.1	6.1	17.5
Tantalum (Ta)	0.05	-	1.26	0.83	0.75	0.82	0.15	0.63	0.5	0.36	0.59	1.46	1.09	0.05
Tellurium (Te)	0.05	-	0.22	0.18	0.39	0.33	0.25	0.5	0.15	0.25	0.26	0.34	0.24	<0.05
Thallium (Tl)	0.02	-	0.03	0.14	0.3	0.07	0.05	0.1	0.27	0.3	0.14	0.54	0.52	0.08
Thorium (Th)	0.01	-	6.83	10.6	22.2	8.92	2.42	13.5	10	7.7	9.68	12.05	12.2	0.75
Tin (Sn)	0.2	-	3.4	2.4	3.2	3	0.5	2.7	1.5	1.4	2.1	5	3.6	0.2
Tungsten (W)	0.1	-	6.3	3.7	4.2	2.7	1.4	2.4	1.7	1.7	2	3.3	3.1	0.3
Uranium (U)	0.1	-	3	2.2	2.5	3	1.8	2.9	1.5	1.5	2.1	4.2	5.4	0.3
Vanadium (V)	1	-	121	113	149	108	22	96	92	69	84	205	151	6
Yttrium (Y)	0.1	-	6.5	13.9	7.2	11.8	4.5	7.9	13.2	8.7	7.4	6.6	24.8	5.2
Zinc (Zn)	2	30000	21	10	8	8	14	33	52	39	11	51	216	6
Zirconium (Zr)	0.5	-	91.5	114.5	136	96.7	27.4	115.5	90.1	67.5	95.7	216	149.5	5.6

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →	Shale	Banded Iron Formation	Low Grade Aluminous	Shale	Shale	Banded Iron Formation	Shale	Shale	Silcrete	Banded Iron Formation	Shale	Shale
	Stratigraphy →	Mount Sylvia	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Detrital	Marra Mamba	Mount McRae Shale	Mount McRae Shale
	RGS Sample Number →	235	236	237	238	239	240	241	242	243	244	245	246
	ALS Laboratory ID →	EB2012968026	EB2012968027	EB2012968028	EB2012968029	EB2012968030	EB2012968031	EB2012968032	EB2012968033	EB2012968034	EB2012968035	EB2012968036	EB2012968037
	Client Sample ID →	IVN449	IVN838	IVN871	IVN891	IWQ038	IWQ128	IWQ166	IWQ167	IWR529	IWR632	IWS032	IWS038
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C											
Major Cations			All units %										
Sulfur (S)	0.01	-	0.01	0.05	0.01	0.01	<0.01	0.01	0.03	0.03	0.01	0.03	0.03	0.05
Aluminium (Al)	0.01	-	3.62	0.12	7.85	3.14	9.43	8.11	2.76	2.02	8.94	1.17	1.01	0.76
Calcium (Ca)	0.01	-	0.12	0.17	0.11	0.50	0.03	0.02	0.02	0.13	0.11	0.25	0.07	0.12
Iron (Fe)	0.01	-	46.60	32.50	20.80	48.00	2.33	3.39	>50	33.20	9.87	43.20	44.80	48.40
Potassium (K)	0.01	-	0.03	0.01	0.20	0.21	1.89	1.82	0.10	0.15	2.30	0.05	0.03	0.02
Magnesium (Mg)	0.01	-	0.17	0.04	0.11	0.34	0.35	0.32	0.05	0.14	0.53	0.08	0.05	0.04
Sodium (Na)	0.01	-	0.01	0.01	0.04	0.01	0.04	0.03	0.01	0.04	0.03	0.03	0.03	0.03
Titanium (Ti)	0.005	-	0.21	0.007	0.665	0.081	0.386	0.34	0.107	0.118	0.364	0.022	0.018	0.015
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	3.1	0.17	2.41	2.23	5.47	7.42	3.51	1.09	6.35	0.48	0.42	0.5
Arsenic (As)	0.2	300	59.5	1.1	24.7	28.4	20.1	61.9	141.5	21.1	44.6	3.8	3	5.1
Barium (Ba)	10	-	20	10	70	20	130	120	20	70	840	50	120	210
Beryllium (Be)	0.05	90	0.97	0.49	0.79	2.18	1.55	1.62	0.7	0.96	4.36	0.92	1.16	3.18
Bismuth (Bi)	0.01	-	0.47	0.01	0.46	0.25	1.43	1.07	0.36	0.2	0.66	0.03	0.03	0.03
Boron (B)	10	20000	20	20	40	10	80	70	20	20	60	10	10	<10
Cadmium (Cd)	0.02	90	0.09	0.08	0.05	0.12	<0.02	0.03	0.08	0.03	1.55	<0.02	<0.02	0.08
Caesium (Cs)	0.05	-	0.43	0.13	2.36	1.31	5.84	4.95	0.59	1.03	10.45	0.17	0.16	0.19
Cerium (Ce)	0.01	-	12.75	2.35	31.3	58.6	23.1	22.5	26.1	15.1	81.5	5.06	4.65	86.9
Chromium (Cr)	1	300	82	10	302	52	133	135	52	43	152	7	6	5
Cobalt (Co)	0.1	300	9.4	2.7	15.2	23.6	0.8	0.5	11.2	3.3	66.6	1	0.9	6.2
Copper (Cu)	0.2	17000	20.6	1.8	105.5	23.5	13.2	9.9	19.7	14.8	65	6.1	5.1	8.6
Fluorine (F)	20	-	150	20	100	180	920	850	160	160	960	100	70	80
Gallium (Ga)	0.05	-	12.35	0.43	28.4	6.89	27.5	23.2	8.21	6.28	24.8	1.57	1.38	1.81
Germanium (Ge)	0.05	-	3.8	0.4	0.9	2.25	0.29	0.31	1.88	0.44	0.51	0.49	0.52	0.79
Hafnium (Hf)	0.1	-	1.9	<0.1	4.1	1.5	4.4	3.1	1.5	1.3	3.6	0.3	0.3	0.3
Indium (In)	0.005	-	0.074	<0.005	0.211	0.024	0.209	0.204	0.057	0.033	0.079	0.01	0.008	0.005
Lanthanum (La)	0.5	-	8	1.4	13.3	28.8	18.6	15.8	6.6	9.7	73.4	2	1.7	114
Lead (Pb)	0.5	600	14	0.5	22.4	10.4	33.6	28.4	20.7	13.8	26.5	2.6	2	10
Lithium (Li)	0.2	-	15.5	2.2	14.7	18.4	26.6	21.9	3.4	4.5	34.9	1.4	1.1	0.8
Manganese (Mn)	5	19000	143	312	425	2190	38	35	413	224	37700	220	254	120
Mercury (Hg)	0.005	80	0.018	0.006	<0.005	0.032	<0.005	0.007	0.033	0.008	0.398	0.006	<0.005	0.013
Molybdenum (Mo)	0.05	-	2.47	1.59	2.01	3.46	2.32	2.68	5.21	1.25	1.09	0.39	0.27	0.82
Nickel (Ni)	0.2	1200	38.8	5.4	59.8	63.9	17.1	9.4	12.3	11.6	233	3.7	3	14.9
Niobium (Nb)	0.1	-	5.6	0.2	11.3	2.2	12.2	9.4	3.6	3.2	9.1	0.8	0.7	0.5
Phosphorus (P)	10	-	360	370	330	280	90	80	430	520	170	640	850	1380
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2.4	0.7	24.2	10.6	129.5	122	6	14.4	99.5	1.8	0.9	0.6
Scandium (Sc)	0.1	-	9.1	0.5	28.6	7.7	19.6	17.2	8.5	5.6	20.2	4.1	3.5	3.2
Selenium (Se)	1	700	1	<1	2	<1	2	4	1	1	1	1	<1	1
Silver (Ag)	0.01	-	0.04	<0.01	0.12	0.04	0.02	0.04	0.05	0.04	0.14	0.01	<0.01	<0.01
Strontium (Sr)	0.2	-	5.4	1.8	16.8	3.5	10.4	7.5	4.5	27.2	58.1	14.2	12.4	53
Tantalum (Ta)	0.05	-	0.45	<0.05	0.89	0.22	1.15	0.94	0.31	0.26	0.85	0.06	0.05	<0.05
Tellurium (Te)	0.05	-	0.53	0.1	0.28	0.22	0.46	0.74	0.36	0.15	0.12	0.21	0.21	0.27
Thallium (Tl)	0.02	-	0.02	<0.02	0.37	0.06	0.57	0.52	0.18	0.15	1.16	0.03	0.03	0.02
Thorium (Th)	0.01	-	6.63	0.17	8.62	5.11	19	15.25	5.98	5.05	14.8	1.01	0.89	0.83
Tin (Sn)	0.2	-	1.6	<0.2	3.6	0.8	5	3.3	1.1	0.9	2.8	0.2	0.2	0.2
Tungsten (W)	0.1	-	1.9	2.1	1.5	0.8	3.7	2.9	2.3	1.6	3	1	1.1	0.7
Uranium (U)	0.1	-	2.1	0.1	1.9	2.9	2.9	2.2	2.6	0.9	3.1	0.2	0.2	0.2
Vanadium (V)	1	-	81	3	344	38	110	130	49	49	122	8	9	8
Yttrium (Y)	0.1	-	9.4	4.3	12.7	60.8	13.6	8.8	6.8	6.9	68.6	3.2	5.3	23.6
Zinc (Zn)	2	30000	549	102	90	272	11	10	40	27	276	9	7	47
Zirconium (Zr)	0.5	-	68.1	2.1	134.5	50.3	137.5	106.5	54.3	45.1	120	12.4	13.2	11.9

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Low Grade Aluminous	Low Grade Aluminous	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Shale	Detrital Waste	Banded Iron Formation	Shale	Banded Iron Formation	Low Grade Detrital
	Stratigraphy →		Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Detrital	Dales Gorge Member	Whaleback Shale	Mount McRae Shale	Detrital
	RGS Sample Number →		247	248	249	250	251	252	253	254	255	256	257	258
	ALS Laboratory ID →		EB2012968038	EB2012968039	EB2012968040	EB2012968041	EB2012968042	EB2012968043	EB2012968044	EB2012968045	EB2012968046	EB2012968047	EB2012968048	EB2012968049
	Client Sample ID →		IWS568	IWS573	IWS575	IWT018	IWT029	IWT048	IWT424	IWT902	IXA209	IXA258	IXW451	IYB792
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.04	0.03	0.01	0.01	0.02	0.01	0.04	0.06	0.04	0.01	<0.01	<0.01
Aluminium (Al)	0.01	-	0.55	0.45	0.23	0.58	0.47	0.17	0.79	1.06	0.62	0.61	0.63	0.54
Calcium (Ca)	0.01	-	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.14	0.22
Iron (Fe)	0.01	-	>50	48.50	37.50	36.10	40.10	39.80	34.50	34.20	18.15	41.20	43.40	34.60
Potassium (K)	0.01	-	0.01	0.01	0.02	0.02	0.02	0.01	0.03	0.02	0.04	0.02	0.01	0.02
Magnesium (Mg)	0.01	-	0.02	0.02	0.02	0.02	0.02	0.03	0.05	0.04	0.03	0.03	0.03	0.03
Sodium (Na)	0.01	-	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Titanium (Ti)	0.005	-	0.02	0.018	0.014	0.014	0.018	<0.005	0.057	0.079	0.071	0.014	0.019	0.017
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.5	0.45	0.47	0.46	0.44	0.29	0.51	0.81	0.54	0.51	0.54	0.82
Arsenic (As)	0.2	300	4.7	3.6	2.7	2.6	3.7	2.1	2.3	2.9	1.8	2.3	2.2	3.4
Barium (Ba)	10	-	50	60	30	20	50	30	30	10	20	20	20	90
Beryllium (Be)	0.05	90	1.28	1.07	1.16	1.33	1.72	0.59	0.96	0.56	0.3	0.71	1.38	2.17
Bismuth (Bi)	0.01	-	0.03	0.03	0.03	0.04	0.04	0.01	0.05	0.07	0.05	0.03	0.04	0.12
Boron (B)	10	20000	10	10	10	10	10	<10	<10	10	<10	10	<10	<10
Cadmium (Cd)	0.02	90	0.02	0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Caesium (Cs)	0.05	-	0.15	0.13	0.2	0.18	0.16	0.12	0.18	0.16	0.26	0.2	0.15	0.22
Cerium (Ce)	0.01	-	7.23	6.1	3.56	6.29	4.43	4.99	5.72	4.22	4.57	6.88	16.05	32.7
Chromium (Cr)	1	300	6	6	6	5	6	2	7	8	6	4	7	6
Cobalt (Co)	0.1	300	1.9	1.4	0.6	0.5	0.8	0.6	1.1	1.1	0.6	0.8	1	1.2
Copper (Cu)	0.2	17000	4.6	4.8	3.1	3.7	4.9	2.3	6.2	9	5.3	3.7	6.3	12.9
Fluorine (F)	20	-	60	40	20	30	40	30	120	110	50	30	160	50
Gallium (Ga)	0.05	-	1.49	1.36	1.03	1.12	1.14	0.21	2.11	3.25	2.41	1.21	1.47	1.87
Germanium (Ge)	0.05	-	0.55	0.55	0.17	0.13	0.12	0.13	0.15	0.36	<0.05	0.12	0.16	0.1
Hafnium (Hf)	0.1	-	0.3	0.3	0.2	0.2	0.3	<0.1	0.4	0.5	0.4	0.3	0.3	0.5
Indium (In)	0.005	-	0.006	0.005	0.008	0.006	0.007	0.005	0.012	0.022	0.015	0.005	0.005	0.011
Lanthanum (La)	0.5	-	3.9	2.3	1.7	7.7	3.5	3.5	7.6	2.4	4.4	2.5	7.6	14.1
Lead (Pb)	0.5	600	2	1.9	1.9	3.3	4.3	<0.5	1.3	1.5	1.1	1.8	3.3	3.9
Lithium (Li)	0.2	-	0.2	0.3	0.8	0.8	0.5	0.6	1	2.3	3.9	0.3	1.7	3
Manganese (Mn)	5	19000	202	212	300	322	487	244	304	190	98	56	255	67
Mercury (Hg)	0.005	80	0.021	0.018	0.006	0.01	0.009	0.009	0.067	0.098	0.05	0.018	0.01	0.016
Molybdenum (Mo)	0.05	-	0.29	0.31	0.28	0.19	0.26	0.14	0.23	0.48	0.24	0.27	0.21	0.55
Nickel (Ni)	0.2	1200	4.7	3.3	2.6	2.3	2.6	2.4	3.4	3.1	1.6	2.4	3.4	4.1
Niobium (Nb)	0.1	-	0.6	0.6	0.6	0.6	0.8	0.1	1.2	1.7	1.5	0.9	0.9	1.7
Phosphorus (P)	10	-	1010	900	780	860	1420	510	760	810	410	670	1890	1110
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.4	0.6	2.2	2	1.6	1	3	2.1	5.2	2	1.1	2
Scandium (Sc)	0.1	-	2.5	2.5	2.7	2.3	1.5	0.5	1.1	1.2	0.6	0.8	1.1	1.7
Selenium (Se)	1	700	1	1	<1	<1	<1	<1	1	2	1	<1	<1	<1
Silver (Ag)	0.01	-	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.01	<0.01	<0.01	<0.01
Strontium (Sr)	0.2	-	4.2	8.1	4.4	5.3	3.8	4.3	5.1	2.5	2.7	2.9	3.8	12.5
Tantalum (Ta)	0.05	-	<0.05	0.05	<0.05	0.05	0.05	<0.05	0.09	0.11	0.1	0.08	0.07	0.1
Tellurium (Te)	0.05	-	0.26	0.28	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
Thallium (Tl)	0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.03
Thorium (Th)	0.01	-	1.01	0.93	0.65	0.76	0.75	0.12	1.03	1.42	0.88	1.12	1.05	2.29
Tin (Sn)	0.2	-	0.2	0.2	<0.2	0.2	0.2	<0.2	0.2	0.3	0.3	0.2	0.2	0.4
Tungsten (W)	0.1	-	0.8	0.8	1	1.1	1.5	1.1	1.4	1.9	1.5	1.2	1.2	2.5
Uranium (U)	0.1	-	0.2	0.3	0.2	0.2	0.3	0.1	0.2	0.3	0.2	0.4	0.5	0.7
Vanadium (V)	1	-	9	7	7	8	10	2	16	28	19	5	9	7
Yttrium (Y)	0.1	-	4.8	3.9	4.3	4.6	7	2.8	3.8	2.6	2.9	2.9	7.5	6.8
Zinc (Zn)	2	30000	11	8	6	6	8	7	6	5	2	4	8	6
Zirconium (Zr)	0.5	-	14.2	11.4	9.1	10.1	10.9	2.1	16.8	20.5	15	11.6	13.1	21.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

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Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Detrital Waste	Hydrated	Shale	Detrital Waste	Dolomite	Banded Iron Formation	Manganiferous Shale	Banded Iron Formation	Shale	Shale	Dolomite	Shale
	Stratigraphy →		Detrital	Whaleback Shale	Mount Sylvia	Detrital	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Whaleback Shale
	RGS Sample Number →		259	260	261	262	263	264	265	266	267	268	269	270
	ALS Laboratory ID →		EB2012968050	EB2012968051	EB2012968052	EB2012968053	EB2012968055	EB2012968056	EB2012968057	EB2012968058	EB2012968059	EB2012968054	EB2012968060	EB2012968061
	Client Sample ID →		IYC986	IYD139	IYD745	IYE845	IYF074	IYF285	IYF389	IYF442	IYF784	IYF868	IYF998	IYN249
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.37	0.02	<0.01	0.03	0.03	0.03	0.03	0.01	0.17	0.05	0.04	0.01
Aluminium (Al)	0.01	-	5.85	8.25	0.56	8.14	9.22	6.57	3.65	1.56	2.55	1.54	2.47	8.12
Calcium (Ca)	0.01	-	0.06	0.06	0.13	0.02	0.05	0.04	0.02	0.01	0.01	0.02	0.04	1.96
Iron (Fe)	0.01	-	25.50	25.30	45.80	5.83	33.90	40.40	>50	>50	>50	>50	>50	7.08
Potassium (K)	0.01	-	1.16	0.08	0.01	1.72	0.47	0.92	0.16	0.01	0.02	0.01	0.05	2.30
Magnesium (Mg)	0.01	-	0.33	0.06	0.03	0.43	0.15	0.22	0.06	0.03	0.01	0.03	0.04	1.97
Sodium (Na)	0.01	-	0.36	0.04	0.01	0.05	0.05	0.03	0.01	0.01	0.01	0.02	0.02	0.03
Titanium (Ti)	0.005	-	0.213	0.146	0.012	0.312	0.175	0.247	0.143	0.008	0.289	0.153	0.212	0.283
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	4.35	2.4	0.5	14.95	6.33	6.63	3.82	0.93	3.43	2.4	4.93	6.7
Arsenic (As)	0.2	300	74.3	2.3	1.9	314	208	95.1	47	24.8	65.5	53.2	123.5	99.1
Barium (Ba)	10	-	110	120	50	340	130	90	30	60	10	20	50	100
Beryllium (Be)	0.05	90	2.35	1.09	1.01	3.02	3.28	18.6	3.71	2.35	0.41	0.52	0.61	3.86
Bismuth (Bi)	0.01	-	0.6	0.31	0.04	1.24	1.01	0.65	0.54	0.03	0.42	0.43	0.57	0.83
Boron (B)	10	20000	80	10	<10	80	60	40	20	10	10	20	20	120
Cadmium (Cd)	0.02	90	0.09	0.02	<0.02	1.28	0.12	0.83	0.15	<0.02	<0.02	<0.02	0.03	0.22
Caesium (Cs)	0.05	-	9.34	0.19	0.15	7.07	1.7	3.8	0.8	0.05	0.16	0.2	0.52	9.03
Cerium (Ce)	0.01	-	61.1	71.3	31.4	70.3	30.7	20.1	23.3	10.25	4.7	8.26	8.54	182
Chromium (Cr)	1	300	84	45	4	101	125	106	376	3	67	35	54	90
Cobalt (Co)	0.1	300	15	2.1	0.9	37.5	20.1	31.2	9.1	2.1	1.7	2	3.4	16.7
Copper (Cu)	0.2	17000	42	15.2	5.9	72.9	55.8	59.2	56.9	7.7	5.6	7.9	3.4	84.6
Fluorine (F)	20	-	1230	130	170	1290	540	520	340	50	110	110	130	1500
Gallium (Ga)	0.05	-	14.7	10.5	1.13	21.4	20.6	17.7	10.8	0.8	14.05	7.58	13.75	23.5
Germanium (Ge)	0.05	-	0.2	1.17	0.18	0.17	1.53	2.12	3.45	4.03	0.8	0.48	0.68	0.23
Hafnium (Hf)	0.1	-	2.7	3.4	0.2	3.9	3.3	2.7	1.8	0.2	1.8	1.5	1.8	4.9
Indium (In)	0.005	-	0.066	0.037	<0.005	0.118	0.186	0.068	0.07	<0.005	0.062	0.053	0.087	0.092
Lanthanum (La)	0.5	-	28.4	39.7	10.3	87.2	19.4	38.4	14.3	4.1	1.6	4.4	2.3	87.9
Lead (Pb)	0.5	600	60.3	13.9	1.7	69.1	49.8	39.6	25.8	1.7	13.4	16.6	18.2	62.5
Lithium (Li)	0.2	-	28.1	11.1	0.7	25.4	27	16.1	7.4	3.5	0.5	0.5	1.2	33.4
Manganese (Mn)	5	19000	401	31	408	6480	522	1720	177	647	191	74	250	250
Mercury (Hg)	0.005	80	0.265	0.023	0.013	0.042	0.197	0.224	0.382	0.017	0.018	0.106	0.009	0.452
Molybdenum (Mo)	0.05	-	5.34	0.66	0.56	7.05	4.36	4.5	5.69	1.1	3.5	2.95	4.92	2.99
Nickel (Ni)	0.2	1200	79.2	13.3	2.4	131	57.7	125	69	6.3	5.6	5.9	7.2	80.2
Niobium (Nb)	0.1	-	8.2	9.4	0.5	10.8	4.6	6.7	4.1	0.7	8	5	7.3	12.4
Phosphorus (P)	10	-	480	750	1480	430	150	240	380	1380	410	300	360	260
Rhenium (Re)	0.002	-	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002
Rubidium (Rb)	0.1	-	101	3.3	0.5	118.5	32.5	47.8	11.3	0.4	1.2	0.8	3.9	169.5
Scandium (Sc)	0.1	-	15.3	8.1	0.8	17.6	14.4	18.3	12	0.9	3.3	4.7	5.3	15.9
Selenium (Se)	1	700	<1	2	<1	1	2	2	2	<1	2	9	1	<1
Silver (Ag)	0.01	-	0.08	<0.01	<0.01	0.18	0.39	0.02	0.25	0.03	0.01	0.13	0.01	0.31
Strontium (Sr)	0.2	-	7.2	27.6	8.6	20.3	10.2	5.3	2.8	3.4	1.4	2.9	9.2	13.9
Tantalum (Ta)	0.05	-	0.69	0.7	<0.05	0.97	0.45	0.63	0.37	<0.05	0.62	0.41	0.59	1.11
Tellurium (Te)	0.05	-	0.17	0.13	<0.05	0.38	0.84	0.25	0.27	<0.05	0.19	0.25	0.21	0.24
Thallium (Tl)	0.02	-	0.52	0.03	0.02	0.79	0.36	0.24	0.11	0.06	0.02	0.02	0.18	0.58
Thorium (Th)	0.01	-	13.85	8.81	0.78	15.95	12.2	12.75	6.73	0.56	5.18	5.16	5.86	18.1
Tin (Sn)	0.2	-	2.1	1.8	<0.2	3.3	2.6	2.2	1.5	<0.2	2.1	1.4	2.4	3.1
Tungsten (W)	0.1	-	3.3	3.4	0.9	5	1.7	1.9	1.6	1.5	3.6	2.6	2.9	4.7
Uranium (U)	0.1	-	4.8	1.4	0.6	5.6	3.3	4.6	14.2	0.5	1.5	1	1	3.9
Vanadium (V)	1	-	70	49	6	102	116	106	60	12	80	50	64	86
Yttrium (Y)	0.1	-	24.5	8.2	7.2	50.5	16.4	39.1	28	11.3	2.8	4.9	3.7	125
Zinc (Zn)	2	30000	427	5	4	425	125	241	92	12	4	6	6	190
Zirconium (Zr)	0.5	-	101	130.5	10	127	109.5	85.1	66.1	10.2	69.9	56.8	63.2	154

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Shale	Shale	Shale	Shale	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation
	Stratigraphy →		Whaleback Shale	Whaleback Shale	Whaleback Shale	Whaleback Shale	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member
	RGS Sample Number →		271	272	273	274	275	276	277	278	279	280	281	282
	ALS Laboratory ID →		EB2012968062	EB2012968063	EB2012968064	EB2012968065	EB2012968066	EB2012968067	EB2012968068	EB2012968069	EB2012969001	EB2012969002	EB2012969003	EB2012969004
	Client Sample ID →		IYN252	IYN256	IYN259	IYN260	IYR078	IYU108	IYU160	IYU295	IYU298	IYU383	IYU618	IYU629
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.03	0.03	0.03	<0.01	<0.01	0.01	0.13	0.03	0.01	0.02	0.01
Aluminium (Al)	0.01	-	3.29	1.95	1.89	1.86	0.38	0.41	5.94	0.33	1.14	0.78	10.05	7.19
Calcium (Ca)	0.01	-	0.02	0.07	0.03	0.03	0.87	0.07	0.21	1.25	0.04	0.01	0.09	0.06
Iron (Fe)	0.01	-	>50	41.10	>50	>50	27.90	26.50	13.20	20.20	28.80	31.40	25.20	13.95
Potassium (K)	0.01	-	0.01	0.11	0.02	0.01	0.01	0.06	0.18	0.35	0.04	0.06	1.32	1.11
Magnesium (Mg)	0.01	-	0.06	0.05	0.07	0.05	0.16	0.16	0.25	1.5	0.04	0.02	0.31	0.31
Sodium (Na)	0.01	-	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.01	0.03	0.04
Titanium (Ti)	0.005	-	0.317	0.149	0.131	0.137	0.02	0.021	0.331	0.02	0.054	0.022	0.339	0.292
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	4.9	2.46	4.67	2.75	0.33	0.86	3.37	0.47	1.29	0.59	5.73	6.95
Arsenic (As)	0.2	300	43.8	51.6	35.4	33.1	3.2	2.2	53.9	1.4	7.7	3.7	34	41.3
Barium (Ba)	10	-	380	200	10	30	10	50	880	10	50	40	120	90
Beryllium (Be)	0.05	90	3	0.5	0.51	2.2	0.51	1.17	2.79	0.89	1.47	1.51	1.67	2.21
Bismuth (Bi)	0.01	-	0.69	0.35	0.41	0.36	0.03	0.06	0.32	0.03	0.17	0.08	1.07	1.02
Boron (B)	10	20000	30	20	10	20	10	10	10	30	20	20	70	60
Cadmium (Cd)	0.02	90	0.17	<0.02	0.07	0.13	0.03	0.03	0.64	0.03	0.03	<0.02	0.03	0.03
Caesium (Cs)	0.05	-	0.58	0.58	0.05	0.11	0.25	1.66	1.03	5.48	0.29	0.52	8.23	5.41
Cerium (Ce)	0.01	-	174.5	6.12	9.59	14.35	5.6	9.11	51.3	6.2	7.36	19.45	11.15	14.85
Chromium (Cr)	1	300	71	49	104	50	19	11	142	8	18	10	181	123
Cobalt (Co)	0.1	300	29.5	1.7	6.2	15.1	4.6	2.9	79.7	2	3.2	1.2	5.1	2.7
Copper (Cu)	0.2	17000	15.8	10.9	20	23.8	6	4.3	70.5	6.9	10.3	2.2	27.7	25.8
Fluorine (F)	20	-	130	110	220	200	40	70	80	70	50	<20	780	660
Gallium (Ga)	0.05	-	18.4	8.36	7.36	7.86	1.11	1.26	18.45	1.19	5.63	2.47	23	19.5
Germanium (Ge)	0.05	-	2.97	0.13	2.79	3.04	<0.05	<0.05	<0.05	0.11	0.22	0.2	0.68	0.1
Hafnium (Hf)	0.1	-	2.7	1.6	1.6	1.5	0.2	0.3	2	0.2	1.2	0.5	3.6	3.2
Indium (In)	0.005	-	0.107	0.046	0.046	0.044	0.005	0.006	0.06	<0.005	0.012	0.006	0.094	0.191
Lanthanum (La)	0.5	-	54.2	3	6.9	9.4	3.7	5.1	36.7	3.4	5.5	6.9	4.6	10.3
Lead (Pb)	0.5	600	36.1	16.2	21.5	14.5	1.6	2.4	14.4	1.3	4.5	3.2	29.7	19.5
Lithium (Li)	0.2	-	7.2	2.6	0.6	0.7	5.3	5	78	0.8	2	1.9	11.2	17.1
Manganese (Mn)	5	19000	1900	152	99	177	275	1140	26300	276	846	2310	281	163
Mercury (Hg)	0.005	80	0.298	0.007	0.557	0.64	0.01	0.024	0.071	0.017	0.007	0.009	0.006	0.011
Molybdenum (Mo)	0.05	-	4.11	2.36	2.65	1.98	1.21	0.74	4.77	0.4	1.06	0.99	2.18	2.85
Nickel (Ni)	0.2	1200	38.5	7.6	21.6	46.2	12.5	7	218	6	9.8	3	23.8	27.1
Niobium (Nb)	0.1	-	11.4	4.2	4.3	4.4	0.6	0.8	4.9	0.5	3	1.5	9.9	9.1
Phosphorus (P)	10	-	330	360	340	280	220	460	480	140	360	410	140	290
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	1.4	8.2	0.8	0.7	1.7	14.3	10.3	38.4	4.4	9.4	97.1	84.2
Scandium (Sc)	0.1	-	5.1	4.9	5.5	5.2	0.9	1.2	21.6	1.3	3.2	1.3	14.7	11.7
Selenium (Se)	1	700	1	3	4	5	<1	<1	<1	<1	<1	<1	<1	1
Silver (Ag)	0.01	-	0.03	0.01	0.2	0.14	0.01	0.01	0.15	<0.01	<0.01	0.01	0.04	0.05
Strontium (Sr)	0.2	-	6.7	15.3	3	3.3	1.6	4	72.4	13	9	8.4	13.2	11.6
Tantalum (Ta)	0.05	-	0.89	0.34	0.36	0.41	<0.05	0.06	0.45	0.05	0.27	0.12	0.98	0.82
Tellurium (Te)	0.05	-	0.17	0.15	0.28	0.26	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	0.19	0.55
Thallium (Tl)	0.02	-	1.06	0.24	0.02	0.09	0.02	0.19	0.56	0.12	0.05	0.07	0.49	0.43
Thorium (Th)	0.01	-	9.74	6.21	5.47	4.4	0.43	0.84	6.47	0.49	5.71	1.97	17.5	15.2
Tin (Sn)	0.2	-	3.1	1.3	1.1	1.1	0.2	0.2	1.4	0.2	0.8	0.3	3.1	3.7
Tungsten (W)	0.1	-	4.2	1.8	2	2.2	3.3	1.4	1.9	1.8	2.6	1.9	2.5	2.7
Uranium (U)	0.1	-	2.9	0.8	6.1	4.1	0.4	0.4	2.1	0.1	0.8	0.5	4.5	2.7
Vanadium (V)	1	-	97	51	56	48	13	7	129	6	18	10	134	104
Yttrium (Y)	0.1	-	64.8	6.4	4.9	11.6	5.7	6.7	52.5	5	6.6	8.6	8.6	14.5
Zinc (Zn)	2	30000	37	10	89	133	32	13	127	13	16	6	39	55
Zirconium (Zr)	0.5	-	90.9	62.9	55.9	50.3	5.1	9.9	68	7.2	41.2	19.9	117.5	107

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Banded Iron Formation	Banded Iron Formation	Detrital Waste	Calcrete	Calcrete	Low Grade Detrital	Low Grade Aluminous	Low Grade Detrital	Detrital Waste	Hydrated Waste	Low Grade Detrital	Low Grade Detrital
	Stratigraphy →		Dales Gorge Member	Marra Mamba	Detrital	Detrital	Detrital	Detrital	Joffre Member	Detrital	Detrital	Mount McRae Shale	Detrital	Detrital
	RGS Sample Number →		283	284	285	286	287	288	289	290	291	292	293	294
	ALS Laboratory ID →		EB2012969005	EB2012969006	EB2012969007	EB2012969008	EB2012969009	EB2012969010	EB2012969011	EB2012969012	EB2012969013	EB2012969014	EB2012969015	EB2012969016
	Client Sample ID →		IYU671	IYV032	IYV175	IYV633	IYV641	IYV899	IYW225	IYW351	IYY280	IYY952	IYZ255	IYZ298
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.01	0.01	0.01	0.05	0.01	0.01	0.03	0.06	0.01	0.16	0.02
Aluminium (Al)	0.01	-	8.62	8.81	1.24	0.91	2.12	8.54	8.09	2.80	2.93	0.50	3.87	2.82
Calcium (Ca)	0.01	-	0.04	0.07	0.24	0.03	0.01	0.03	0.02	0.02	0.03	0.01	0.06	0.03
Iron (Fe)	0.01	-	34.40	12.00	26.80	28.70	>50	33.20	17.95	>50	>50	>50	>50	>50
Potassium (K)	0.01	-	1.12	1.51	0.23	0.14	0.01	1.29	2.17	0.02	0.04	0.01	0.09	0.01
Magnesium (Mg)	0.01	-	0.2	0.35	0.1	0.06	0.03	0.22	0.31	0.02	0.03	0.03	0.04	0.05
Sodium (Na)	0.01	-	0.04	0.04	0.02	0.01	0.01	0.02	0.02	<0.01	<0.01	<0.01	0.02	0.02
Titanium (Ti)	0.005	-	0.259	0.346	0.063	0.045	0.112	0.211	0.284	0.092	0.108	0.01	0.28	0.067
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	4.56	6.39	1	0.84	4.88	11.1	11.15	1.83	2.72	0.46	1.68	3.46
Arsenic (As)	0.2	300	81.9	29.1	31.9	28.2	186	251	119	35.9	47.7	9.9	17	73.6
Barium (Ba)	10	-	110	150	100	50	50	90	100	330	860	20	120	50
Beryllium (Be)	0.05	90	2.09	2.03	1.19	1.09	1.34	3.79	2.75	1.87	3.05	1.07	0.3	2.48
Bismuth (Bi)	0.01	-	0.82	1.1	0.13	0.09	0.57	0.68	0.89	0.27	0.5	0.03	0.24	0.29
Boron (B)	10	20000	80	80	10	10	20	50	70	10	10	10	40	20
Cadmium (Cd)	0.02	90	0.08	0.03	0.05	0.04	0.16	0.15	0.11	0.05	0.1	0.02	<0.02	0.12
Caesium (Cs)	0.05	-	3.97	7.15	1.76	1.27	<0.05	2.51	4.29	0.06	0.06	0.05	0.07	<0.05
Cerium (Ce)	0.01	-	25.9	8.97	18.7	16.15	35.4	45.5	34.5	52.6	130	11.9	19.1	72.3
Chromium (Cr)	1	300	141	187	30	26	47	182	172	26	25	1	42	20
Cobalt (Co)	0.1	300	9.5	7.8	7	5.8	14.6	19.2	17.3	6.6	13.7	1.3	1.9	16.1
Copper (Cu)	0.2	17000	73.5	24.4	15.5	13.8	14.3	104	97.8	21.6	18.8	5.8	4.4	32.9
Fluorine (F)	20	-	560	870	100	50	100	390	560	50	60	<20	50	190
Gallium (Ga)	0.05	-	18.2	21.3	3.52	2.58	9.19	18.65	23.8	7.4	7.75	0.9	11.85	5.74
Germanium (Ge)	0.05	-	0.91	0.18	0.14	0.13	1.77	0.86	0.35	0.94	2.01	0.27	0.6	2.99
Hafnium (Hf)	0.1	-	2.8	3.5	0.7	0.5	1.5	2.9	3.8	2.1	2.2	0.2	2.4	1.7
Indium (In)	0.005	-	0.109	0.089	0.022	0.015	0.087	0.067	0.082	0.05	0.083	<0.005	0.066	0.052
Lanthanum (La)	0.5	-	11.3	4.6	9.3	8	19.5	23.9	17.6	9.5	17.3	5	7.5	13.3
Lead (Pb)	0.5	600	39.2	28.7	9.1	6.4	14.2	32.1	30.3	10.9	19.4	2.5	14.8	27.8
Lithium (Li)	0.2	-	14.2	17.6	5	3.7	1.8	8.1	12.5	1.7	1.3	0.7	2.6	1.9
Manganese (Mn)	5	19000	171	323	596	394	507	209	185	2880	7730	169	211	353
Mercury (Hg)	0.005	80	0.03	<0.005	0.008	0.008	0.199	0.034	0.015	0.009	0.04	0.009	0.005	0.066
Molybdenum (Mo)	0.05	-	2.97	1.45	1.1	0.96	4.67	8.14	4.23	1.71	1.99	0.35	2.72	1.46
Nickel (Ni)	0.2	1200	46.6	41.8	15.7	14.5	24.9	125.5	85.2	13.3	11.5	5	8.8	33.7
Niobium (Nb)	0.1	-	7.8	10.4	1.8	1.3	3.9	5.5	7.5	5.4	5.5	0.7	8	3.6
Phosphorus (P)	10	-	330	70	380	410	250	1430	670	1800	2410	1350	550	930
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	86.2	127	25.9	18.4	0.3	64.7	109	0.3	0.5	0.2	0.7	0.3
Scandium (Sc)	0.1	-	15.8	16.4	2.6	1.9	3.9	29.1	24.4	4.5	4.3	0.6	6.9	4.2
Selenium (Se)	1	700	1	<1	<1	<1	5	1	1	<1	<1	<1	1	1
Silver (Ag)	0.01	-	0.19	0.03	0.03	0.04	0.11	0.04	0.01	0.01	0.04	<0.01	<0.01	0.06
Strontium (Sr)	0.2	-	12.5	13.8	14.7	8.8	1.3	6	6.9	12.8	30	2.6	126	5
Tantalum (Ta)	0.05	-	0.75	1.03	0.14	0.1	0.31	0.55	0.76	0.41	0.42	<0.05	0.6	0.32
Tellurium (Te)	0.05	-	0.25	0.16	0.06	<0.05	0.48	0.18	0.48	0.21	0.45	<0.05	0.1	0.17
Thallium (Tl)	0.02	-	0.45	0.47	0.23	0.18	0.51	0.24	0.4	1.91	7.66	0.03	0.03	0.09
Thorium (Th)	0.01	-	14.55	19.65	2.56	2.01	6.87	13.95	16.6	6.19	6.68	0.62	7.79	6.27
Tin (Sn)	0.2	-	2.7	3.2	0.5	0.4	1.4	2.2	2.9	1.1	1.2	<0.2	1.9	0.9
Tungsten (W)	0.1	-	2.3	3.1	1.2	0.8	1.7	1.8	2	1.3	1.6	1.4	2.4	2.2
Uranium (U)	0.1	-	3.1	3.8	0.7	0.6	2.5	9.5	11.8	2.1	2.5	0.4	1.3	4.8
Vanadium (V)	1	-	99	126	31	29	69	231	166	36	40	8	80	32
Yttrium (Y)	0.1	-	14	13.9	9.7	7.5	19	33.9	25.2	16.8	17.2	7.1	2.7	30.3
Zinc (Zn)	2	30000	70	36	26	27	47	379	212	63	108	9	<2	56
Zirconium (Zr)	0.5	-	90.2	117.5	27.2	18.2	54.5	96.2	126	78.1	78.9	10.8	84.8	63.1

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Detrital Waste	Detrital Waste	Detrital Waste	Detrital Waste	Shale	Shale	Dolomite	Detrital Waste	Banded Iron Formation	Clay	Hydrated Waste	Carbonaceous Shale
	Stratigraphy →		Detrital	Detrital	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Marra Mamba	Detrital	Detrital	Wittenoom Formation
	RGS Sample Number →		295	296	297	298	299	300	301	302	303	304	305	306
	ALS Laboratory ID →		EB2012969017	EB2012969018	EB2012969019	EB2012969020	EB2012969021	EB2012969022	EB2012969023	EB2012969024	EB2012969025	EB2012969026	EB2012969027	EB2012969028
	Client Sample ID →		IYZ407	IYZ567	IYZ574	IYZ677	IYZ822	IYZ887	IYZ931	IZA020	IZA182	IZA952	IZA972	IZB305
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	0.05	0.01	0.19	0.03	<0.01	0.29	0.01	0.01	0.03	0.01	0.01
Aluminium (Al)	0.01	-	4.98	1.26	15.45	2.38	1.51	6.83	4.05	1.95	13.40	8.24	12.90	11.80
Calcium (Ca)	0.01	-	0.02	0.11	0.04	0.01	0.08	3.22	0.02	0.07	0.04	0.04	0.05	0.02
Iron (Fe)	0.01	-	46.90	33.00	2.40	>50	>50	7.11	48.40	40.10	12.40	34.80	15.50	4.29
Potassium (K)	0.01	-	0.01	0.31	0.71	0.01	0.02	2.01	0.10	0.02	0.13	0.42	0.30	0.56
Magnesium (Mg)	0.01	-	0.04	0.11	0.06	0.02	0.05	2.35	0.03	0.05	0.04	0.13	0.07	0.04
Sodium (Na)	0.01	-	0.02	0.01	0.04	0.01	0.01	0.03	0.02	0.01	0.03	0.04	0.04	0.03
Titanium (Ti)	0.005	-	0.095	0.047	1.125	0.245	0.198	0.249	0.213	0.045	0.869	0.269	0.908	1.02
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	2.89	1.52	2.48	1.4	1.39	5.03	3.69	0.84	5.13	6.87	3.41	2.59
Arsenic (As)	0.2	300	39.2	41.5	10.1	18.2	47.2	175.5	65.9	8.5	107.5	153	318	85.9
Barium (Ba)	10	-	80	90	10	10	50	80	470	10	60	60	20	20
Beryllium (Be)	0.05	90	1.82	1.28	1.17	0.19	0.97	2.74	1.58	2.05	0.87	0.8	0.8	0.83
Bismuth (Bi)	0.01	-	1.16	0.18	0.16	0.19	0.18	0.76	0.4	0.14	0.13	1.02	0.21	0.03
Boron (B)	10	20000	10	20	40	20	50	130	10	10	30	60	30	30
Cadmium (Cd)	0.02	90	0.12	0.11	<0.02	<0.02	0.03	0.35	0.06	0.02	0.03	0.02	<0.02	<0.02
Caesium (Cs)	0.05	-	0.2	1.39	0.88	0.06	0.1	8.93	<0.05	0.17	0.61	3.24	2.24	1.13
Cerium (Ce)	0.01	-	143	16.85	1.46	2.37	7.5	99.7	105	11.25	23	63.3	25.4	7.88
Chromium (Cr)	1	300	33	29	187	36	30	81	70	12	340	105	349	351
Cobalt (Co)	0.1	300	6	6.5	3.1	1.7	2.5	47.2	59	1.8	5.4	3.9	2.4	1.2
Copper (Cu)	0.2	17000	18.1	17.6	21.3	4.8	10.7	81.8	42.7	7.9	57.7	14.8	14.5	15.1
Fluorine (F)	20	-	50	130	60	40	60	1620	20	50	60	390	140	90
Gallium (Ga)	0.05	-	8.31	3.75	36.4	9.74	7.04	16.95	11.05	3.58	29.1	23.3	29.4	31.2
Germanium (Ge)	0.05	-	0.75	0.17	0.07	0.75	2	0.16	2.23	0.49	0.26	1.14	0.79	0.12
Hafnium (Hf)	0.1	-	2.4	0.7	3.5	1.1	1.1	3.5	2.2	0.7	3.2	4.4	3.2	3.2
Indium (In)	0.005	-	0.107	0.028	0.156	0.04	0.044	0.072	0.057	0.014	0.135	0.144	0.139	0.134
Lanthanum (La)	0.5	-	78.3	9	0.6	1	4	48.3	9.6	4	11	24.2	13.2	2
Lead (Pb)	0.5	600	39.8	11.9	9.8	7.9	7.3	69.2	23.4	4.9	66.3	55.2	39.3	23
Lithium (Li)	0.2	-	22.7	4.6	10.5	0.4	0.5	22.8	4.3	3	14.5	7.1	5.5	5.7
Manganese (Mn)	5	19000	451	758	63	100	190	159	9070	175	245	142	130	60
Mercury (Hg)	0.005	80	0.049	0.019	0.052	<0.005	0.038	0.213	0.007	0.006	0.031	0.021	0.014	0.009
Molybdenum (Mo)	0.05	-	1.73	1.54	2.21	2.67	2.17	3.28	2.69	0.88	2.55	8.18	8.37	4.65
Nickel (Ni)	0.2	1200	22.3	19.2	85.6	4.1	9.4	165.5	29.4	7.7	73.7	26.6	48.8	27
Niobium (Nb)	0.1	-	5.2	1.6	7.2	6.5	6.2	9.7	6.1	2.4	6.2	9.9	5.4	5.2
Phosphorus (P)	10	-	850	600	60	280	720	250	1210	1860	130	450	70	80
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.6	20	36	0.6	1.3	167	0.7	2.4	6	32.2	17.6	23.9
Scandium (Sc)	0.1	-	5.1	2.7	44.8	2.7	3.5	11.3	8.1	2.4	47.8	10.5	46.1	32.6
Selenium (Se)	1	700	<1	<1	1	2	2	<1	<1	<1	<1	2	2	1
Silver (Ag)	0.01	-	0.03	0.06	0.01	<0.01	0.07	0.07	0.02	<0.01	0.03	0.06	0.01	0.01
Strontium (Sr)	0.2	-	13.7	13.1	2.5	1.1	12.6	34.6	52.1	3.6	4.2	9.6	7.8	3.9
Tantalum (Ta)	0.05	-	0.41	0.13	0.52	0.48	0.46	0.85	0.49	0.18	0.45	0.87	0.38	0.35
Tellurium (Te)	0.05	-	0.11	0.09	0.19	0.08	0.12	0.25	0.19	0.06	0.16	0.38	0.11	<0.05
Thallium (Tl)	0.02	-	0.15	0.34	0.25	<0.02	0.03	0.64	0.87	0.08	0.11	0.22	0.15	0.2
Thorium (Th)	0.01	-	8.9	2.73	3	2.95	3.33	15.4	7.75	3.01	3.8	16.3	3.46	0.5
Tin (Sn)	0.2	-	1.6	0.5	1.5	1.4	1.2	2.4	1.4	0.5	1.4	2.9	1.4	1
Tungsten (W)	0.1	-	3.5	2	0.9	2.7	2.6	4.5	2.6	0.7	0.9	5.9	0.7	0.2
Uranium (U)	0.1	-	2.4	0.9	0.7	0.6	1.1	2.4	2.1	1.1	1.8	4	1.6	1
Vanadium (V)	1	-	56	33	420	63	48	80	79	19	765	102	337	450
Yttrium (Y)	0.1	-	26.2	9.2	1.5	1.8	5.7	42	19.7	8.7	12.8	17.6	8.7	1.8
Zinc (Zn)	2	30000	30	57	47	2	19	646	87	21	75	66	58	24
Zirconium (Zr)	0.5	-	86.7	25.6	110	45.9	45	116.5	80.4	32.4	107.5	145.5	102	98.1

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Carbonaceous Shale	High Grade	Detrital Waste	Detrital Waste	Low grade siliceous	Low grade siliceous	Low grade siliceous	Low grade siliceous	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation
	Stratigraphy →		Wittenoom Formation	Detrital	Detrital	Detrital	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member
	RGS Sample Number →		307	308	309	310	311	312	313	314	315	316	317	318
	ALS Laboratory ID →		EB2012969029	EB2012969030	EB2012969031	EB2012969032	EB2012969033	EB2012969034	EB2012969035	EB2012969036	EB2012969037	EB2012969038	EB2012969039	EB2012969040
	Client Sample ID →		IZB311	IZB745	IZB766	IZC724	IZR189	IZR191	IZR193	IZR194	IZR195	IZR200	IZR202	IZR203
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.02	0.01	0.02	0.01	0.02	<0.01	0.01	0.02	0.02	0.01	0.02	0.10
Aluminium (Al)	0.01	-	1.90	8.25	6.63	2.17	2.06	0.16	0.18	1.69	1.69	1.16	8.08	3.54
Calcium (Ca)	0.01	-	0.03	0.04	0.96	0.40	0.03	0.10	0.05	0.04	0.07	0.01	0.54	0.01
Iron (Fe)	0.01	-	34.30	11.95	34.70	26.60	>50	37.10	34.00	>50	41.20	27.90	6.60	>50
Potassium (K)	0.01	-	0.18	1.59	0.32	0.22	0.05	0.02	0.03	0.02	0.02	0.01	2.49	0.01
Magnesium (Mg)	0.01	-	0.07	0.27	0.58	0.09	0.05	0.03	0.04	0.04	0.06	0.01	0.8	0.02
Sodium (Na)	0.01	-	0.03	0.02	0.02	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
Titanium (Ti)	0.005	-	0.083	0.276	0.317	0.102	0.071	<0.005	<0.005	0.032	0.047	0.036	0.36	0.192
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.26	4.31	3.93	2.06	2.14	0.13	0.13	0.8	1.98	0.95	6.11	2.21
Arsenic (As)	0.2	300	18.7	50	101	107.5	79.2	4.1	4.1	5.8	76.2	10.5	246	16.3
Barium (Ba)	10	-	40	110	30	140	130	10	10	210	10	10	190	20
Beryllium (Be)	0.05	90	0.98	1.62	0.91	1.33	0.62	0.65	0.67	2.23	1.46	0.93	2.06	0.71
Bismuth (Bi)	0.01	-	0.2	0.78	0.76	0.2	0.25	0.01	0.01	0.07	0.32	0.12	1	0.29
Boron (B)	10	20000	20	80	50	20	10	10	10	10	20	10	120	30
Cadmium (Cd)	0.02	90	<0.02	0.07	0.03	0.05	0.04	<0.02	<0.02	<0.02	0.33	<0.02	0.12	<0.02
Caesium (Cs)	0.05	-	1.01	5.58	4.24	1.37	0.24	0.22	0.3	0.05	0.12	0.05	9.49	0.07
Cerium (Ce)	0.01	-	13.65	417	26.9	27.4	19.05	5.2	10.55	65.9	12.25	12	80.9	85
Chromium (Cr)	1	300	33	145	239	62	146	<1	1	8	29	12	144	47
Cobalt (Co)	0.1	300	2.8	9.6	2.2	6.1	10.5	1	0.9	4.2	4.9	1	9.1	2.4
Copper (Cu)	0.2	17000	14.2	38.7	37.6	32.9	91.7	1.7	2.4	5.7	34.5	5	67.1	32.6
Fluorine (F)	20	-	80	660	180	80	90	70	<20	70	<20	<20	1940	70
Gallium (Ga)	0.05	-	5.47	21.1	19.1	6.34	4.83	0.36	0.37	2.61	4.02	2.95	23.1	10.45
Germanium (Ge)	0.05	-	0.2	0.24	1.15	0.16	0.56	0.18	0.17	0.99	0.25	0.16	0.21	1.28
Hafnium (Hf)	0.1	-	1	2.9	2.8	1.1	0.9	<0.1	<0.1	0.5	0.5	0.9	3.8	2.4
Indium (In)	0.005	-	0.033	0.1	0.146	0.048	0.037	<0.005	<0.005	0.007	0.061	0.022	0.117	0.046
Lanthanum (La)	0.5	-	8	30.5	15.9	14.6	4.4	1.7	6.8	21.2	8.7	10.3	35.7	41.9
Lead (Pb)	0.5	600	11.6	46.4	30.3	14.2	19.7	<0.5	<0.5	3.1	16.4	7.4	88.2	15.1
Lithium (Li)	0.2	-	3.6	22.9	17.8	6.4	1.3	0.8	0.7	0.4	7.8	1.2	26.2	0.5
Manganese (Mn)	5	19000	204	130	109	296	1930	107	208	6050	201	72	44	202
Mercury (Hg)	0.005	80	0.013	0.065	0.185	0.013	0.046	<0.005	0.005	0.011	0.058	<0.005	0.241	0.006
Molybdenum (Mo)	0.05	-	1.67	2.72	1.72	2.25	1.7	0.28	0.34	0.53	1.01	2.08	5.21	2.83
Nickel (Ni)	0.2	1200	13.6	37	16.6	24.1	13.9	1.7	2.7	5.4	15.7	5.4	76.4	6
Niobium (Nb)	0.1	-	2.6	7.9	7.5	2.6	2	0.2	0.2	1.4	1.6	2.2	10.6	5.7
Phosphorus (P)	10	-	540	210	80	350	170	1190	980	1760	190	660	270	2130
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002
Rubidium (Rb)	0.1	-	16.6	107	34.7	21.4	3.1	3	4	0.6	1.1	0.6	197	0.3
Scandium (Sc)	0.1	-	3.8	14.1	19.1	5.2	10.5	0.2	0.2	1.6	5	1.1	24.3	10.9
Selenium (Se)	1	700	1	<1	2	1	1	<1	<1	<1	1	<1	1	1
Silver (Ag)	0.01	-	0.05	0.13	0.19	0.1	0.1	<0.01	0.01	0.01	0.23	<0.01	1.05	<0.01
Strontium (Sr)	0.2	-	10	5.7	7.7	28.7	6.9	2.5	3.4	43.9	4.1	2	23.4	37
Tantalum (Ta)	0.05	-	0.19	0.75	0.66	0.2	0.15	<0.05	<0.05	0.1	0.15	0.17	0.95	0.48
Tellurium (Te)	0.05	-	0.1	0.26	0.41	0.1	0.24	<0.05	<0.05	<0.05	0.19	<0.05	0.35	0.15
Thallium (Tl)	0.02	-	0.13	0.56	0.12	0.32	0.71	0.02	0.02	0.86	0.18	<0.02	1.35	0.02
Thorium (Th)	0.01	-	3.79	15.2	16.85	4.56	3.99	0.15	0.18	1.53	2.33	2.73	21.5	7.83
Tin (Sn)	0.2	-	0.7	2.6	2.2	0.8	0.6	<0.2	<0.2	0.3	0.8	0.6	3.2	1.3
Tungsten (W)	0.1	-	2.6	2.3	2.1	1.2	1.3	1.1	1.4	0.9	1	2.6	5.7	2
Uranium (U)	0.1	-	0.9	3	3.1	1	3.7	0.3	0.3	1.2	0.9	0.7	6.5	2
Vanadium (V)	1	-	45	113	242	66	43	3	2	15	28	8	121	54
Yttrium (Y)	0.1	-	6.9	18.6	22.2	13.2	4.2	3.4	4.1	10.2	10.7	8.3	37.9	7.3
Zinc (Zn)	2	30000	16	82	18	49	50	7	10	12	153	21	193	25
Zirconium (Zr)	0.5	-	38.1	96.9	94.4	39.4	35	3	2.2	21.2	20.5	34.2	123	82.3

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Low grade siliceous	Banded Iron Formation	Shale	Hydrated	High Phos High grade	Shale	Detrital Waste
	Stratigraphy →	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Mount McRae Shale	Joffre Member	Joffre Member	Mount McRae Shale	Detrital
	RGS Sample Number →	319	320	321	322	323	324	325	326	327	328	329	331
	ALS Laboratory ID →	EB2012969041	EB2012969042	EB2012969043	EB2012969044	EB2012969045	EB2012969046	EB2012969047	EB2012969048	EB2012969049	EB2012969050	EB2012969051	EB2012969052
	Client Sample ID →	IZR208	IZR212	IZR213	IZR214	IZV196	IZV226	IZV353	IZV668	KAC147	KAC172	KAC711	KAD179
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C											
Major Cations			All units %										
Sulfur (S)	0.01	-	0.03	0.10	0.01	0.06	0.01	0.08	0.04	0.19	0.02	0.04	0.03	0.01
Aluminium (Al)	0.01	-	7.21	1.69	1.76	5.30	9.40	3.62	2.02	1.42	0.26	3.31	0.40	3.66
Calcium (Ca)	0.01	-	0.03	0.01	0.01	0.02	0.04	0.10	0.02	<0.01	0.01	0.01	0.18	1.08
Iron (Fe)	0.01	-	28.00	>50	5.18	40.60	26.50	46.70	>50	>50	39.60	36.00	49.80	48.80
Potassium (K)	0.01	-	0.33	0.01	0.11	0.20	0.09	0.03	0.01	<0.01	0.01	0.01	0.01	0.07
Magnesium (Mg)	0.01	-	0.1	0.02	0.03	0.07	0.07	0.06	0.03	0.01	0.02	0.02	0.06	0.16
Sodium (Na)	0.01	-	0.07	0.02	0.01	0.01	0.02	0.01	0.01	<0.01	0.01	0.03	0.02	0.01
Titanium (Ti)	0.005	-	0.161	0.15	0.065	0.173	0.377	0.343	0.092	0.071	<0.005	0.063	0.01	0.237
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	5.5	2.2	0.95	10.2	5.9	2.38	2.2	1.67	0.12	0.65	0.49	2.75
Arsenic (As)	0.2	300	106	93	24.7	626	86.1	38.4	78.6	58.8	10.9	17.6	5	31.9
Barium (Ba)	10	-	70	10	30	30	40	50	10	<10	20	40	30	80
Beryllium (Be)	0.05	90	0.56	0.66	0.36	0.79	2.01	0.3	0.69	0.47	1.35	1.78	0.55	2.42
Bismuth (Bi)	0.01	-	1.1	0.31	0.14	0.6	0.21	0.33	0.25	0.22	0.01	0.09	0.03	0.22
Boron (B)	10	20000	40	20	10	40	10	40	20	10	10	30	10	20
Cadmium (Cd)	0.02	90	<0.02	<0.02	0.02	0.02	0.07	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	0.05
Caesium (Cs)	0.05	-	1.01	<0.05	0.84	1.09	0.47	0.05	<0.05	<0.05	0.06	<0.05	0.06	0.46
Cerium (Ce)	0.01	-	15.15	7.69	7.02	29.5	49.5	5.74	6.85	11	29.4	15.85	2.31	44.4
Chromium (Cr)	1	300	83	21	23	71	1190	49	28	17	4	15	4	57
Cobalt (Co)	0.1	300	1.1	1.3	1.7	4.6	26.2	5.5	4.3	2.1	3.2	3.6	0.6	8
Copper (Cu)	0.2	17000	9.4	7.2	8.1	40.8	146.5	6.3	13.7	8.3	5.8	22.4	4	25.3
Fluorine (F)	20	-	290	140	70	330	160	150	170	90	<20	70	40	180
Gallium (Ga)	0.05	-	21.6	7.39	4.81	12.65	19.3	16	6	4.34	0.6	3.75	0.81	13
Germanium (Ge)	0.05	-	0.45	2.28	0.05	1.36	0.84	0.95	2.21	2.21	0.27	0.9	0.34	2.71
Hafnium (Hf)	0.1	-	4.1	1.2	0.7	2.6	1.3	1.8	1.1	0.8	0.1	0.8	0.2	2.4
Indium (In)	0.005	-	0.122	0.034	0.024	0.124	0.079	0.077	0.036	0.025	<0.005	0.016	0.007	0.063
Lanthanum (La)	0.5	-	8.7	5.6	3.6	24.3	11	2.2	3.2	1	13.4	10.7	0.7	19.5
Lead (Pb)	0.5	600	26.1	8.1	6.1	39.4	22.3	11.3	7.6	12	0.8	5.5	2.1	14
Lithium (Li)	0.2	-	6.4	0.2	6.2	4.7	14	1.2	<0.2	0.2	0.8	2.5	0.2	7
Manganese (Mn)	5	19000	31	6	134	66	461	146	30	59	145	152	30	868
Mercury (Hg)	0.005	80	0.03	0.05	0.007	0.063	0.028	<0.005	0.086	0.11	<0.005	0.011	0.006	0.026
Molybdenum (Mo)	0.05	-	3.55	2.63	1.5	12.65	2.15	3.34	2.88	1.81	0.88	0.86	0.62	2.21
Nickel (Ni)	0.2	1200	17.4	4.1	8.8	23.1	156.5	8.1	12.3	4.5	2.9	17	1.9	22.8
Niobium (Nb)	0.1	-	5.2	5.2	1.7	6.3	2.7	9.4	3.3	2.7	0.4	2	0.5	7.1
Phosphorus (P)	10	-	110	470	80	350	450	310	390	410	1100	980	650	750
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	22.5	0.4	10.4	15.5	5.5	1	0.2	0.1	1	0.3	0.4	5.9
Scandium (Sc)	0.1	-	9.1	2.3	3	12.4	41.7	4.9	2.9	2.4	0.6	3.4	2.2	14.9
Selenium (Se)	1	700	4	4	<1	3	1	2	4	6	<1	1	1	1
Silver (Ag)	0.01	-	0.03	0.04	0.01	0.07	0.04	0.01	0.06	0.05	0.01	0.02	<0.01	0.03
Strontium (Sr)	0.2	-	14.9	1.9	3.8	6	4.9	28.7	4.3	0.3	5.4	2.9	10.5	24
Tantalum (Ta)	0.05	-	0.47	0.42	0.15	0.52	0.24	0.77	0.25	0.21	<0.05	0.16	<0.05	0.54
Tellurium (Te)	0.05	-	0.49	0.23	0.05	0.26	0.15	0.17	0.23	0.24	<0.05	0.07	0.05	0.1
Thallium (Tl)	0.02	-	0.18	<0.02	0.1	0.11	0.11	0.03	<0.02	0.02	<0.02	<0.02	<0.02	0.11
Thorium (Th)	0.01	-	16.5	2.85	2.91	9.56	3.34	5.22	3.7	2.59	0.28	2.11	0.9	7.19
Tin (Sn)	0.2	-	2.9	1.2	0.6	1.7	1.1	2.6	0.8	0.6	<0.2	0.5	<0.2	1.5
Tungsten (W)	0.1	-	2.2	2.4	0.9	2.4	0.8	2.3	1.8	1.4	2.6	1.4	1.4	3.7
Uranium (U)	0.1	-	2.2	0.9	0.5	2.5	2.9	0.7	1.1	1	0.1	0.7	0.2	3.7
Vanadium (V)	1	-	89	38	25	91	265	75	38	27	5	13	6	180
Yttrium (Y)	0.1	-	10.9	5.1	2.6	8.7	10.8	2.9	4.8	2.5	5.9	10.5	1.7	17
Zinc (Zn)	2	30000	16	10	14	38	140	2	27	20	9	22	5	37
Zirconium (Zr)	0.5	-	131.5	44.4	26.8	86	47.2	63.4	40.4	28.8	5	28.8	10.1	89.1

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Detrital Waste	Low Grade Limonite	High Phos High grade	High Grade Detritals	Low Grade Detrital	Low Grade Detrital	Shale	Low Grade Detrital	Detrital Waste	Low Grade Detrital	Low Grade Detrital	Banded Iron Formation
	Stratigraphy →		Detrital	Detrital	Whaleback Shale	Detrital	Detrital	Detrital	Mount McRae Shale	Detrital	Detrital	Detrital	Detrital	Marra Mamba
	RGS Sample Number →		332	333	334	335	336	337	338	339	340	341	342	343
	ALS Laboratory ID →		EB2012969053	EB2012969054	EB2012969055	EB2012969056	EB2012969057	EB2012969058	EB2012969059	EB2012969060	EB2012969061	EB2012969062	EB2012969063	EB2012969064
	Client Sample ID →		KAD240	KAG037	KAG209	KAH259	KAI049	KAI758	KAJ336	KAJ625	KAK169	KAK399	KAK464	KAL098
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	<0.01	0.01	0.01	0.04	0.02	0.01	0.05	0.05	0.01	0.01	0.05	0.16
Aluminium (Al)	0.01	-	0.17	1.31	1.30	2.27	1.62	11.65	7.51	2.71	0.45	0.41	8.39	8.93
Calcium (Ca)	0.01	-	0.03	0.13	0.41	0.05	0.02	0.06	0.01	0.01	0.01	0.01	0.05	0.03
Iron (Fe)	0.01	-	35.50	>50	>50	49.30	>50	20.80	37.40	>50	42.40	42.10	18.05	3.48
Potassium (K)	0.01	-	0.03	0.01	0.06	0.02	0.01	0.03	0.01	0.01	0.01	0.01	1.49	1.85
Magnesium (Mg)	0.01	-	0.03	0.07	0.22	0.07	0.03	0.16	0.02	0.03	0.03	0.02	0.36	0.49
Sodium (Na)	0.01	-	0.01	0.01	<0.01	0.05	0.01	0.05	0.01	0.01	0.01	0.01	0.04	0.19
Titanium (Ti)	0.005	-	<0.005	0.027	0.04	0.175	0.04	0.875	0.246	0.099	0.011	0.021	0.293	0.346
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.73	0.94	1.23	3.01	0.99	3.75	4.82	2.35	0.31	0.25	9.18	3.73
Arsenic (As)	0.2	300	4.2	50.8	13.3	7.9	9.2	15.4	54.1	38.9	7.4	7.5	98.3	50.8
Barium (Ba)	10	-	20	10	1030	30	170	10	60	30	20	10	90	100
Beryllium (Be)	0.05	90	0.77	2.04	3.34	1.06	2.12	0.44	2.32	1.4	1.08	1.11	1.97	1.95
Bismuth (Bi)	0.01	-	0.01	0.05	0.08	0.61	0.11	1.28	1.27	1.78	0.05	0.12	0.77	1.04
Boron (B)	10	20000	10	30	10	20	20	180	10	20	20	20	140	140
Cadmium (Cd)	0.02	90	<0.02	0.1	0.05	0.03	0.05	<0.02	0.03	0.18	<0.02	0.02	0.06	0.02
Caesium (Cs)	0.05	-	0.28	0.19	0.06	0.05	0.08	0.45	0.05	0.05	0.11	<0.05	10.7	13.8
Cerium (Ce)	0.01	-	4.59	37.3	18.1	20.2	29.9	129.5	78.1	61.9	25.7	24.1	44.4	81.1
Chromium (Cr)	1	300	6	9	10	70	11	225	52	21	1	2	108	109
Cobalt (Co)	0.1	300	1	13.8	9.2	2.7	13.1	3	5.3	4.2	1	1.5	2.2	6.7
Copper (Cu)	0.2	17000	3.2	29.8	7.1	13.1	8.7	14.1	21.9	18.6	2.7	6.2	56.8	74.6
Fluorine (F)	20	-	<20	50	60	150	70	220	160	20	<20	<20	1370	2080
Gallium (Ga)	0.05	-	0.37	2.22	3.09	9.96	3.52	37.1	19	5.58	1.11	0.98	21.1	22.5
Germanium (Ge)	0.05	-	0.14	3.83	3.23	1.6	1.98	3.06	2.06	2.17	0.15	0.15	0.4	0.09
Hafnium (Hf)	0.1	-	<0.1	0.3	0.5	3.8	0.9	6.4	7.5	1.3	0.4	0.2	4.3	3.7
Indium (In)	0.005	-	<0.005	0.01	0.011	0.075	0.01	0.168	0.316	0.093	0.012	0.011	0.081	0.102
Lanthanum (La)	0.5	-	3.2	10	5.1	7.8	4.2	53.6	46.8	39.8	12	11.3	18.8	44.2
Lead (Pb)	0.5	600	0.5	4	4.1	9.5	6.1	23.3	38.6	25.4	1.8	2	75.3	68.6
Lithium (Li)	0.2	-	3.8	3.7	2.9	0.7	0.6	62.1	2.6	1.3	1.6	1.7	45.8	78.7
Manganese (Mn)	5	19000	55	399	9990	258	2190	159	193	403	195	170	18	14
Mercury (Hg)	0.005	80	0.009	0.046	0.014	0.022	0.022	0.056	0.025	0.012	0.009	0.01	0.366	0.289
Molybdenum (Mo)	0.05	-	0.97	3.2	0.85	1.13	0.59	1.82	4.46	0.7	0.32	0.25	13.7	3.62
Nickel (Ni)	0.2	1200	3.1	20.5	10.5	7.8	7.8	89.3	26.8	14.3	3.3	4	31.4	36
Niobium (Nb)	0.1	-	0.3	1.1	1.8	7.7	2.3	21.6	16.7	3.5	0.9	0.6	11.5	10.9
Phosphorus (P)	10	-	720	1470	2000	1110	1680	190	1650	1570	490	730	360	110
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.004
Rubidium (Rb)	0.1	-	3.4	1	1.9	0.7	0.4	1.8	0.3	0.2	0.9	0.4	124.5	148.5
Scandium (Sc)	0.1	-	0.3	3	2	10.6	2	11.4	9.3	4.5	0.6	1	16.4	19.9
Selenium (Se)	1	700	<1	1	<1	3	<1	1	<1	<1	<1	<1	4	1
Silver (Ag)	0.01	-	<0.01	0.01	0.01	<0.01	<0.01	0.09	<0.01	<0.01	<0.01	<0.01	0.26	0.18
Strontium (Sr)	0.2	-	3.2	6.2	20.7	10.3	3.1	8.9	30.7	29.5	15	12.3	14.5	8.4
Tantalum (Ta)	0.05	-	<0.05	0.11	0.13	0.55	0.19	1.8	1.29	0.29	<0.05	<0.05	1.03	1.1
Tellurium (Te)	0.05	-	<0.05	<0.05	<0.05	0.17	<0.05	0.16	0.3	0.31	<0.05	<0.05	0.27	0.31
Thallium (Tl)	0.02	-	0.05	0.07	0.59	0.05	1.39	0.02	0.03	0.07	0.02	0.03	0.49	0.87
Thorium (Th)	0.01	-	0.15	1.12	1.66	13.2	3.49	14.45	19.9	4.9	1.09	0.56	16.9	19
Tin (Sn)	0.2	-	0.2	0.3	0.4	1.8	0.5	5.9	4.1	1.7	0.2	0.2	2.7	3.3
Tungsten (W)	0.1	-	7.3	1.3	1.5	4.9	2.4	8.4	3.2	1.8	1.2	0.7	4.8	5.5
Uranium (U)	0.1	-	0.3	1.5	1.1	1.1	1.6	2.1	3.8	1.8	0.3	0.3	4.2	4.5
Vanadium (V)	1	-	5	21	25	74	15	213	67	28	6	9	95	121
Yttrium (Y)	0.1	-	5.2	13.8	16.4	7.1	16.9	11.5	29	8.8	5.5	4.6	18.8	11.9
Zinc (Zn)	2	30000	6	96	22	13	18	21	123	50	7	10	20	19
Zirconium (Zr)	0.5	-	3	13.3	23.2	141	33.1	217	261	49.4	15.9	10.4	143	112

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

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Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Banded Iron Formation	Shale	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Shale	Cherty Shale	Shale	Shale	Detrital Waste	Detrital Waste	Low Grade Detrital
	Stratigraphy →		Marra Mamba	Wittenoom Formation	Marra Mamba	Joffre Member	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital
	RGS Sample Number →		344	345	346	347	348	349	350	351	352	353	354	355
	ALS Laboratory ID →		EB2012969065	EB2012969066	EB2012969067	EB2012969068	EB2012969069	EB2012970001	EB2012970002	EB2012970003	EB2012970004	EB2012970005	EB2012970006	EB2012970007
	Client Sample ID →		KAL383	KAL432	KAL552	KAM124	KAM176	KAN042	KAN056	KAN060	KAN075	KAO351	KAO369	KAO607
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.16	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	<0.01
Aluminium (Al)	0.01	-	1.94	2.44	2.31	1.03	2.70	3.38	5.53	2.98	3.99	3.01	3.26	4.40
Calcium (Ca)	0.01	-	0.01	0.01	0.37	0.02	0.02	0.03	0.02	0.05	2.33	0.09	1.06	2.82
Iron (Fe)	0.01	-	>50	>50	33.70	13.85	>50	>50	27.20	>50	37.70	>50	45.50	41.10
Potassium (K)	0.01	-	0.03	0.01	0.01	0.05	0.11	0.01	0.04	0.01	0.04	0.06	0.03	0.12
Magnesium (Mg)	0.01	-	0.02	0.05	0.12	0.03	0.09	0.04	0.03	0.09	1.34	0.15	0.56	0.98
Sodium (Na)	0.01	-	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	<0.01	0.01	0.01
Titanium (Ti)	0.005	-	0.055	0.198	0.08	0.085	0.117	0.111	0.232	0.117	0.512	0.097	0.137	0.186
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.71	1.73	0.96	1.11	2.09	1.83	4.07	1.02	3.45	1.44	1.73	2.44
Arsenic (As)	0.2	300	10.1	19	25.3	3.1	33.2	23.3	15.9	24.8	39.7	60.9	57.5	53.6
Barium (Ba)	10	-	10	10	10	10	40	10	10	10	20	330	270	30
Beryllium (Be)	0.05	90	3.83	0.8	2.4	0.62	1.16	1.66	1.36	0.65	1.84	3.88	2.7	2.63
Bismuth (Bi)	0.01	-	0.23	0.2	0.19	0.06	0.31	0.29	0.94	0.13	0.43	0.21	0.25	0.4
Boron (B)	10	20000	20	20	40	40	30	20	30	30	40	30	40	10
Cadmium (Cd)	0.02	90	0.11	<0.02	0.05	<0.02	0.3	0.4	0.2	0.08	0.1	0.18	0.03	0.05
Caesium (Cs)	0.05	-	0.07	<0.05	0.15	0.39	0.2	0.08	0.18	<0.05	0.63	0.44	1.05	1.95
Cerium (Ce)	0.01	-	35.5	24.1	45.4	16.35	27.6	106	10.2	16.7	14.8	35.5	21.9	40.2
Chromium (Cr)	1	300	13	20	23	15	31	57	80	32	81	36	45	72
Cobalt (Co)	0.1	300	20.2	2.5	3.8	2.9	18.8	45.4	15.7	8.6	12.7	48.5	33.8	21.1
Copper (Cu)	0.2	17000	9.9	12	12.8	14.5	23.6	38.1	54.7	12.1	20.4	15.9	8.4	16.5
Fluorine (F)	20	-	90	130	490	60	70	80	30	80	310	70	180	610
Gallium (Ga)	0.05	-	5.52	8.25	5.17	2.33	7.08	8.85	20.4	4.92	17.8	6.56	8.54	11.05
Germanium (Ge)	0.05	-	2.42	2.43	1.18	<0.05	2.57	2.17	1	2.61	2.43	2.66	1.85	1.82
Hafnium (Hf)	0.1	-	1.3	1.4	1.3	0.6	1.8	1.4	4.1	0.9	2.9	0.9	1	1.7
Indium (In)	0.005	-	0.016	0.027	0.021	0.013	0.036	0.034	0.098	0.045	0.082	0.045	0.052	0.064
Lanthanum (La)	0.5	-	16.2	14.8	14.7	3.9	8.3	14	2.8	3.9	6.4	20.7	12.3	23.7
Lead (Pb)	0.5	600	13.1	8.9	9.6	2.7	10.5	7.1	13.5	9.6	23.8	16.1	17	17.4
Lithium (Li)	0.2	-	17.7	0.8	3.5	1.5	6.4	11.4	42.6	0.9	21.5	18.9	9.3	34.4
Manganese (Mn)	5	19000	5400	50	405	63	2000	2390	825	113	197	8220	3260	1440
Mercury (Hg)	0.005	80	0.009	0.441	0.023	0.05	0.037	0.059	0.027	0.207	0.027	0.341	0.045	0.064
Molybdenum (Mo)	0.05	-	1.04	1.36	1.65	0.99	0.86	0.57	0.45	1.32	1.76	3.42	2.23	1.84
Nickel (Ni)	0.2	1200	18.3	6.8	16.3	6.2	43.2	68.1	54.1	18.3	49.7	59.7	37.7	44.5
Niobium (Nb)	0.1	-	3.6	6.7	4.6	2.2	3.6	2.6	6	2.7	11.7	2.6	3.6	5.3
Phosphorus (P)	10	-	1990	680	3130	270	490	270	190	1070	170	1210	170	360
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	0.9	0.2	0.9	5.6	5.2	0.5	1	0.2	2.3	1.7	2.7	6.1
Scandium (Sc)	0.1	-	3.2	1.9	3.5	1.9	5.5	9.8	6.6	4.5	6.7	5.4	4.6	6.6
Selenium (Se)	1	700	<1	2	<1	3	<1	<1	<1	2	1	1	1	1
Silver (Ag)	0.01	-	0.01	0.03	<0.01	0.01	0.03	0.09	0.01	0.03	0.02	0.05	0.01	0.01
Strontium (Sr)	0.2	-	15.5	4.4	8.5	3	2.2	1.7	1.2	2.2	24	52.8	18.2	7.4
Tantalum (Ta)	0.05	-	0.32	0.5	0.31	0.19	0.32	0.25	0.68	0.24	1.01	0.23	0.34	0.45
Tellurium (Te)	0.05	-	<0.05	0.08	0.05	<0.05	0.08	0.07	0.19	0.09	0.11	0.11	0.14	0.22
Thallium (Tl)	0.02	-	0.08	<0.02	0.08	0.03	0.46	0.05	0.04	<0.02	0.02	1.14	0.45	0.1
Thorium (Th)	0.01	-	5.99	3.51	5.47	1.39	5.38	5.33	4.91	2.8	4.84	2.93	3.08	5.57
Tin (Sn)	0.2	-	1	1.3	1	0.5	1	0.8	2.5	0.7	2.8	0.9	1.2	1.5
Tungsten (W)	0.1	-	1.5	3	0.9	2.3	1.3	1.6	2.7	1.2	2.6	1.1	1.2	2
Uranium (U)	0.1	-	2.1	1.2	2.8	0.4	1.4	2.1	3	1.9	2.1	2.1	1.6	2.1
Vanadium (V)	1	-	20	52	26	18	50	66	106	54	125	55	71	81
Yttrium (Y)	0.1	-	18.6	15.8	19.5	5.7	18.7	39.2	9.5	6.4	12.2	32.3	15.5	32.8
Zinc (Zn)	2	30000	27	6	45	6	255	493	252	83	243	188	85	68
Zirconium (Zr)	0.5	-	46.6	54.6	49.6	22.4	62.8	48.7	133.5	32.1	99.4	34.3	39.6	63.4

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Shale	Shale	High Phos High grade	High Phos High grade	High Phos High grade	Low Grade Detrital	Shale	Shale	Detrital Waste	Shale	Detrital Waste	Low Grade Aluminous
	Stratigraphy →		Wittenoom Formation	Wittenoom Formation	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Detrital	Dales Gorge Member	Dales Gorge Member	Detrital	Wittenoom Formation	Detrital	Mount McRae Shale
	RGS Sample Number →		356	357	358	359	360	361	362	363	364	365	366	367
	ALS Laboratory ID →		EB2012970008	EB2012970009	EB2012970010	EB2012970011	EB2012970012	EB2012970013	EB2012970014	EB2012970015	EB2012970016	EB2012970017	EB2012970018	EB2012970019
	Client Sample ID →		KAP645	KAP647	KAS712	KAS713	KAS731	KAW128	KAW711	KAW714	KBA863	KBG514	KBG666	KBH061
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	<0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.01	0.02	0.09	0.01
Aluminium (Al)	0.01	-	7.50	2.45	3.20	3.72	0.27	0.66	0.77	0.44	2.66	8.15	5.17	10.75
Calcium (Ca)	0.01	-	2.94	7.05	0.07	0.15	0.02	0.01	0.02	0.01	0.10	0.05	0.01	0.10
Iron (Fe)	0.01	-	20.80	33.80	47.90	>50	45.10	>50	>50	40.00	>50	25.80	46.70	27.40
Potassium (K)	0.01	-	0.25	0.02	0.14	0.38	0.01	0.01	0.01	0.02	0.01	0.27	0.01	0.80
Magnesium (Mg)	0.01	-	3.1	3.52	0.18	0.16	0.04	0.05	0.03	0.02	0.06	0.09	0.02	0.17
Sodium (Na)	0.01	-	0.03	0.02	0.01	0.01	<0.01	<0.01	0.02	0.01	0.01	0.02	0.02	0.04
Titanium (Ti)	0.005	-	0.284	0.094	0.229	0.125	0.013	0.02	0.01	0.015	0.048	0.217	0.19	0.275
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	2.17	1.03	3.17	4.01	0.38	0.58	0.41	0.42	1.34	9.5	4.96	9.58
Arsenic (As)	0.2	300	18.3	50.3	55.7	97.4	4.5	8.1	3.9	2.6	26.7	648	43.2	91
Barium (Ba)	10	-	50	30	30	40	10	20	20	20	20	40	50	140
Beryllium (Be)	0.05	90	2.63	1.84	0.78	1.21	0.64	0.56	0.89	1.24	1.95	1.41	1.8	2.69
Bismuth (Bi)	0.01	-	0.61	0.16	0.54	0.44	0.02	0.03	0.02	0.07	0.11	1.92	0.62	1.29
Boron (B)	10	20000	20	20	30	40	20	20	30	30	40	60	20	110
Cadmium (Cd)	0.02	90	0.02	0.02	0.02	0.03	0.06	0.04	<0.02	<0.02	0.06	0.07	0.04	0.23
Caesium (Cs)	0.05	-	1.9	0.92	1.9	1.16	0.13	<0.05	0.1	0.24	0.24	1.48	0.1	2.69
Cerium (Ce)	0.01	-	55.4	23.7	11.85	26.2	7.28	12.05	61.7	18.55	91.6	111	37.1	129
Chromium (Cr)	1	300	104	34	111	85	7	11	4	6	15	112	44	132
Cobalt (Co)	0.1	300	15.1	19.6	3	4.4	1.7	5.5	2.6	0.8	14.9	7.1	4.7	11.1
Copper (Cu)	0.2	17000	20	11.9	16.4	31.3	4.1	11.2	6.8	5	21.7	103	22.7	47.2
Fluorine (F)	20	-	1360	390	160	170	<20	<20	60	<20	120	340	70	520
Gallium (Ga)	0.05	-	17.05	6.87	11.15	10.9	0.81	1.61	1.04	1.14	3.79	16.45	14.2	29.2
Germanium (Ge)	0.05	-	1.67	1.35	2.16	2.53	0.45	2.94	0.47	0.2	4.27	1.37	1.88	3.74
Hafnium (Hf)	0.1	-	2.9	0.8	2.2	1.8	0.1	0.2	0.1	0.2	0.7	4.1	4.1	5.7
Indium (In)	0.005	-	0.092	0.034	0.084	0.063	0.005	<0.005	<0.005	0.005	0.021	0.166	0.112	0.185
Lanthanum (La)	0.5	-	31.8	7	7.5	4.2	5.3	3.7	71.1	11	39.5	7.6	30.8	28.9
Lead (Pb)	0.5	600	15.6	14.6	12.9	21.4	0.8	3.5	3.6	1.9	7.6	97.1	21.9	54.4
Lithium (Li)	0.2	-	88.1	5.6	18.9	11.7	4.5	2	0.7	0.5	8.7	30.5	1.3	51.9
Manganese (Mn)	5	19000	1180	558	1170	4240	214	567	170	72	280	48	224	158
Mercury (Hg)	0.005	80	0.103	0.022	0.088	0.077	0.022	0.05	0.025	0.008	0.034	0.071	0.014	0.019
Molybdenum (Mo)	0.05	-	1.14	2.44	2.16	3.69	0.94	0.69	0.66	0.28	2.78	12.1	2.22	4.06
Nickel (Ni)	0.2	1200	72.9	22.6	10.7	17.7	9.9	15.7	5.3	3.1	17.5	50	25.5	45.6
Niobium (Nb)	0.1	-	7.2	2.5	7.8	3.9	0.4	0.5	0.4	0.6	2.1	8.3	9.4	9.3
Phosphorus (P)	10	-	520	190	750	590	450	550	1200	910	2810	580	2170	660
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	7.7	2.9	8.7	20.4	0.9	0.2	0.5	2.5	0.6	18.6	0.3	59.1
Scandium (Sc)	0.1	-	9.6	4	5.7	9.4	0.6	1.4	1.4	0.9	2.7	15.1	8.2	15.7
Selenium (Se)	1	700	<1	<1	1	1	<1	<1	<1	<1	<1	3	1	1
Silver (Ag)	0.01	-	0.05	0.02	0.03	0.07	<0.01	0.01	0.01	<0.01	0.02	0.03	<0.01	<0.01
Strontium (Sr)	0.2	-	9.1	90.5	6.7	11.9	0.9	1.2	26.1	4.1	30.4	7.4	22.1	22.5
Tantalum (Ta)	0.05	-	0.64	0.23	0.65	0.32	<0.05	0.05	<0.05	<0.05	0.18	0.82	0.77	0.88
Tellurium (Te)	0.05	-	0.14	0.09	0.43	0.22	<0.05	<0.05	0.05	0.05	0.1	0.54	0.26	0.69
Thallium (Tl)	0.02	-	0.13	0.04	0.11	0.15	0.04	0.04	<0.02	<0.02	0.24	0.24	0.02	0.34
Thorium (Th)	0.01	-	8.04	2.66	6.32	7.34	0.33	0.56	0.4	0.66	2.69	13.25	12.5	13.8
Tin (Sn)	0.2	-	2.4	0.8	1.9	1.4	0.2	0.2	<0.2	0.2	0.4	3.9	2.4	4
Tungsten (W)	0.1	-	2.1	0.9	2.9	1.7	1.2	0.9	0.9	0.8	0.7	3	2.7	2
Uranium (U)	0.1	-	2	1.7	2.4	2.2	0.5	0.6	0.4	0.3	1.5	4.6	2.7	3.6
Vanadium (V)	1	-	78	46	51	63	4	10	6	6	20	110	51	131
Yttrium (Y)	0.1	-	31.2	10.6	7.4	7.9	7.9	6.1	6.5	7.8	14.6	21.9	18.5	23.3
Zinc (Zn)	2	30000	55	46	36	53	44	41	8	6	43	119	77	64
Zirconium (Zr)	0.5	-	95.2	28.1	77.7	62.4	4.3	5.9	6.7	9.3	26.9	135.5	143	189.5

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Shale	Shale	High Grade	Dolerite	Dolerite	Dolerite	Dolerite	Detrital Waste	Shale	Shale	Detrital Waste	Low Grade Detrital
	Stratigraphy →		Mount McRae Shale	Whaleback Shale	Dales Gorge Member	Dolerite	Dolerite	Dolerite	Dolerite	Detrital	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital
	RGS Sample Number →		368	369	370	371	372	373	374	375	376	377	378	379
	ALS Laboratory ID →		EB2012970020	EB2012970021	EB2012970022	EB2012970023	EB2012970024	EB2012970025	EB2012970026	EB2012970027	EB2012970028	EB2012970029	EB2012970030	EB2012970031
	Client Sample ID →		KBH109	KBJ443	KBJ611	KBL717	KBL765	KBL768	KBL774	KBL818	KBO224	KBO255	KBO349	KBO817
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	0.01	0.01	0.02	<0.01	0.01	<0.01	<0.01	0.02	0.01	0.01	0.01	0.36
Aluminium (Al)	0.01	-	6.96	7.28	4.32	0.62	4.03	0.35	0.68	4.42	1.30	0.30	3.39	4.93
Calcium (Ca)	0.01	-	6.07	0.67	0.17	0.02	0.04	0.01	0.02	0.07	0.03	0.02	0.59	0.65
Iron (Fe)	0.01	-	18.10	16.85	>50	40.80	46.20	37.20	>50	47.90	>50	41.00	48.60	48.30
Potassium (K)	0.01	-	0.18	0.84	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02
Magnesium (Mg)	0.01	-	1.82	1.9	0.12	0.04	0.07	0.03	0.04	0.2	0.04	0.04	0.15	0.06
Sodium (Na)	0.01	-	0.06	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.03
Titanium (Ti)	0.005	-	0.576	0.556	0.578	0.017	0.246	0.006	0.009	0.158	0.03	0.008	0.181	0.31
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	1.71	0.14	2.68	1.42	3.36	0.32	0.47	3.16	0.92	0.22	1.55	2
Arsenic (As)	0.2	300	16.1	0.5	26.7	15.5	50.2	5	9.8	67.6	34.2	5.5	12.7	19
Barium (Ba)	10	-	70	40	80	10	40	10	10	20	20	10	10	50
Beryllium (Be)	0.05	90	0.68	0.27	0.25	2.92	2.52	0.81	2.09	2.59	2.21	1.39	4.09	0.84
Bismuth (Bi)	0.01	-	0.31	0.01	0.37	0.12	0.66	0.01	0.04	0.43	0.08	0.01	0.21	0.19
Boron (B)	10	20000	70	50	70	30	30	40	20	60	40	40	40	40
Cadmium (Cd)	0.02	90	0.07	0.71	0.07	0.03	0.05	<0.02	<0.02	0.13	0.05	<0.02	<0.02	0.03
Caesium (Cs)	0.05	-	2.85	6.72	0.18	0.1	0.1	0.11	<0.05	0.16	0.1	0.07	0.17	0.11
Cerium (Ce)	0.01	-	39.5	14.3	6.91	15.35	34.7	3.85	29.1	40.2	26.2	6.56	28.7	14.65
Chromium (Cr)	1	300	130	125	130	5	76	4	1	57	28	4	32	66
Cobalt (Co)	0.1	300	12	184	6.7	2.1	6.4	1.3	2.9	11.8	5.1	1.8	3.6	4.6
Copper (Cu)	0.2	17000	39.6	109.5	8.5	7.6	17	2.6	2.6	43.2	9.8	4.1	7.2	5.6
Fluorine (F)	20	-	650	200	90	<20	50	20	30	210	20	<20	140	120
Gallium (Ga)	0.05	-	19.7	16.25	19.15	2.03	17.4	0.55	1.27	11.8	2.53	0.6	9.61	14.55
Germanium (Ge)	0.05	-	0.31	0.33	3.9	0.69	1.87	0.22	1.44	1.64	2.52	0.21	4.34	2.65
Hafnium (Hf)	0.1	-	4.3	1.7	3.8	0.8	6.7	0.1	0.3	2.4	0.4	0.1	1.7	3.3
Indium (In)	0.005	-	0.117	0.066	0.083	0.036	0.104	<0.005	<0.005	0.067	0.014	<0.005	0.04	0.064
Lanthanum (La)	0.5	-	17.4	7.5	2.5	5.1	12.7	1.1	2.8	12.4	6	4.2	11.7	6.2
Lead (Pb)	0.5	600	18.1	2	14.1	5.7	29.6	0.9	1.9	20.1	4.9	0.8	10.9	12.5
Lithium (Li)	0.2	-	13.1	7	3.3	2.7	12.8	2.9	2.2	5.9	5	3.7	19.6	5.7
Manganese (Mn)	5	19000	649	17300	121	189	375	97	268	1400	351	123	100	237
Mercury (Hg)	0.005	80	0.005	0.059	0.016	0.036	0.027	0.011	0.011	0.025	0.026	0.017	0.021	0.012
Molybdenum (Mo)	0.05	-	1.7	0.11	4.23	1.05	4.16	0.45	0.59	2.9	2.77	0.91	1.44	3.15
Nickel (Ni)	0.2	1200	40.1	120	25.4	7.4	19.5	3	3.3	31	18.3	3.1	15.3	19.5
Niobium (Nb)	0.1	-	12.2	2.4	13.2	2.1	15.6	0.4	0.8	5.8	1.4	0.4	5.9	8.3
Phosphorus (P)	10	-	290	360	170	1240	1330	640	1090	1320	1420	860	720	320
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	29.6	145	2.1	1	0.6	2.2	0.3	0.5	0.4	0.7	0.6	0.8
Scandium (Sc)	0.1	-	19.1	46.1	8.3	1.1	9.2	0.4	0.8	9.9	2	0.6	5.1	11
Selenium (Se)	1	700	1	1	1	<1	<1	<1	<1	<1	<1	<1	1	1
Silver (Ag)	0.01	-	0.03	0.08	0.01	0.02	0.02	<0.01	<0.01	0.05	0.02	<0.01	<0.01	<0.01
Strontium (Sr)	0.2	-	72	111.5	19.2	3.7	7.9	1.6	1.8	7.1	3	2.6	8.7	80.7
Tantalum (Ta)	0.05	-	1.01	0.18	1.07	0.17	1.2	<0.05	0.06	0.52	0.11	<0.05	0.48	0.69
Tellurium (Te)	0.05	-	0.14	<0.05	0.15	<0.05	0.37	<0.05	<0.05	0.2	0.05	<0.05	0.06	0.07
Thallium (Tl)	0.02	-	0.27	0.13	0.02	0.16	0.08	0.18	0.09	0.14	0.03	0.02	<0.02	<0.02
Thorium (Th)	0.01	-	11.55	0.35	7.98	2.71	16.6	0.35	1.09	9.78	1.65	0.44	5.22	10.4
Tin (Sn)	0.2	-	3	0.5	3.6	0.7	3.3	<0.2	0.2	1.4	0.3	<0.2	1.3	2
Tungsten (W)	0.1	-	1.9	0.3	2.6	1.4	3.7	0.9	1.7	2.5	2.6	5.5	3	2.6
Uranium (U)	0.1	-	2.1	0.1	1.5	0.7	2.4	0.4	0.7	3.6	0.9	0.3	1.9	2.5
Vanadium (V)	1	-	142	209	137	11	81	5	7	49	19	5	63	78
Yttrium (Y)	0.1	-	17.2	49.7	4.5	9.4	38.4	3.1	11.2	25.4	17.6	5.8	18.6	4.8
Zinc (Zn)	2	30000	116	163	115	37	82	5	10	157	64	8	10	5
Zirconium (Zr)	0.5	-	142	55.4	134.5	30	230	5.9	12	86.8	18.6	6.8	67.2	115

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →		Banded Iron Formation	Banded Iron Formation	Low Grade Aluminous	Shale	High Grade	Shale	Low Grade Aluminous	Shale	Low Grade Detrital	Cherty Shale	Shale	Shale
	Stratigraphy →		Dales Gorge Member	Dales Gorge Member	Whaleback Shale	Mount Sylvia	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Mount Sylvia	Detrital	Mount Sylvia	Mount Sylvia	Mount Sylvia
	RGS Sample Number →		380	381	382	383	384	385	386	387	388	389	390	391
	ALS Laboratory ID →		EB2012970032	EB2012970033	EB2012970034	EB2012970035	EB2012970036	EB2012970037	EB2012970038	EB2012970039	EB2012970040	EB2012970041	EB2012970042	EB2012970043
	Client Sample ID →		KBR002	KBR003	KCH462	KCH854	KCI118	KCI669	KCI918	KCJ122	KCJ187	KCJ214	KCJ271	KCJ308
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C												
Major Cations			All units %											
Sulfur (S)	0.01	-	<0.01	0.02	0.01	<0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	0.01
Aluminium (Al)	0.01	-	0.45	0.64	1.39	0.09	0.13	0.60	0.32	0.39	1.64	3.55	4.13	7.88
Calcium (Ca)	0.01	-	0.02	0.04	0.02	0.01	0.01	0.02	0.02	0.02	0.03	0.10	0.04	0.04
Iron (Fe)	0.01	-	41.00	28.30	>50	30.20	25.60	>50	39.60	33.80	28.00	41.00	29.20	34.10
Potassium (K)	0.01	-	0.02	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.06	0.03	0.02	0.01
Magnesium (Mg)	0.01	-	0.03	0.05	0.07	0.02	0.02	0.03	0.03	0.03	0.04	0.2	0.07	0.07
Sodium (Na)	0.01	-	0.01	0.03	0.01	<0.01	0.01	0.02	0.01	0.01	0.01	0.05	0.02	0.02
Titanium (Ti)	0.005	-	0.006	0.021	0.053	0.005	0.006	0.016	0.009	0.015	0.089	0.194	0.1	0.282
Major, Minor and Trace Elements			All units mg/kg											
Antimony (Sb)	0.05	-	0.34	0.45	0.79	0.28	0.26	0.58	0.68	0.92	0.79	1.2	1.3	4.55
Arsenic (As)	0.2	300	4.6	1.2	6.7	1.4	3	3.2	4.1	4.7	5.7	7.7	10.2	44.2
Barium (Ba)	10	-	20	10	30	10	10	10	40	30	80	40	30	70
Beryllium (Be)	0.05	90	1.21	0.68	1.48	0.93	0.94	0.59	1.79	1.96	1.63	1.96	2	3.36
Bismuth (Bi)	0.01	-	<0.01	0.03	0.06	<0.01	0.01	0.06	0.04	0.03	0.14	0.18	0.23	0.8
Boron (B)	10	20000	10	20	10	10	10	20	10	10	20	20	20	20
Cadmium (Cd)	0.02	90	<0.02	<0.02	0.28	0.1	0.09	0.02	<0.02	<0.02	0.03	<0.02	<0.02	0.06
Caesium (Cs)	0.05	-	0.15	0.14	<0.05	0.05	<0.05	<0.05	0.29	0.28	0.45	0.16	0.22	0.27
Cerium (Ce)	0.01	-	15.3	5.12	7.11	13.3	8.04	25.3	7.24	8.25	25.6	48	53.7	45.4
Chromium (Cr)	1	300	3	8	10	5	9	5	5	7	71	22	45	63
Cobalt (Co)	0.1	300	1.8	3	14.4	4.3	5.2	2.6	1.2	1.1	3.9	0.9	1.9	3.2
Copper (Cu)	0.2	17000	3.8	4	18.9	4.4	6.3	3.8	8.3	6.2	12.9	5.5	15.2	31.7
Fluorine (F)	20	-	<20	40	20	<20	<20	30	<20	<20	<20	220	50	110
Gallium (Ga)	0.05	-	0.71	1.02	2.31	0.44	0.48	1.17	0.94	0.96	4.22	8.79	7.14	20.9
Germanium (Ge)	0.05	-	0.26	0.11	3.42	0.17	0.11	2.63	0.2	0.16	0.18	1.43	0.8	1.14
Hafnium (Hf)	0.1	-	0.1	0.2	0.3	<0.1	0.1	0.2	0.2	0.2	1.2	1.7	1.7	8.3
Indium (In)	0.005	-	<0.005	0.005	0.01	<0.005	<0.005	0.006	0.006	<0.005	0.02	0.027	0.022	0.125
Lanthanum (La)	0.5	-	17.3	2.7	3.3	8.2	4.5	2.4	3.4	3.4	9.2	28	46.3	27.2
Lead (Pb)	0.5	600	1	2.3	4.6	0.6	0.9	3.1	1.4	1.7	5.7	10.5	19.6	42.1
Lithium (Li)	0.2	-	3.4	2.3	5.6	4.7	4.1	0.7	2	2.7	5.3	28.3	7.5	25.1
Manganese (Mn)	5	19000	144	148	412	127	159	128	124	68	134	79	151	184
Mercury (Hg)	0.005	80	0.026	0.009	0.027	0.018	0.02	0.016	0.01	0.01	0.03	0.02	0.01	0.023
Molybdenum (Mo)	0.05	-	0.45	0.59	0.92	0.52	0.62	0.42	0.67	0.47	0.58	0.75	0.89	5
Nickel (Ni)	0.2	1200	5.7	6.3	27.4	6.6	8.1	5.7	3.2	4	5	8	10.8	19.2
Niobium (Nb)	0.1	-	0.3	0.5	0.8	0.2	0.3	0.6	0.6	0.7	2.5	5.8	3.8	19.3
Phosphorus (P)	10	-	830	220	690	230	190	610	1120	730	890	1030	1200	1310
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.1	-	2	1.3	0.3	0.5	0.6	0.3	3.1	2.7	5.9	0.9	1.7	0.8
Scandium (Sc)	0.1	-	0.5	1.9	6.9	0.5	0.7	2	0.7	0.9	4.8	3.5	4.4	12.7
Selenium (Se)	1	700	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Silver (Ag)	0.01	-	0.01	<0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.01
Strontium (Sr)	0.2	-	6.1	6	1.3	1.2	0.8	3	2.4	1.8	12.4	16.3	33.4	13.4
Tantalum (Ta)	0.05	-	<0.05	<0.05	0.06	<0.05	<0.05	0.05	<0.05	<0.05	0.18	0.48	0.35	1.5
Tellurium (Te)	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.47
Thallium (Tl)	0.02	-	0.02	0.04	0.14	0.02	0.02	0.02	0.02	0.03	0.04	0.02	<0.02	0.07
Thorium (Th)	0.01	-	0.27	0.5	0.74	0.12	0.18	0.86	0.56	0.66	2.91	5.47	6.7	20
Tin (Sn)	0.2	-	<0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.6	1.3	0.9	3.9
Tungsten (W)	0.1	-	1.6	0.6	0.6	3.2	6.2	0.6	2.8	2.3	2	3.2	1.6	4.4
Uranium (U)	0.1	-	0.3	0.2	0.7	0.1	0.1	0.6	0.4	0.3	1.2	1	1.7	3.2
Vanadium (V)	1	-	4	7	23	3	4	7	5	7	38	33	31	72
Yttrium (Y)	0.1	-	7.2	5.7	11.5	10.4	8.1	5.5	7.7	6	14.8	11.9	12.9	35.4
Zinc (Zn)	2	30000	9	7	280	78	102	10	7	13	14	5	26	89
Zirconium (Zr)	0.5	-	4.3	7.6	11.7	1.8	2.5	8.8	8.1	10.9	49.5	61.6	63	275

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B2: Multi-Element Test Results for Waste Rock from Rio Tinto Brockman

Parameters	Lithology →	Detrital Waste	Low Grade Detrital	Low Grade Detrital	Banded Iron Formation	Chert	Hydrated						
	Stratigraphy →	Detrital	Detrital	Detrital	Dales Gorge Member	Mount McRae Shale	Dales Gorge Member						
	RGS Sample Number →	392	393	394	395	396	397						
	ALS Laboratory ID →	EB2012970044	EB2012970045	EB2012970046	EB2012970047	EB2012970048	EB2012970049						
	Client Sample ID →	KCJ374	KCJ440	KCJ549	KDD600	KDR301	KDR479						
	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C											
Major Cations			All units %										
Sulfur (S)	0.01	-	0.01	0.01	0.01	0.02	0.01	0.02						
Aluminium (Al)	0.01	-	0.88	7.80	2.25	3.51	4.80	0.26						
Calcium (Ca)	0.01	-	0.03	0.05	0.03	0.04	3.43	0.03						
Iron (Fe)	0.01	-	28.10	20.70	35.00	15.50	42.40	32.80						
Potassium (K)	0.01	-	0.01	0.03	0.02	0.09	0.02	0.01						
Magnesium (Mg)	0.01	-	0.04	0.08	0.06	0.06	0.74	0.04						
Sodium (Na)	0.01	-	0.01	0.03	0.01	0.01	0.02	0.01						
Titanium (Ti)	0.005	-	0.035	1.23	0.091	0.255	0.32	0.015						
Major, Minor and Trace Elements			All units mg/kg										
Antimony (Sb)	0.05	-	0.66	3.23	1.5	1	1.81	0.18						
Arsenic (As)	0.2	300	44.2	3.3	13.6	16.3	62.6	1.7						
Barium (Ba)	10	-	10	40	10	40	20	10						
Beryllium (Be)	0.05	90	1.48	1.58	1.48	0.61	2.82	0.48						
Bismuth (Bi)	0.01	-	0.07	0.33	0.25	0.17	0.28	0.01						
Boron (B)	10	20000	30	30	20	30	40	20						
Cadmium (Cd)	0.02	90	0.05	0.02	0.02	0.03	0.02	0.06						
Caesium (Cs)	0.05	-	<0.05	0.09	0.13	0.99	1.32	0.23						
Cerium (Ce)	0.01	-	17.9	135	12.3	8.57	65.9	3.22						
Chromium (Cr)	1	300	12	77	28	47	78	8						
Cobalt (Co)	0.1	300	2.1	1.7	4.5	4.1	33.3	2.1						
Copper (Cu)	0.2	17000	5.8	8.9	15.4	9.4	14.7	2.4						
Fluorine (F)	20	-	30	150	40	60	210	20						
Gallium (Ga)	0.05	-	2.25	29.9	6.87	8.46	14.4	0.74						
Germanium (Ge)	0.05	-	0.13	2.7	0.36	<0.05	2.99	0.25						
Hafnium (Hf)	0.1	-	0.4	5.6	1.9	1.4	2.6	0.1						
Indium (In)	0.005	-	0.012	0.073	0.025	0.04	0.084	0.005						
Lanthanum (La)	0.5	-	8.6	80.7	2.1	5.4	19.9	2						
Lead (Pb)	0.5	600	4.7	25.4	10.2	8.4	27.9	1						
Lithium (Li)	0.2	-	4	134.5	5.5	6.7	26.8	2.8						
Manganese (Mn)	5	19000	259	64	322	304	615	140						
Mercury (Hg)	0.005	80	0.014	0.023	0.013	0.018	0.02	0.016						
Molybdenum (Mo)	0.05	-	1.16	1.24	0.98	1.4	3.17	0.52						
Nickel (Ni)	0.2	1200	9.9	23.8	7.7	15.3	53.1	4.6						
Niobium (Nb)	0.1	-	1.3	25.2	4.4	5.5	7.6	0.5						
Phosphorus (P)	10	-	770	820	1050	90	90	190						
Rhenium (Re)	0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002						
Rubidium (Rb)	0.1	-	0.3	0.7	1.3	9	4.1	1.2						
Scandium (Sc)	0.1	-	1.8	8.5	3.9	5.9	13.1	0.8						
Selenium (Se)	1	700	<1	1	<1	1	<1	<1						
Silver (Ag)	0.01	-	0.04	0.05	<0.01	0.06	0.04	0.01						
Strontium (Sr)	0.2	-	3.1	33	2.7	6.5	16.1	1.5						
Tantalum (Ta)	0.05	-	0.09	2.16	0.35	0.47	0.63	<0.05						
Tellurium (Te)	0.05	-	0.05	<0.05	0.05	0.08	0.1	<0.05						
Thallium (Tl)	0.02	-	0.07	<0.02	<0.02	0.07	0.08	0.02						
Thorium (Th)	0.01	-	1.53	8.94	6.67	3.54	7.59	0.33						
Tin (Sn)	0.2	-	0.3	5.4	1.1	1.4	2.1	0.2						
Tungsten (W)	0.1	-	4.6	10.8	1.8	2.7	1.9	3.6						
Uranium (U)	0.1	-	1.1	1	1.7	0.7	2.4	0.1						
Vanadium (V)	1	-	14	66	30	64	90	5						
Yttrium (Y)	0.1	-	15.6	11.1	12.3	5.8	19.5	7.4						
Zinc (Zn)	2	30000	26	4	22	28	10	45						
Zirconium (Zr)	0.5	-	19.2	186.5	65.4	55.1	85.6	4.6						

Notes: < indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit.

** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)* , Amendment of Schedule B1-B7 of 1999 version.

Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Low Grade Detrital	Shale	Manganiferous Shale	Shale	Banded Iron Formation	Banded Iron Formation	Detrital Waste	Low Grade Detrital	Banded Iron Formation	Hydrated Waste	Shale	Banded Iron Formation	Banded Iron Formation	Detrital Waste	Hydrated	Shale	Detrital Waste	Low grade siliceous	Shale	Detrital Waste
			Stratigraphy →	Detrital	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Detrital	Detrital	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Detrital	Marra Mamba	Wittenoom Formation	Detrital	Wittenoom Formation	Wittenoom Formation	Detrital
			RGS Sample Number →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			Pit→	IKN091	IKN707	IKO454	IKO712	IKO939	IKQ120	ILA414	ILA602	ILA658	ILA964	ILA976	ILB540	ILC560	ILD638	ILD720	IPM179	IPN302	IPO347	IPP003	IPP032
	Detection Limit	Average Crustal Abundance[1]		RC19BSNA0329	RC19BS10109	RC19BSNA0188	RC19BSNA0191	RC19BSNA0194	RC19BSNA0139	RC19BSNA0037	RC19BSNA0040	RC19BSNA0040	RC19BSNA0042	RC19BSNA0042	RC19BSNA0130	RC19BSNA0253	RC19BSNA0090	RC19BSNA0261	RC19BSNA0209	RC19BSNA0162	RC19BSNA0045	RC19BS10005	RC19BS10006
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4		3	3	3	1	2	2	2	3	3	1	2	2	2	3	3	3	3	3	3	3
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6		1	3	0	1	0	0	3	4	1	0	0	0	0	1	1	0	3	1	3	4
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Cobalt (Co)	0.1	8		0	0	1	2	0	0	0	0	0	0	1	3	0	0	0	0	0	1	0	0
Copper (Cu)	0.2	30		0	0	0	0	0	0	0	0	0	1	2	2	1	0	0	0	0	0	0	0
Fluorine (F)	20	200		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	2	2	2
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06		0	0	1	3	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	1	0	0	0	0	1	0	0	2	2	2	0	1	0	0	1	0	0	0
Selenium (Se)	1	0.4		1	1	0	1	0	0	2	2	0	1	0	1	1	2	1	0	2	0	1	1
Silver (Ag)	0.01	0.057		0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		4	4	3	1	3	2	5	6	1	2	3	2	3	4	4	3	4	4	4	4
Thallium (Tl)	0.02	0.2		0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90		0	0	0	0	0	0	0	0	0	1	1	2	0	1	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	2	0	2	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Shale	Banded Iron Formation	Banded Iron Formation	High Phos High grade	Low Grade Limonite	Banded Iron Formation	Detrital Waste	Shale	Detrital Waste	Dolerite	Shale	Shale	Banded Iron Formation	Banded Iron Formation	Shale	Dolomite	Lignite	Lignite	Silcrete	Silcrete
		Stratigraphy →	Mount McRae Shale	Dales Gorge Member	Joffre Member	Joffre Member	Detrital	Mount McRae Shale	Detrital	Wittenoom Formation	Detrital	Dolerite	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	#N/A	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital
		RGS Sample Number →	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
		Pit→	IPP152	IPP456	IPP783	IPP791	IPP981	IPU900	IPY508	IPY536	IPY819	IPY877	IPY893	IPY901	IQP002	IQP120	IQP915	IQS087	IQS139	IQS283	IQS289	IQS300
	Detection Limit	Average Crustal Abundance[1]	RC19BS10010	RC19BS10016	RC19BS10022	RC19BS10022	RC19BS10027	RC19BS10172	RC19BSNA0006	RC19BSNA0006	RC19BSNA0010	RC19BSNA0010	RC19BSNA0010	RC19BSNA0010	RC19BSNA0095	RC19BSNA0091	RC19BSNA0234	RC19BSNA0396	RC19BSNA0396	RC19BSNA0397	RC19BSNA0397	RC19BSNA0397
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	4	2	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Iron (Fe)	0.01	4	2	3	3	3	0	2	3	2	3	2	2	3	2	3	0	0	0	1	1	0
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	4	0	0	0	0	0	1	2	2	2	0	0	0	1	1	0	2	2	2	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	0	0	0	2	0	1	1	0	0	0	2	0	0	0	0	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0
Mercury (Hg)	0.005	0.06	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	2
Molybdenum (Mo)	0.05	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	1	0	0	0	0	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0
Selenium (Se)	1	0.4	3	0	0	2	0	0	1	1	1	1	1	0	0	0	0	1	2	1	0	0
Silver (Ag)	0.01	0.057	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	5	4	3	4	1	3	3	4	4	3	3	3	3	4	1	0	3	2	2	1
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Thorium (Th)	0.01	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Uranium (U)	0.1	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Calcrete	Cherty Shale	Red Ochre Waste	Calcrete	Limonitic Waste	Hydrated	Banded Iron Formation	Shale	Shale	Shale	Shale	Calcrete	Low Grade Limonite	Shale	Pisolite Waste	Dolomite	Dolomite
			Stratigraphy →	Detrital	Wittenoom Formation	Wittenoom Formation	Marra Mamba	Detrital	Wittenoom Formation	Detrital	Detrital	Detrital	Marra Mamba	Marra Mamba	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Wittenoom Formation	Detrital	Wittenoom Formation
			RGS Sample Number →	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
			Pit→	IQS307	IQS377	IQS406	IQS418	IQS454	IQS493	IQS554	IQS585	IQS975	IRA551	IRA619	IRI357	IRI399	IRI434	IRI603	IRI671	IRI781	IRI843	IRI876	IRI877
	Detection Limit	Average Crustal Abundance[1]		RC19BSNA0397	RC19BSNA0397	RC19BSNA0397	RC19BSNA0397	RC19BSNA0398	RC19BSNA0398	RC19BSNA0399	RC19BSNA0400	RC19BSNA0433	RC19BSNA0270	RC19BSNA0270	RC19BS20001	RC19BS20002	RC19BS20003	RC19BS20007	RC19BS20009	RC19BS20012	RC19BS20014	RC19BS20015	RC19BS20015
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	1	3	1
Iron (Fe)	0.01	4		2	3	3	0	1	3	3	3	3	2	0	0	3	3	2	3	3	3	0	2
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	4	0	0	1	0	0	1	0	0	0	0	3	0	0	1	4	2
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Arsenic (As)	0.2	6		3	1	0	0	2	5	2	2	1	0	2	1	4	6	2	3	3	2	0	3
Barium (Ba)	10	500		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		0	0	0	0	1	2	0	2	0	0	2	0	1	2	1	1	1	0	0	1
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70		0	0	0	0	1	1	0	1	0	0	1	3	0	0	0	0	0	0	0	1
Cobalt (Co)	0.1	8		0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Copper (Cu)	0.2	30		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Fluorine (F)	20	200		0	0	0	1	2	0	0	0	0	0	2	0	0	0	2	0	0	0	0	1
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		0	1	0	0	0	1	1	1	1	0	0	0	1	2	0	1	0	1	0	0
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06		0	0	0	0	0	1	0	0	0	0	0	0	1	2	0	1	0	0	0	0
Molybdenum (Mo)	0.05	2		0	0	0	0	0	2	0	1	0	0	0	0	0	2	0	1	0	1	0	1
Nickel (Ni)	0.2	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007		0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0
Selenium (Se)	1	0.4		0	0	0	1	0	4	0	4	1	0	0	1	2	3	1	2	3	1	1	1
Silver (Ag)	0.01	0.057		0	0	0	0	2	0	0	1	0	0	0	0	3	1	0	0	0	0	0	0
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		3	4	4	0	3	6	2	6	1	0	3	1	4	4	3	3	3	2	0	3
Thallium (Tl)	0.02	0.2		0	6	0	0	0	2	1	0	0	0	1	0	1	0	0	0	0	0	0	0
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0
Uranium (U)	0.1	2		0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Vanadium (V)	1	90		0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Dolomite	#N/A	High Grade	Shale	Banded Iron Formation	Low Grade Aluminous	Dolerite	Shale	Low Grade Red Ochre Detrital	Calcrete	Banded Iron Formation	Low grade siliceous	Hydrated	Hydrated	Low Grade Aluminous	Shale	Low Grade Aluminous	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation
			Stratigraphy →	Wittenoom Formation	Wittenoom Formation	Detrital	Wittenoom Formation	Mount McRae Shale	Dales Gorge Member	Whaleback Shale	Dolerite	Mount Sylvia	Detrital	Detrital	Dales Gorge Member	Mount McRae Shale	Whaleback Shale	Joffre Member	Whaleback Shale	Wittenoom Formation	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member
			RGS Sample Number →	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
			Pit→	IRI883	IRI885	IRJ297	IRJ561	IRK083	IRK629	IRK837	IRL014	IRL163	IRL691	IRM602	IRM663	IRO039	IRQ039	IRQ201	IRQ767	IRR109	IRR624	IRR628	IRR651
	Detection Limit	Average Crustal Abundance[1]		RC19BS20015	RC19BS20015	RC19BSNA0426	RC19BSNA0430	RC19BS10278	RC19BS10287	RC19BS10290	RC19BS20044	RC19BS20049	RC19BS20070	RC19BS10269	RC19BS10268	RC19BS10200	RC19BS10330	RC19BS10334	RC19BS10348	RC19BSNA0435	RC19BS20075	RC19BS20075	RC19BS20075
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0
Iron (Fe)	0.01	4		0	3	3	0	3	3	2	0	3	1	3	3	3	3	1	1	2	2	0	3
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6		0	1	2	3	1	0	3	1	2	5	0	0	0	0	0	0	2	3	0	0
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		1	1	0	2	0	0	1	2	0	1	0	0	0	0	0	0	0	1	0	0
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4		0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Chromium (Cr)	1	70		1	1	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0
Cobalt (Co)	0.1	8		0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30		0	1	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Fluorine (F)	20	200		0	0	0	3	0	0	1	1	0	3	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	2	0
Mercury (Hg)	0.005	0.06		0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007		0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	1	0	1	0	0	1	1	0	1	0	0	0	0	2	1	0	1	0	0
Selenium (Se)	1	0.4		1	1	1	1	0	0	2	1	0	0	0	0	0	2	1	1	2	1	1	0
Silver (Ag)	0.01	0.057		0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		0	3	2	4	0	0	3	3	2	3	0	0	1	1	2	1	2	3	0	1
Thallium (Tl)	0.02	0.2		0	0	0	2	0	0	0	0	0	1	0	0	1	0	0	0	2	1	0	0
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1
Uranium (U)	0.1	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90		0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Shale	Shale	Low Grade Aluminous	Hydrated	Banded Iron Formation	Hydrated Waste	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Hydrated	Limonitic Waste	Low Grade Limonite	Shale	Shale	Dolomite	Calcrete	Low Grade Red Ochre Detrital	Low Grade Red Ochre Detrital	Banded Iron Formation	High Grade
			Stratigraphy →	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Whaleback Shale	Whaleback Shale	Dales Gorge Member	Joffre Member	Wittenoom Formation	Marra Mamba	Marra Mamba	Marra Mamba	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital	Marra Mamba
			RGS Sample Number →	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
			Pit→	IRR653	IRR945	IRR948	IRU033	IRU100	IRU451	IRU776	IRZ397	IRZ661	IRZ663	ISD283	ISD467	ISD761	ISD892	ISD896	ISD900	ISD936	ISE024	ISE033	ISE515
	Detection Limit	Average Crustal Abundance[1]		RC19BS20075	RC19BS10364	RC19BS10364	RC19BS10119	RC19BS10120	RC19BS10126	RC19BS10134	RC19BSNA0283	RC19BSNA0287	RC19BSNA0287	RC19BS3X0028	RC19BS3X0033	RC19BS3X0040	RC19BS3X0041	RC19BS3X0041	RC19BS3X0041	RC19BS3X0042	RC19BS3X0043	RC19BS3X0043	RC19BS3X0052
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Iron (Fe)	0.01	4		3	2	3	2	3	2	3	2	2	3	3	3	3	3	3	3	3	2	0	0
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6		0	0	0	2	2	0	3	2	0	0	2	2	3	0	0	0	0	0	0	3
Barium (Ba)	10	500		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cerium (Ce)	0.01	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cobalt (Co)	0.1	8		0	0	0	2	2	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0
Copper (Cu)	0.2	30		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Fluorine (F)	20	200		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0	0
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	0	0	2	3	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Molybdenum (Mo)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Nickel (Ni)	0.2	50		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Selenium (Se)	1	0.4		0	0	0	0	0	0	2	1	0	0	1	1	1	0	0	0	0	0	1	1
Silver (Ag)	0.01	0.057		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		1	1	1	3	2	0	3	3	1	2	3	2	3	2	2	2	2	2	0	5
Thallium (Tl)	0.02	0.2		0	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Uranium (U)	0.1	2		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Vanadium (V)	1	90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		2	2	0	1	0	0	0	0	0	0	2	0	2	2	0	0	0	0	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Low grade siliceous	Banded Iron Formation	Low Grade Aluminous	Shale	Low Grade Aluminous	Shale	Calcrete	Banded Iron Formation	Detrital Waste	Banded Iron Formation	High Grade	High Grade	Low grade siliceous	Hydrated	High Grade	Banded Iron Formation	Hydrated	Detrital Waste	Banded Iron Formation	Banded Iron Formation
		Stratigraphy →	Marra Mamba	#N/A	#N/A	Joffre Member	Joffre Member	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Wittenoom Formation	Detrital	Wittenoom Formation	Detrital	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Whaleback Shale	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member
		RGS Sample Number →	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
		Pit→	ISE864	ISI700	ISI842	ISI845	ISI859	ISJ051	ISJ062	ISJ277	ISJ804	ISL158	ISL365	ISL976	ITC180	ITC740	ITC748	ITC933	ITD460	ITD582	ITD726	ITD748
	Detection Limit	Average Crustal Abundance[1]	RC19BS3X0106	RC19BS10078	RC19BS10082	RC19BS10082	RC19BS10082	RC19BS10028	RC19BS10028	RC19BS10033	RC19BS10043	RC19BSNA0196	RC19BSNA0197	RC19BSNA0395	RC19BS10718	RC19BS10733	RC19BS10733	RC19BS10738	RC19BS10751	RC19BS10752	RC19BS10754	RC19BS10755
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	3	3	2	2	3	2	3	1	2	3	3	2	1	3	3	3	3	2	3
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	1	1	3	2	0	2	2	2	2	0	2	0	2	2	3	0	0	1	1	3
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	0	1	1	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1	1
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
Cobalt (Co)	0.1	8	0	0	0	1	0	1	0	1	0	0	1	0	0	0	1	0	0	2	0	0
Copper (Cu)	0.2	30	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	2	2	1	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	1
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	5	0	0
Mercury (Hg)	0.005	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	0	1	0	0	1	0	1	0	0	0	2	2	0	0	0	0	1	0
Selenium (Se)	1	0.4	0	1	0	1	0	1	1	1	0	0	1	1	1	0	1	1	0	0	1	1
Silver (Ag)	0.01	0.057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	2	3	4	3	2	3	3	3	3	2	3	3	2	2	3	3	3	3	3	4
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	0	0	1	0	0	1	0	0	0	0	0	2	1	0	0	0	0	1	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Zinc (Zn)	2	90	0	0	0	0	0	1	0	1	0	0	1	0	0	0	2	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Hydrated	Shale	Low Grade Aluminous	Banded Iron Formation	Hydrated	Shale	Detrital Waste	Calcrete	Banded Iron Formation	Carbonaceous Shale	Shale	Shale	Manganese
		Stratigraphy →	Detrital	Dales Gorge Member	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Whaleback Shale	Dales Gorge Member	Mount McRae Shale	Joffre Member	Whaleback Shale	Detrital	Detrital	Marra Mamba	Mount McRae Shale
		RGS Sample Number →	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
		Pit→	ITD802	ITD887	ITE611	ITG282	ITG526	ITG535	ITH923	ITI334	ITI426	ITI461	ITI551	ITI571	ITI713	ITI787	ITI951	ITI971	ITJ305	ITJ709	ITK609	ITL213
	Detection Limit	Average Crustal Abundance[1]	RC19BS10756	RC19BS10757	RC19BS3X0300	RC19BSNA0052	RC19BSNA0055	RC19BSNA0055	RC19BSNA0352	RC19BS10402	RC19BS10404	RC19BS10405	RC19BS10408	RC19BS10408	RC19BS10411	RC19BS10412	RC19BS10418	RC19BS10418	RC19BS30006	RC19BS3X0204	RC19BS3X0159	RC19BS10368
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	3	3	3	3	3	3	3	3	2	0	1	3	3	2	3	2	1	3	2
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	4	3	4	4	2	5	2	2	3	0	0	0	0	4	3	0	4	2	3	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	2	1	3	2	0	2	0	0	1	0	2	3	0	0	3	0	1	1	2	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorine (F)	20	200	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	1	1	2	1	0	1	0	0	1	0	0	0	0	1	0	0	2	0	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Mercury (Hg)	0.005	0.06	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	2	1	2	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Selenium (Se)	1	0.4	2	1	2	3	1	2	2	1	1	1	1	1	0	1	1	0	1	0	0	0
Silver (Ag)	0.01	0.057	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	5	4	5	5	3	5	4	3	4	3	4	4	3	3	4	3	2	2	3	0
Thallium (Tl)	0.02	0.2	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	1	1	2	1	0	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1
Uranium (U)	0.1	2	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
Vanadium (V)	1	90	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Shale	Detrital Waste	Detrital Waste	Shale	Detrital Waste	Dolomite	Banded Iron Formation	High Grade	Banded Iron Formation	Shale	Shale	Banded Iron Formation	Shale	Detrital Waste	Detrital Waste	Banded Iron Formation	Low grade siliceous	Low Grade Limonite	Low Grade Limonite	Low Grade Limonite
		Stratigraphy →	Whaleback Shale	Whaleback Shale	Whaleback Shale	Joffre Member	Detrital	Detrital	Wittenoom Formation	Detrital	Wittenoom Formation	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Wittenoom Formation	Dales Gorge Member	Whaleback Shale	Detrital	Detrital	Wittenoom Formation	Marra Mamba
		RGS Sample Number →	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
		Pit→	ITL714	ITL727	ITL781	ITL838	ITM231	ITM284	ITM309	ITM458	ITM815	ITN418	ITN542	ITN784	ITN964	ITO839	ITQ041	ITQ586	ITS268	ITS739	ITU268	ITU333
	Detection Limit	Average Crustal Abundance[1]	RC19BS10375	RC19BS10375	RC19BS10377	RC19BS10378	RC19BS3X0215	RC19BS3X0216	RC19BS3X0216	RC19BS3X0219	RC19BS3X0223	RC19BS3X0142	RC19BS3X0144	RC19BS3X0146	RC19BS3X0148	RC19BSNA0448	RC19BS10175	RC19BS10185	RC19BS20205	RC19BS20218	RC19BS3X0125	RC19BS3X0126
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	2	2	3	2	2	2	2	1	3	3	2	3	2	2	2	3	3	3	3
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	0	0	0	1	2	3	3	4	4	5	2	3	0	2	0	0	1	2	4	3
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	0	0	0	1	0	0	3	3	1	1	1	0	0	0	0	0	0	1	0
Boron (B)	10	100	0	0	0	0	2	0	0	2	3	0	0	3	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Copper (Cu)	0.2	30	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	6	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0
Mercury (Hg)	0.005	0.06	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	2	2	1	0	1	0	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	1	0.4	0	0	0	2	0	1	1	1	1	1	1	2	0	2	0	0	0	0	4	2
Silver (Ag)	0.01	0.057	0	0	0	0	1	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	0	0	0	4	2	2	2	5	5	4	3	3	0	2	1	0	2	3	4	2
Thallium (Tl)	0.02	0.2	0	0	0	0	2	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	1	1	0	1
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Calcrete	Shale	Hydrated	Hydrated	Hydrated	Clay	Banded Iron Formation	Detrital Waste	Detrital Waste	Low Grade Limonite	Shale	Banded Iron Formation	Detrital Waste	High Phos High grade	Dolerite
		Stratigraphy →	Detrital	Detrital	Detrital	Marra Mamba	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Detrital	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Detrital	Marra Mamba	#N/A	Detrital	Detrital	Detrital	Wittenoom Formation
		RGS Sample Number →	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
		Pit→	ITU361	ITU378	ITU558	ITU783	ITV160	ITV171	ITV178	ITV182	ITV767	ITV838	ITV914	ITV916	ITV995	ITW108	ITW348	ITW429	ITW556	ITW668	ITW975	ITY333
	Detection Limit	Average Crustal Abundance[1]	RC19BS3X0127	RC19BS3X0127	RC19BS3X0130	RC19BS3X0133	RC19BS10233	RC19BS10233	RC19BS10233	RC19BS10233	RC19BS10242	RC19BS10243	RC19BS10244	RC19BS10244	RC19BS10245	RC19BS3X0109	RC19BS3X0112	RC19BS3X0114	RC19BS3X0116	RC19BS3X0118	RC19BS3X0123	RC19BS3X0067
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	0	3	3	0	3	3	3	2	1	1	0	3	3	3	3	3	3	3	1
Potassium (K)	0.01	1.4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Arsenic (As)	0.2	6	2	2	0	3	4	5	0	2	2	0	0	5	5	1	1	2	0	0	0	5
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	2	0	0	2	1	0	2	2	0	0	4	0	0	2	0	0	0	0	2
Boron (B)	10	100	0	3	0	0	4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Copper (Cu)	0.2	30	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Mercury (Hg)	0.005	0.06	0	6	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	1	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
Selenium (Se)	1	0.4	1	4	0	0	2	1	0	2	1	0	0	2	3	2	1	1	0	0	0	1
Silver (Ag)	0.01	0.057	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	2	5	0	2	4	4	0	3	3	0	2	5	3	3	3	3	2	2	2	3
Thallium (Tl)	0.02	0.2	0	1	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	0	1	0	0	1	1	0	0	2	0	2	1	0	0	1	0	1
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Banded Iron Formation	Hydrated Waste	Shale	Banded Iron Formation	Manganiferous Shale	Detrital Waste	Shale	Shale	Cherty Shale	Limonitic Waste	Shale	Detrital Waste	Detrital Waste	Low Grade Pisolite	Detrital Waste	Banded Iron Formation	Banded Iron Formation	Shale	Low Grade Aluminous	Banded Iron Formation
		Stratigraphy →	Marra Mamba	Detrital	Joffre Member	Dolerite	Dales Gorge Member	Detrital	Whaleback Shale	Dales Gorge Member	Wittenoom Formation	Detrital	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Wittenoom Formation	Detrital	Detrital	Detrital	Detrital	Dales Gorge Member
		RGS Sample Number →	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
		Pit→	ITY858	ITY943	IUI061	IUI522	IUI533	IUJ616	IUK907	IUK935	IUL147	IUL857	IUO164	IUO168	IUO309	IUO422	IUO469	IUO484	IUO694	IUO927	IUO947	IUP204
	Detection Limit	Average Crustal Abundance[1]	RC19BS3X0082	RC19BS3X0085	RC19BS10476	RC19BS10487	RC19BS10487	RC19BS3X0254	RC19BS10254	RC19BS10254	RC19BSNA0417	RC19BS3X0057	RC19BS20022	RC19BS20022	RC19BS20026	RC19BS20029	RC19BS20030	RC19BS20031	RC19BS20036	RC19BS20042	RC19BS20043	RC19BS10211
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0	3	0	0	0	0
Iron (Fe)	0.01	4	2	3	3	3	3	3	3	3	2	2	1	2	0	2	1	0	2	3	3	3
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	1	3	0	4	0	1	4	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	2	0	3	1	2	3	0	2	2	1	2	0	0	0	0	0	0	0	1	1
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	1	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	1	0	0	0	0	0	0	3	1	0	0	0	4	0	0	0	0	0
Copper (Cu)	0.2	30	0	0	1	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	1	1
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	3	5	0	2	0	0	1	0	0	0	0
Mercury (Hg)	0.005	0.06	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0
Selenium (Se)	1	0.4	1	0	1	0	2	2	1	1	2	0	1	0	0	0	0	0	1	1	1	0
Silver (Ag)	0.01	0.057	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	2	2	3	2	4	3	3	4	3	2	1	2	0	2	1	0	2	3	3	3
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Shale	Low Grade Aluminous	Banded Iron Formation	Shale	Hydrated Waste	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Red Ochre High grade	Manganiferous Shale	Detrital Waste	Detrital Waste	Detrital Waste	Detrital Waste	Low Grade Detrital	Hydrated	Shale	High Grade
		Stratigraphy →	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	#N/A	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Whaleback Shale	#N/A	Joffre Member	Joffre Member	Joffre Member	Detrital	Wittenoom Formation	Detrital	Detrital
		RGS Sample Number →	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
		Pit→	IUP212	IUP217	IUP669	IUP864	IUV157	IUV445	IVA003	IVA087	IVA196	IVA220	IVA275	IVA504	IVA737	IVB053	IVB275	IVB278	IVB424	IVB481	IVB619	IVB621
	Detection Limit	Average Crustal Abundance[1]	RC19BS10211	RC19BS10211	RC19BS10224	RC19BS10227	RC19BS10085	RC19BS10091	RC19BS10245	RC19BS10246	RC19BS10248	RC19BS10249	RC19BS10250	RC19BS10509	RC19BS10439	RC19BS10381	RC19BS10385	RC19BS10385	RC19BSNA0437	RC19BSNA0437	RC19BS20079	RC19BS20079
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	2	3	2	2	2	3	3	2	3	2	3	0	0	3	3	3	2	2	3
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	1	0	2	2	0	1	2	1	0	0	0	3	0	0	2	0	2	3	4	3
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cerium (Ce)	0.01	50	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Selenium (Se)	1	0.4	0	0	0	0	0	1	0	3	0	4	0	1	0	0	1	0	1	0	2	1
Silver (Ag)	0.01	0.057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	3	3	3	3	3	3	3	3	2	3	2	3	1	0	3	2	3	3	4	3
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Detrital Waste	Banded Iron Formation	Banded Iron Formation	Hydrated	Banded Iron Formation	Low Grade Detrital	Detrital Waste	Banded Iron Formation	Shale	Banded Iron Formation	Low Grade Aluminous	Shale	Shale	Banded Iron Formation	Shale	Shale	Silcrete	Banded Iron Formation	Shale	Shale
			Stratigraphy →	Detrital	Detrital	Detrital	Dales Gorge Member	Mount McRae Shale	Marra Mamba	Detrital	Joffre Member	Joffre Member	Dales Gorge Member	Mount McRae Shale	Detrital	Detrital	Dales Gorge Member	Mount Sylvia	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member
			RGS Sample Number →	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
			Pit→	IVB839	IVB842	IVB921	IVC092	IVC161	IVD337	IVK485	IVL209	IVL225	IVM058	IVM080	IVM112	IVM713	IVN356	IVN449	IVN838	IVN871	IVN891	IWQ038	IWQ128
	Detection Limit	Average Crustal Abundance[1]		RC19BS20083	RC19BS20083	RC19BS20084	RC19BS10454	RC19BS10454	RC19BS3X0182	RC19BS20281	RC19BS10521	RC19BS10521	RC19BS20187	RC19BS20187	RC19BS20188	RC19BS20197	RC19BS20302	RC19BS10570	RC19BS20303	RC19BS20303	RC19BS20303	RC19BS40099	RC19BS40104
Major Elements	%			Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4		3	3	2	3	3	1	2	0	3	2	2	3	0	0	3	2	1	3	3	3
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6		3	4	2	3	3	2	3	0	3	0	1	2	1	3	4	1	2	0	0	0
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		0	2	0	1	0	2	2	0	1	0	1	0	2	2	0	0	1	0	0	0
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Caesium (Cs)	0.05	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Cerium (Ce)	0.01	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70		0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0	1	0	0	0
Cobalt (Co)	0.1	8		0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	2	0	0	0
Copper (Cu)	0.2	30		0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0
Fluorine (F)	20	200		0	0	0	0	0	1	2	0	0	0	0	0	2	2	0	0	2	0	0	0
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	5	0	0	0
Mercury (Hg)	0.005	0.06		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Molybdenum (Mo)	0.05	2		0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Nickel (Ni)	0.2	50		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	0	0	0	0	1	1	0	0	0	1	0	1	1	0	0	1	0	0	0
Selenium (Se)	1	0.4		2	3	2	2	2	0	1	0	1	0	2	0	2	3	1	1	1	1	0	1
Silver (Ag)	0.01	0.057		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		3	4	2	3	3	4	3	0	4	2	3	3	4	5	4	2	2	3	3	3
Thallium (Tl)	0.02	0.2		0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	2	0	0	0
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Uranium (U)	0.1	2		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90		0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		0	0	0	0	0	0	1	0	2	0	0	1	0	0	0	0	1	0	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Low Grade Aluminous	Low Grade Aluminous	Low Grade Aluminous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Shale	Detrital Waste	Banded Iron Formation	Shale	Banded Iron Formation	Low Grade Detrital	Detrital Waste	Hydrated	Shale	Detrital Waste	Dolomite	Banded Iron Formation	Manganiferous Shale	Banded Iron Formation
			Stratigraphy →	Dales Gorge Member	Dales Gorge Member	Detrital	Marra Mamba	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Detrital	Dales Gorge Member	Whaleback Shale	Mount McRae Shale	Detrital	Detrital	Whaleback Shale
			RGS Sample Number →	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
			Pit→	IWQ166	IWQ167	IWR529	IWR632	IWS032	IWS038	IWS568	IWS573	IWS575	IWT018	IWT029	IWT048	IWT424	IWT902	IXA209	IXA258	IXW451	IYB792	IYC986	IYD139
	Detection Limit	Average Crustal Abundance[1]		RC19BS40106	RC19BS40106	RC19BS3X0413	RC19BS3X0415	RC19BS20502	RC19BS20503	RC19BS40201	RC19BS40201	RC19BS40201	RC19BS20569	RC19BS20569	RC19BS20570	RC19BS20582	RC19BS20705	RC19BS10653	RC19BS10654	RC19BS40284	RC19BSNA0522	RC19BS20148	RC19BS10422
Major Elements	%		Geochemical Abundance Index																					
Sulfur (S)	0.01	0.07		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4		3	3	3	3	3	3	3	3	2	3	3	3	2	2	3	0	2	3	3	3	3
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																							
Antimony (Sb)	0.05	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Arsenic (As)	0.2	6		0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	5	5	3	2	1	
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
Bismuth (Bi)	0.01	0.2		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2	1	1	0	
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
Caesium (Cs)	0.05	4		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
Cerium (Ce)	0.01	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Chromium (Cr)	1	70		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	
Cobalt (Co)	0.1	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	
Copper (Cu)	0.2	30		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Fluorine (F)	20	200		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1	1	0	0	
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Germanium (Ge)	0.05	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lanthanum (La)	0.5	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Manganese (Mn)	5	1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	
Mercury (Hg)	0.005	0.06		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	1	2	0	
Molybdenum (Mo)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0	
Nickel (Ni)	0.2	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
Rhenium (Re)	0.002	0.0007		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Scandium (Sc)	0.1	7		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	
Selenium (Se)	1	0.4		1	1	0	0	0	0	1	2	1	0	0	0	0	2	0	1	2	2	2	0	
Silver (Ag)	0.01	0.057		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tellurium (Te)	0.05	0.02*		3	3	0	0	0	0	0	1	0	0	0	0	3	2	0	4	5	3	3	0	
Thallium (Tl)	0.02	0.2		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tungsten (W)	0.1	1.5		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	
Uranium (U)	0.1	2		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	2	0	
Vanadium (V)	1	90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Zinc (Zn)	2	90		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	0	
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Shale	Shale	Dolomite	Shale	Shale	Shale	Shale	Shale	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Detrital Waste	Calcrete
			Stratigraphy →	Mount Sylvia	Detrital	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Whaleback Shale	Whaleback Shale	Whaleback Shale	Whaleback Shale	Whaleback Shale	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale
			RGS Sample Number →	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
			Pit→	IYD745	IYE845	IYF074	IYF285	IYF389	IYF442	IYF784	IYF868	IYF998	IYN249	IYN252	IYN256	IYN259	IYN260	IYR078	IYU108	IYU160	IYU295	IYU298	IYU383
	Detection Limit	Average Crustal Abundance[1]		RC19BS10434	RC19BS20139	RC19BS3X0246	RC19BS3X0356	RC19BS3X0358	RC19BS3X0360	RC19BS3X0370	RC19BS3X0372	RC19BS3X0375	RC19BS40258	RC19BS40258	RC19BS40258	RC19BS40258	RC19BS40258	RC19BS10600	RC19BS20329	RC19BS20331	RC19BS20336	RC19BS20336	RC19BS20340
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4		3	3	3	0	3	3	3	3	2	2	1	2	2	2	2	1	3	1	2	2
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6		3	3	4	3	2	3	2	2	0	0	3	0	0	0	2	2	3	2	2	2
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		0	1	1	1	1	0	0	0	0	0	0	0	0	0	2	2	1	2	0	0
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50		0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Cobalt (Co)	0.1	8		0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30		0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Fluorine (F)	20	200		0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	1	1	2	0	0
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	0	0	0	0	0	0	0	0	0	4	0	0	1	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06		0	0	0	2	2	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2		0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50		0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0
Selenium (Se)	1	0.4		2	4	1	0	1	2	3	3	0	0	0	0	0	0	0	1	1	0	0	0
Silver (Ag)	0.01	0.057		0	1	0	2	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		3	3	3	3	3	2	3	3	0	0	1	0	0	0	3	4	3	2	1	0
Thallium (Tl)	0.02	0.2		0	0	0	1	2	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2		0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Vanadium (V)	1	90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
	Lithology →		Calcrete	Low Grade Detrital	Low Grade Aluminous	Low Grade Detrital	Detrital Waste	Hydrated Waste	Low Grade Detrital	Low Grade Detrital	Detrital Waste	Detrital Waste	Detrital Waste	Detrital Waste	Shale	Shale	Dolomite	Detrital Waste	Banded Iron Formation	Clay	Hydrated Waste	Carbonaceous Shale
	Stratigraphy →		Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Marra Mamba	Detrital	Detrital	Detrital	Detrital	Joffre Member	Detrital	Detrital	Mount McRae Shale	Detrital	Detrital	Detrital	Detrital	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation
	RGS Sample Number →		281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
	Pit→		IYU618	IYU629	IYU671	IYV032	IYV175	IYV633	IYV641	IYV899	IYW225	IYW351	IYY280	IYY952	IYZ255	IYZ298	IYZ407	IYZ567	IYZ574	IYZ677	IYZ822	IYZ887
	Detection Limit	Average Crustal Abundance[1]	RC19BS20347	RC19BS20347	RC19BS20349	RC19BS3X0335	RC19BS3X0339	RC19BS3X0348	RC19BS3X0348	RC19BS3X0388	RC19BS10682	RC19BS10687	RC19BS20469	RC19BS20485	RC19BS20436	RC19BS20437	RC19BS20439	RC19BS20443	RC19BS20443	RC19BS20445	RC19BS20448	RC19BS20449
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	2	2	3	3	3	3	3	3	2	0	3	3	0	3	3	1	3	1	0
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	4	5	4	2	2	0	1	3	2	2	0	1	2	4	3	0	4	4	5	3
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	1	1	2	0	1	0	0	0	2	0	0	0	0	1	0	0	0	2	0	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	2	2
Cobalt (Co)	0.1	8	0	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
Copper (Cu)	0.2	30	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Fluorine (F)	20	200	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	1	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Mercury (Hg)	0.005	0.06	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Nickel (Ni)	0.2	50	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	1	1	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	2	2
Selenium (Se)	1	0.4	3	1	1	0	0	0	1	1	0	0	1	2	2	0	0	0	0	2	2	1
Silver (Ag)	0.01	0.057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	4	3	4	3	4	0	2	3	2	2	3	1	2	3	3	1	2	4	2	0
Thallium (Tl)	0.02	0.2	1	0	0	3	5	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
Uranium (U)	0.1	2	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	0	1	2
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Carbonaceous Shale	High Grade	Detrital Waste	Detrital Waste	Low grade siliceous	Low grade siliceous	Low grade siliceous	Low grade siliceous	Low grade siliceous	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Banded Iron Formation	Low grade siliceous	Banded Iron Formation	Shale
		Stratigraphy →	Wittenoom Formation	Detrital	Marra Mamba	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member
		RGS Sample Number →	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
		Pit→	IYZ931	IZA020	IZA182	IZA952	IZA972	IZB305	IZB311	IZB745	IZB766	IZC724	IZR189	IZR191	IZR193	IZR194	IZR195	IZR200	IZR202	IZR203	IZR208	IZR212
	Detection Limit	Average Crustal Abundance[1]	RC19BS20450	RC19BS3X0259	RC19BS3X0261	RC19BS3X0281	RC19BS3X0281	RC19BS20152	RC19BS20152	RC19BS20161	RC19BS20162	RC19BS3X0234	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382	RC19BS40382
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	1	3	2	3	3	3	3	3	2	0	3	2	3	0	3	2	3	3	3
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	1	2	3	4	3	0	0	0	3	0	5	1	4	3	1	6	3	2	3	3
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	1	1	0	0	0	0	0	0	0	2	0	2	0	0	1	0	0	0	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Copper (Cu)	0.2	30	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0
Fluorine (F)	20	200	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0
Selenium (Se)	1	0.4	1	0	2	1	1	0	0	0	1	0	1	1	3	3	0	2	1	2	3	3
Silver (Ag)	0.01	0.057	0	1	1	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	2	3	4	2	3	0	0	0	3	0	4	2	4	3	1	3	2	3	3	3
Thallium (Tl)	0.02	0.2	0	1	0	0	1	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Hydrated	High Phos High grade	Shale	Detrital Waste	Detrital Waste	Low Grade Limonite	High Phos High grade	High Grade Detritals	Low Grade Detrital	Low Grade Detrital	Shale	Low Grade Detrital	Detrital Waste	Low Grade Detrital	Low Grade Detrital	Banded Iron Formation	Banded Iron Formation	Shale	Banded Iron Formation	Banded Iron Formation
		Stratigraphy →	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Mount McRae Shale	Joffre Member	Joffre Member	Mount McRae Shale	#N/A	Detrital	Detrital	Detrital	Whaleback Shale	Detrital	Detrital	Detrital	Mount McRae Shale	Detrital	Detrital
		RGS Sample Number →	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
		Pit→	IZR213	IZR214	IZV196	IZV226	IZV353	IZV668	KAC147	KAC172	KAC711	KAC812	KAD179	KAD240	KAG037	KAG209	KAH259	KAI049	KAI758	KAJ336	KAJ625	KAK169
	Detection Limit	Average Crustal Abundance[1]	RC19BS40382	RC19BS40382	RC19BS10661	RC19BS10661	RC19BS10664	RC19BS10670	RC19BS10541	RC19BS10541	RC19BS20310	RC19BS20315	RC19BS20412	RC19BS20414	RC19BS20306	RC19BS40004	RC19BS20367	RC19BS20170	RC19BS20181	RC19BS20529	RC19BS20539	RC19BS20256
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	3	3	3	3	3	3	3	3	3	2	3	3	3	3	2	0	3	3	2	1
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	0	1	0	2	0	2	1	0	0	1	3	2	0	0	3	2	0	1	1	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	0	0	0	0	0	0	1	0	2	2	3	0	0	1	2	0	0	0	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Copper (Cu)	0.2	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	1	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	0	1	0	1	1	0	0	1	0	1	0	0	0	0	1	1	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Manganese (Mn)	5	1000	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	2	0	0	0
Mercury (Hg)	0.005	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Selenium (Se)	1	0.4	0	1	1	1	0	1	0	2	0	1	0	0	0	0	3	1	0	2	0	2
Silver (Ag)	0.01	0.057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	0	1	1	2	0	0	0	3	0	2	3	3	0	0	3	3	0	1	1	0
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	1	0	2	0	0	0	0	0	1	2	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	1	2	0	0	1	0	2	1	0	0	0	1	1	0	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters			Lithology →	Banded Iron Formation	Shale	Cherty Shale	Shale	Shale	Detrital Waste	Detrital Waste	Low Grade Detrital	Shale	Shale	High Phos High grade	High Phos High grade	High Phos High grade	Low Grade Detrital	Shale	Shale	Detrital Waste	Shale	Detrital Waste	Low Grade Aluminous
			Stratigraphy →	Detrital	Detrital	Marra Mamba	Marra Mamba	Wittenoom Formation	Marra Mamba	Joffre Member	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member
			RGS Sample Number →	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
			Pit→	KAK399	KAK464	KAL098	KAL383	KAL432	KAL552	KAM124	KAM176	KAN042	KAN056	KAN060	KAN075	KAO351	KAO369	KAO607	KAP645	KAP647	KAS712	KAS713	KAS731
	Detection Limit	Average Crustal Abundance[1]		RC19BS20259	RC19BS20260	RC19BS3X0378	RC19BS3X0384	RC19BS30016	RC19BS30019	RC19BS30107	RC19BS30107	RC19BS40138	RC19BS40139	RC19BS40139	RC19BS40140	RC19BS20644	RC19BS20645	RC19BS20754	RC19BS3X0299	RC19BS3X0299	RC19BS40049	RC19BS40049	RC19BS40049
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5		0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4		3	3	2	3	3	3	3	3	2	2	3	3	3	3	3	3	3	2	3	2
Potassium (K)	0.01	1.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5		0	0	0	0	1	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6		2	1	1	1	2	3	3	3	1	2	3	3	0	0	0	0	2	6	2	3
Barium (Ba)	10	500		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2		0	0	2	0	1	0	0	0	1	0	1	1	0	0	0	0	0	3	1	2
Boron (B)	10	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Chromium (Cr)	1	70		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8		1	2	0	0	0	2	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Fluorine (F)	20	200		0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	1
Gallium (Ga)	0.05	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1		1	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	2	0	0	1
Hafnium (Hf)	0.1	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lithium (Li)	0.2	25		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000		0	1	0	0	0	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06		0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Nickel (Ni)	0.2	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Rhenium (Re)	0.002	0.0007		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Selenium (Se)	1	0.4		0	0	0	2	1	1	1	1	0	0	1	1	0	0	0	0	0	2	1	1
Silver (Ag)	0.01	0.057		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*		1	1	3	2	2	2	2	3	2	2	4	3	0	0	1	1	2	4	3	5
Thallium (Tl)	0.02	0.2		1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Vanadium (V)	1	90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90		1	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zirconium (Zr)	0.5	400		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																						
		Lithology →	Shale	Shale	High Grade	Dolerite	Dolerite	Dolerite	Dolerite	Detrital Waste	Shale	Shale	Detrital Waste	Low Grade Detrital	Banded Iron Formation	Banded Iron Formation	Low Grade Aluminous	Shale	High Grade	Shale	Low Grade Aluminous	Shale
		Stratigraphy →	Detrital	Dales Gorge Member	Dales Gorge Member	Detrital	Wittenoom Formation	Detrital	Mount McRae Shale	Mount McRae Shale	Whaleback Shale	Dales Gorge Member	Dolerite	Dolerite	Dolerite	Dolerite	Detrital	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Dales Gorge Member
		RGS Sample Number →	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
		Pit→	KAW128	KAW711	KAW714	KBA863	KBG514	KBG666	KBH061	KBH109	KBJ443	KBJ611	KBL717	KBL765	KBL768	KBL774	KBL818	KBO224	KBO255	KBO349	KBO817	KBR002
	Detection Limit	Average Crustal Abundance[1]	RC19BS40215	RC19BS40226	RC19BS40226	RC19BS20358	RC19BS20453	RC19BS20457	RC19BS40021	RC19BS40022	RC19BS10616	RC19BS10618	RC19BS20560	RC19BS20562	RC19BS20562	RC19BS20562	RC19BS20564	RC19BS20605	RC19BS20606	RC19BS20609	RC19BS20620	RC19BS10627
Major Elements	%		Geochemical Abundance Index																			
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	0.01	1.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	0.01	4	2	1	3	3	3	3	3	3	3	3	3	3	3	2	3	2	2	3	3	2
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	0.01	0.5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Titanium (Ti)	0.005	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Elements	mg/kg																					
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.2	6	1	0	2	1	2	0	0	3	2	0	0	1	0	0	0	0	0	0	0	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bismuth (Bi)	0.01	0.2	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerium (Ce)	0.01	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	1	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.2	30	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorine (F)	20	200	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germanium (Ge)	0.05	1	0	0	1	0	0	0	0	0	1	0	2	1	0	0	1	0	0	1	0	0
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithium (Li)	0.2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	5	1000	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.005	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.2	50	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niobium (Nb)	0.1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (P)	10	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scandium (Sc)	0.1	7	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	1	0.4	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Silver (Ag)	0.01	0.057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellurium (Te)	0.05	0.02*	2	0	2	0	4	0	0	3	1	0	1	1	0	0	0	0	0	0	0	0
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thorium (Th)	0.01	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tungsten (W)	0.1	1.5	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium (V)	1	90	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B3: Geochemical Abundance Index (GAI) Results for Rio Tinto Brockman Selected Waste Rock Samples

Parameters																							
		Lithology →	Low Grade Detrital	Cherty Shale	Shale	Shale	Detrital Waste	Low Grade Detrital	Low Grade Detrital	Banded Iron Formation	Chert	Hydrated											
		Stratigraphy →	Dales Gorge Member	Whaleback Shale	Mount Sylvia	Dales Gorge Member	Mount McRae Shale	Mount McRae Shale	Mount Sylvia	Detrital	Mount Sylvia	Mount Sylvia											
		RGS Sample Number →	381	382	383	384	385	386	387	388	389	390											
		Pit→	KBR003	KCH462	KCH854	KCI118	KCI669	KCI918	KCJ122	KCJ187	KCJ214	KCJ271											
	Detection Limit	Average Crustal Abundance[1]	RC19BS10627	RC19BS10585	RC19BS10594	RC19BS40186	RC19BS20651	RC19BS20656	RC19BS40054	RC19BS40058	RC19BS40060	RC19BS40063											
Major Elements	%		Geochemical Abundance Index																				
Sulfur (S)	0.01	0.07	0	0	0	0	0	0	0	0	0	0											
Aluminium (Al)	0.01	7.1	0	0	0	0	0	0	0	0	0	0											
Calcium (Ca)	0.01	1.5	0	0	0	0	0	0	0	0	1	0											
Iron (Fe)	0.01	4	2	3	2	3	2	2	3	1	3	2											
Potassium (K)	0.01	1.4	0	0	0	0	0	0	0	0	0	0											
Magnesium (Mg)	0.01	0.5	0	0	0	0	0	0	0	0	0	0											
Sodium (Na)	0.01	0.5	0	0	0	0	0	0	0	0	0	0											
Titanium (Ti)	0.005	0.5	0	0	0	0	0	1	0	0	0	0											
Minor Elements	mg/kg																						
Antimony (Sb)	0.05	5	0	0	0	0	0	0	0	0	0	0											
Arsenic (As)	0.2	6	0	0	0	2	2	0	1	1	3	0											
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0											
Beryllium (Be)	0.05	6	0	0	0	0	0	0	0	0	0	0											
Bismuth (Bi)	0.01	0.2	0	0	0	1	0	0	0	0	0	0											
Boron (B)	10	100	0	0	0	0	0	0	0	0	0	0											
Cadmium (Cd)	0.02	0.35	0	0	0	0	0	0	0	0	0	0											
Caesium (Cs)	0.05	4	0	0	0	0	0	0	0	0	0	0											
Cerium (Ce)	0.01	50	0	0	0	0	0	1	0	0	0	0											
Chromium (Cr)	1	70	0	0	0	0	0	0	0	0	0	0											
Cobalt (Co)	0.1	8	0	0	0	0	0	0	0	0	1	0											
Copper (Cu)	0.2	30	0	0	0	0	0	0	0	0	0	0											
Fluorine (F)	20	200	0	0	0	0	0	0	0	0	0	0											
Gallium (Ga)	0.05	20	0	0	0	0	0	0	0	0	0	0											
Germanium (Ge)	0.05	1	0	0	0	0	0	1	0	0	1	0											
Hafnium (Hf)	0.1	6	0	0	0	0	0	0	0	0	0	0											
Indium (In)	0.005	1	0	0	0	0	0	0	0	0	0	0											
Lanthanum (La)	0.5	40	0	0	0	0	0	0	0	0	0	0											
Lead (Pb)	0.5	35	0	0	0	0	0	0	0	0	0	0											
Lithium (Li)	0.2	25	0	0	0	0	0	2	0	0	0	0											
Manganese (Mn)	5	1000	0	0	0	0	0	0	0	0	0	0											
Mercury (Hg)	0.005	0.06	0	0	0	0	0	0	0	0	0	0											
Molybdenum (Mo)	0.05	2	0	0	0	1	0	0	0	0	0	0											
Nickel (Ni)	0.2	50	0	0	0	0	0	0	0	0	0	0											
Niobium (Nb)	0.1	10	0	0	0	0	0	1	0	0	0	0											
Phosphorus (P)	10	800	0	0	0	0	0	0	0	0	0	0											
Rhenium (Re)	0.002	0.0007	0	0	0	0	0	0	0	0	0	0											
Rubidium (Rb)	0.1	150	0	0	0	0	0	0	0	0	0	0											
Scandium (Sc)	0.1	7	0	0	0	0	0	0	0	0	0	0											
Selenium (Se)	1	0.4	0	1	0	0	0	1	0	1	0	0											
Silver (Ag)	0.01	0.057	0	0	0	0	0	0	0	0	0	0											
Strontium (Sr)	0.2	250	0	0	0	0	0	0	0	0	0	0											
Tantalum (Ta)	0.05	2	0	0	0	0	0	0	0	0	0	0											
Tellurium (Te)	0.05	0.02*	0	0	0	4	1	0	1	1	2	0											
Thallium (Tl)	0.02	0.2	0	0	0	0	0	0	0	0	0	0											
Thorium (Th)	0.01	9	0	0	0	1	0	0	0	0	0	0											
Tin (Sn)	0.2	4	0	0	0	0	0	0	0	0	0	0											
Tungsten (W)	0.1	1.5	0	1	0	1	1	2	0	0	0	1											
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0											
Vanadium (V)	1	90	0	0	0	0	0	0	0	0	0	0											
Yttrium (Y)	0.1	40	0	0	0	0	0	0	0	0	0	0											
Zinc (Zn)	2	90	0	0	0	0	0	0	0	0	0	0											
Zirconium (Zr)	0.5	400	0	0	0	0	0	0	0	0	0	0											

Notes:

GAI's greater than or equal to 3 are highlighted. *Tellurium naturally elevated in Pilbara region (GSWA Geochemistry (DMIRS-047) WACHEM database)

1. Average Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009).
2. Se = all samples below LOR = entered zero (ICP-AES detection limits)
3. Concentrations less than LoR have been halfed
4. When no GARD Guide value is available for particular element, then values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, Academic Press, New York, p60-61.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Low Grade Detrital	Shale	Manganiferous Shale	Shale	Banded Iron Formation	Banded Iron Formation	Hydrated Waste	Shale	Banded Iron Formation	Shale	Detrital Waste	Detrital Waste	Dolerite	Shale	Dolomite	Lignite	Lignite	Silcrete	Calcrete	Red Ochre Waste
	Stratigraphy →			Detrital	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Marra Mamba	Wittenoom Formation	Detrital	Detrital	Dolerite	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital	Detrital	Detrital
	RGS Sample Number →			EB2012964001	EB2012964002	EB2012964003	EB2012964004	EB2012964005	EB2012964009	EB2012964010	EB2012964011	EB2012964012	EB2012964019	EB2012964020	EB2012964029	EB2012964030	EB2012964035	EB2012964036	EB2012964037	EB2012964038	EB2012964039	EB2012964044	EB2012964046
	ALS Laboratory ID →			EB2018655001	EB2018655002	EB2018655003	EB2018655004	EB2018655005	EB2018655006	EB2018655007	EB2018655008	EB2018655009	EB2018655010	EB2018655011	EB2018655013	EB2018655014	EB2018655016	EB2018655017	EB2018655018	EB2018655019	EB2018655020	EB2018655021	EB2018655022
	Client Sample ID →			IKN091	IKN707	IKO454	IKO712	IKO939	ILA658	ILA964	ILA976	ILB540	IPP003	IPP032	IPY819	IPY877	IQS087	IQS139	IQS283	IQS289	IQS300	IQS454	IQS554
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	7.44	4.93	7.06	8.09	8.23	7.66	6.52	5.28	6.83	7.87	8	8.03	6.66	6.59	8.2	6.05	6.54	5.65	7.66	6.52
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	386	859	450	607	351	203	182	512	275	500	369	291	539	840	259	982	1490	1700	367	481
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	65	2	138	137	123	45	47	20	31	70	66	86	34	50	100	94	33	21	88	67
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	65	2	138	137	123	45	47	20	31	70	66	86	34	50	100	94	33	21	88	67
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	2	13	4	<1	<1	<1	3	22	2	2	2	2	----	15	<1	18	43	50	4	5
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	22	22	38	42	12	13	8	20	8	44	17	16	21	48	16	57	172	174	22	33
Magnesium (Mg)	1	-	-	15	25	20	31	24	8	8	20	8	9	4	8	20	53	22	67	94	122	24	31
Potassium (K)	1	-	-	6	12	12	8	9	3	4	7	6	3	5	6	6	7	2	8	6	7	4	7
Sodium (Na)	1	-	-	33	90	22	28	20	11	16	40	29	30	46	30	44	44	6	49	13	18	15	11
Chloride (Cl)	1	0.003	-	42	222	16	40	24	17	43	93	37	85	54	17	104	34	9	68	11	13	29	10
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	44	74	15	34	15	13	10	64	23	37	20	19	41	273	16	190	712	822	68	108
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	0.06	0.45	0.1	0.42	0.04	0.26	0.2	0.38	0.16	0.18	0.07	0.11	0.2	1.39	0.12	1.54	0.99	1.46	0.19	0.52
Nitrite as N	0.01	-	-	0.09	<0.01	0.02	0.02	0.01	<0.01	<0.01	<0.01	0.02	0.1	0.03	0.07	0.03	<0.01	0.02	<0.01	<0.01	<0.01	0.06	<0.01
Nitrate as N	0.01	0.7	-	0.23	0.12	0.34	0.34	0.41	0.04	0.38	0.1	0.25	0.8	0.33	0.64	0.01	0.37	0.02	1.15	0.3	0.27	0.03	0.62
Nitrite + Nitrate as N	0.01	-	400	0.32	0.12	0.36	0.36	0.42	0.04	0.38	0.1	0.27	0.9	0.36	0.71	0.04	0.37	0.04	1.15	0.3	0.27	0.09	0.62
Total Kjeldahl Nitrogen as N	0.1	-	-	0.3	0.5	0.2	0.6	0.2	0.3	0.4	0.6	0.3	0.4	0.2	0.3	0.4	2.1	0.5	3.1	1.2	1.8	0.4	0.7
Total Nitrogen as N	0.1	-	-	0.6	0.6	0.6	1	0.6	0.3	0.8	0.7	0.6	1.3	0.6	1	0.4	2.5	0.5	4.2	1.5	2.1	0.5	1.3
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	<0.01	0.03	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	0.06	<0.01	<0.01	0.4	0.04	0.23	0.54	0.7	<0.01	<0.01
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	0.012	<0.001	0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	<0.001	0.14	0.003	0.003	0.002	0.002
Barium (Ba)	0.001	-	-	0.021	0.029	0.006	0.003	0.062	0.006	0.01	0.018	0.003	0.009	0.004	0.011	0.006	0.007	0.002	0.01	0.012	0.014	0.009	0.009
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.16	0.31	0.07	<0.05	<0.05	<0.05	0.08	0.1	0.06	0.14	0.05	0.14	0.09	0.68	<0.05	1.54	0.37	0.64	<0.05	0.19
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0012	0.0008	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.002	<0.001	0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.004	0.005	<0.001	0.012	0.004	0.071	0.025	0.018	<0.001	0.002
Cobalt (Co)	0.001	-	1	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	0.004	0.163	0.272	<0.001	0.002
Copper (Cu)	0.001	0.0014	1	<0.001	0.002	0.002	0.004	0.001	<0.001	<0.001	0.003	0.001	<0.001	<0.001	0.004	0.001	0.003	0.002	0.009	0.014	0.013	<0.001	0.002
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	<0.05	<0.05	0.32	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.21	0.08	0.08	2.86	3.87	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.001	0.002	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.004	0.005	0.019	0.006	0.004	0.006	0.004	0.005	0.009	0.023	0.014	<0.001	<0.001	0.004	0.004	0.002	0.012	0.014	<0.001	0.024
Manganese (Mn)	0.001	1.9	-	0.005	0.797	0.293	0.355	0.003	0.004	0.026	0.01	0.009	0.001	0.002	0.001	0.008	1.11	0.005	0.923	24.2	24.7	0.003	0.082
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	0.001	<0.001	<0.001	<0.001	0.006	0.001	<0.001	<0.001	<0.001	0.001	0.006	0.005	<0.001	0.018	0.002	0.014	<0.001	<0.001	0.004	<0.001
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	<0.001	0.003	0.002	0.003	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	0.009	<0.001	0.008	0.226	0.365	<0.001	0.005
Niobium (Nb)	0.001	-	-	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.019	0.013	0.04	0.013	0.023	0.006	0.01	0.013	0.033	0.008	0.007	0.016	0.013	0.024	0.006	0.042	0.045	0.055	0.01	0.038
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.1	0.02	0.02	<0.01	0.12
Silicon (Si)	0.05	-	-	36.4	13.2	11.5	6.18	16.4	10.3	15.8	17.8	10.8	6.08	6.44	23.9	6.79	10.5	4.52	17.4	6.6	7.38	11.5	21.6
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.12	0.087	0.053	0.046	0.052	0.047	0.037	0.099	0.025	0.128	0.036	0.065	0.068	0.124	0.028	0.147	0.231	0.306	0.062	0.072
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.003	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	<0.005	0.011	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.017	0.292	0.841	<0.005	<0.005
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Calcrete	Hydrated	Banded Iron Formation	Calcrete	Pisolite Waste	Dolomite	Dolomite	Dolomite	Detrital Waste	Shale	Banded Iron Formation	Dolerite	Shale	Calcrete	Low grade siliceous	Hydrated	Hydrated	Shale	Banded Iron Formation	Hydrated Waste
	Stratigraphy →			Detrital	Marra Mamba	Marra Mamba	Detrital	Detrital	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Mount McRae Shale	Dales Gorge Member	Dolerite	Mount Sylvia	Detrital	Mount McRae Shale	Whaleback Shale	Joffre Member	Mount McRae Shale	Dales Gorge Member	Joffre Member
	RGS Sample Number →			EB2012964047	EB2012964049	EB2012964050	EB2012964055	EB2012964058	EB2012964059	EB2012964060	EB2012964061	EB2012964062	EB2012964064	EB2012964065	EB2012964067	EB2012964068	EB2012965001	EB2012965003	EB2012965004	EB2012965005	EB2012965012	EB2012965016	EB2012965017
	ALS Laboratory ID →			EB2018655023	EB2018655024	EB2018655025	EB2018655026	EB2018655027	EB2018655028	EB2018655029	EB2018655030	EB2018655031	EB2018655032	EB2018655033	EB2018655034	EB2018655035	EB2018655036	EB2018655037	EB2018655038	EB2018655039	EB2018655041	EB2018655044	EB2018655045
	Client Sample ID →			IQS585	IRA551	IRA619	IRI671	IRI876	IRI877	IRI883	IRI885	IRJ297	IRK083	IRK629	IRL014	IRL163	IRM602	IRO039	IRQ039	IRQ201	IRR945	IRU451	IRU776
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	8.08	8.04	8.2	8.12	8.21	8.26	8.17	8.08	7.39	8.88	7.02	7.3	7.11	8.1	7.36	8.02	7.16	7.71	7.28	7.29
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	440	311	831	419	312	309	414	580	127	1280	707	364	1020	360	359	407	731	537	771	125
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	197	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	102	89	143	86	88	70	88	91	27	66	85	54	32	102	42	68	34	53	95	30
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	102	89	143	86	88	70	88	91	27	263	85	54	32	102	42	68	34	53	95	30
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	2	2	<1	<1	<1	<1	<1	2	2	<1	3	2	2	2	2	<1	2	<1	3	2
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	31	28	27	22	20	11	23	32	3	60	35	14	25	48	13	17	9	14	46	4
Magnesium (Mg)	1	-	-	18	11	23	16	12	22	17	22	3	46	37	11	31	4	12	10	16	18	38	5
Potassium (K)	1	-	-	6	4	52	6	5	3	6	7	7	17	6	6	24	6	6	6	7	12	8	4
Sodium (Na)	1	-	-	26	16	86	32	21	16	34	42	15	147	50	42	96	12	32	45	103	55	44	12
Chloride (Cl)	1	0.003	-	35	28	56	37	22	28	35	80	8	71	93	47	256	24	48	42	125	77	96	8
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	27	17	130	29	13	16	24	35	6	261	58	18	80	17	38	49	121	61	72	14
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	0.01	0.44	0.06	0.12	0.1	0.15	0.02	0.07	0.01	0.52	0.1	0.17	0.44	0.38	0.2	0.14	0.08	0.18	0.37	0.16
Nitrite as N	0.01	-	-	0.11	0.02	0.02	0.05	0.04	0.02	<0.01	0.03	<0.01	0.01	0.03	0.01	0.01	0.09	0.02	0.02	0.04	0.05	0.14	<0.01
Nitrate as N	0.01	0.7	-	0.05	0.25	0.16	0.02	0.11	0.04	0.02	0.6	0.04	11.7	0.2	0.74	0.41	0.02	0.04	0.01	0.12	<0.01	1.02	0.21
Nitrite + Nitrate as N	0.01	-	400	0.16	0.27	0.18	0.07	0.15	0.06	0.02	0.63	0.04	11.7	0.23	0.75	0.42	0.11	0.06	0.03	0.16	0.05	1.16	0.21
Total Kjeldahl Nitrogen as N	0.1	-	-	0.4	0.5	0.9	0.3	0.2	0.3	0.2	0.3	0.1	<0.5	0.3	0.4	0.7	0.8	0.4	0.3	0.3	0.3	0.8	0.4
Total Nitrogen as N	0.1	-	-	0.6	0.8	1.1	0.4	0.4	0.4	0.2	0.9	0.1	11.7	0.5	1.2	1.1	0.9	0.5	0.3	0.5	0.4	2	0.6
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	0.01	<0.01	0.02	<0.01	0.02	0.03	<0.01	<0.01	0.03	0.13	<0.01	0.02	<0.01	0.02	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	0.002	<0.001	<0.001	0.001	0.002	0.002	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Ba)	0.001	-	-	0.014	0.011	0.137	0.032	0.017	0.013	0.019	0.131	0.027	0.094	0.014	0.037	0.011	0.019	0.007	0.036	0.009	0.007	0.02	0.023
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.06	<0.05	0.06	0.08	0.08	<0.05	0.09	0.11	2.5	92.8	1.44	1.32	0.4	0.22	0.24	0.21	0.46	0.21	0.19	0.14
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	<0.001	<0.001	0.003	0.006	0.001	<0.001	0.002	0.001	0.002	<0.001	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)	0.001	-	1	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	0.001	0.0014	1	<0.001	<0.001	0.009	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.007	0.001	0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.001
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	0.07	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.031	0.009	0.003	0.004	0.013	0.003	0.002	<0.001	<0.001	0.006	0.003	0.006	<0.001	<0.001	0.007	0.004	0.002	0.009	0.006	<0.001
Manganese (Mn)	0.001	1.9	-	0.002	0.002	0.009	<0.001	<0.001	0.002	0.001	0.002	0.003	0.007	0.003	0.004	0.003	0.003	0.001	0.002	0.001	<0.001	0.006	0.005
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	0.003	<0.001	0.017	0.002	0.002	0.004	0.004	0.002	<0.001	0.003	<0.001	<0.001	0.002	<0.001	<0.001	0.004	<0.001	0.004	<0.001	<0.001
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Niobium (Nb)	0.001	-	-	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.012	0.011	0.19	0.019	0.013	0.008	0.018	0.02	0.013	0.018	0.016	0.012	0.013	0.006	0.016	0.009	0.007	0.016	0.024	0.004
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.16	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon (Si)	0.05	-	-	18.3	9.27	9.21	14	17.1	14.3	10	4.25	41.9	9.96	9.79	27	14.8	5.63	11.4	10.8	31	8.85	7.88	22.9
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.08	0.067	0.088	0.079	0.066	0.054	0.071	0.148	0.029	0.233	0.162	0.052	0.269	0.14	0.057	0.083	0.091	0.068	0.17	0.036
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.024	0.089	<0.005	0.026	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.024
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Hydrated	Limonitic Waste	Shale	Shale	Calcrete	Low Grade Red Ochre Detrital	Low grade siliceous	Calcrete	Banded Iron Formation	Hydrated	Detrital Waste	Banded Iron Formation	Hydrated	Shale	Hydrated	Shale	Calcrete	Carbonaceous Shale	Shale	Manganese
	Stratigraphy →			Marra Mamba	Detrital	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Joffre Member	Detrital	Wittenoom Formation	Dales Gorge Member	Detrital	Joffre Member	Joffre Member	Whaleback Shale	Joffre Member	Whaleback Shale	Detrital	Mount McRae Shale	Whaleback Shale	Whaleback Shale
	RGS Sample Number →			EB2012965021	EB2012965022	EB2012965024	EB2012965025	EB2012965027	EB2012965029	EB2012965032	EB2012965038	EB2012965039	EB2012965049	EB2012965050	EB2012965059	EB2012965060	EB2012965061	EB2012965064	EB2012965065	EB2012965067	EB2012967001	EB2012967002	EB2012967004
	ALS Laboratory ID →			EB2018655046	EB2018655047	EB2018655048	EB2018655049	EB2018655051	EB2018655053	EB2018655054	EB2018655056	EB2018655057	EB2018655058	EB2018655059	EB2018655060	EB2018669001	EB2018669002	EB2018669003	EB2018669004	EB2018669005	EB2018669006	EB2018669007	EB2018669008
	Client Sample ID →			ISD283	ISD467	ISD892	ISD896	ISD936	ISE033	ISI845	ISL158	ISL365	ITD748	ITD802	ITI461	ITI551	ITI571	ITI951	ITI971	ITJ709	ITL213	ITL714	ITL781
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	7.14	7.97	8.08	8.04	7.98	7.08	7.19	8.16	7.59	8.17	7.68	6.33	7.62	6.55	4.92	6.8	7.92	7.16	7.02	6.21
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	156	288	431	371	349	438	226	492	382	397	2610	261	800	537	112	200	354	1050	529	557
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	36	74	102	94	76	88	13	116	60	92	47	25	99	26	1	34	93	46	89	156
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	36	74	102	94	76	88	13	116	60	92	47	25	99	26	1	34	93	46	89	156
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	2	<1	2	<1	<1	3	2	<1	2	<1	2	3	5	6	14	6	3	4	5	17
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	10	20	32	34	22	34	5	33	19	26	628	9	6	18	1	7	23	32	22	37
Magnesium (Mg)	1	-	-	7	11	17	13	13	24	6	15	15	12	29	10	12	18	<1	7	13	45	30	21
Potassium (K)	1	-	-	3	5	5	6	5	6	3	7	4	4	8	5	22	8	7	4	6	16	7	6
Sodium (Na)	1	-	-	10	23	31	24	27	18	28	46	34	39	55	22	129	53	14	21	30	96	44	24
Chloride (Cl)	1	0.003	-	8	24	37	28	30	26	33	46	55	40	58	41	116	117	10	25	31	257	59	34
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	10	19	43	34	26	7	28	22	32	44	1490	23	108	41	17	17	15	101	35	20
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	0.16	0.14	<0.01	0.22	0.12	0.42	0.06	0.13	0.02	0.02	0.14	0.3	0.21	0.27	0.1	0.17	0.12	0.21	0.22	0.24
Nitrite as N	0.01	-	-	0.07	0.04	0.09	0.08	0.03	0.02	<0.01	0.06	0.02	0.05	0.06	<0.01	0.01	0.01	<0.01	0.03	0.03	0.02	0.01	<0.01
Nitrate as N	0.01	0.7	-	0.01	<0.01	<0.01	<0.01	0.02	1.27	0.09	0.66	0.54	0.3	3.26	0.12	1.65	0.1	0.08	0.05	0.48	0.05	0.17	1.27
Nitrite + Nitrate as N	0.01	-	400	0.08	0.03	0.07	0.07	0.05	1.29	0.09	0.72	0.56	0.35	3.32	0.12	1.66	0.11	0.08	0.08	0.51	0.07	0.18	1.27
Total Kjeldahl Nitrogen as N	0.1	-	-	0.4	0.4	0.4	0.4	0.2	0.6	0.1	0.4	0.2	0.2	0.8	<0.5	0.6	0.3	0.2	0.2	0.2	0.4	0.4	0.4
Total Nitrogen as N	0.1	-	-	0.5	0.4	0.5	0.5	0.2	1.9	0.2	1.1	0.8	0.6	4.1	<0.5	2.3	0.4	0.3	0.3	0.7	0.5	0.6	1.7
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.02	0.01
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001
Barium (Ba)	0.001	-	-	0.026	0.02	0.014	0.003	0.014	0.005	0.024	0.017	0.007	0.015	0.051	0.023	0.022	0.019	0.005	0.006	0.013	0.023	0.129	0.01
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.06	0.06	<0.05	<0.05	<0.05	<0.05	0.08	0.13	0.07	0.15	0.17	0.06	0.19	0.09	0.14	0.29	0.07	0.18	0.13	0.09
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001
Cobalt (Co)	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013
Copper (Cu)	0.001	0.0014	1	0.002	0.003	0.005	<0.001	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.002	0.001
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.003	0.006	0.003	0.006	0.003	0.014	0.001	<0.001	0.001	0.009	0.002	0.007	0.02	0.008	0.019	0.005	0.007	0.005	0.006	0.001
Manganese (Mn)	0.001	1.9	-	0.004	<0.001	0.002	0.014	<0.001	0.123	<0.001	0.014	0.051	<0.001	0.003	0.002	0.01	0.012	0.002	0.002	0.001	0.008	0.537	43
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	<0.001	0.007	0.003	0.006	0.013	<0.001	<0.001	0.002	<0.001	0.006	0.008	<0.001	0.01	<0.001	<0.001	<0.001	0.004	0.001	<0.001	<0.001
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Niobium (Nb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.002	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.008	0.014	0.013	0.019	0.014	0.008	0.003	0.018	<0.001	0.008	0.012	0.01	0.014	0.014	0.003	0.008	0.019	0.014	0.011	0.008
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon (Si)	0.05	-	-	11.7	15.5	8.63	8.2	20.8	8.33	8.82	36.1	19	15.4	25.8	16.8	14.5	19	33.8	19.1	13.3	9.5	23.9	12.7
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.03	0.07	0.062	0.06	0.069	0.138	0.036	0.163	0.028	0.091	4.03	0.061	0.048	0.07	0.009	0.029	0.042	0.141	0.186	0.063
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	0.012	0.005	0.011	<0.005	<0.005	<0.005	<0.005	<0.005	0.017	<0.005	<0.005	<0.005	<0.005	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	0.008
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Shale	Detrital Waste	Detrital Waste	Detrital Waste	Dolomite	High Grade	Banded Iron Formation	Banded Iron Formation	Low Grade Limonite	Low grade siliceous	Calcrete	Shale	Hydrated	Hydrated	Hydrated	Clay	Banded Iron Formation	Detrital Waste	High Phos High grade	Dolerite
	Stratigraphy →			Joffre Member	Detrital	Detrital	Detrital	Wittenoom Formation	Marra Mamba	Marra Mamba	Dales Gorge Member	Detrital	Marra Mamba	Detrital	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Detrital	Marra Mamba	Detrital	Joffre Member	Dolerite
	RGS Sample Number →			EB2012967005	EB2012967006	EB2012967007	EB2012967009	EB2012967010	EB2012967012	EB2012967013	EB2012967016	EB2012967023	EB2012967025	EB2012967030	EB2012967031	EB2012967033	EB2012967034	EB2012967035	EB2012967036	EB2012967043	EB2012967044	EB2012967045	EB2012967046
	ALS Laboratory ID →			EB2018669009	EB2018669010	EB2018669011	EB2018669012	EB2018669013	EB2018669014	EB2018669015	EB2018669016	EB2018669017	EB2018669018	EB2018669019	EB2018669020	EB2018669021	EB2018669022	EB2018669023	EB2018669024	EB2018669025	EB2018669026	EB2018669027	EB2018669028
	Client Sample ID →			ITL838	ITM231	ITM284	ITM458	ITM815	ITN542	ITN784	ITQ041	ITU378	ITU783	ITV767	ITV838	ITV914	ITV916	ITV995	ITW108	ITY858	ITY943	IUI061	IUI522
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	6.28	7.17	7.44	7.06	8.16	7.12	7.54	7.11	7.84	7.09	7.88	4.19	7.88	7.95	6.89	7.39	6.97	6.31	5.75	7.95
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	1090	345	310	328	410	173	259	672	253	219	423	1580	609	578	328	245	132	206	173	1060
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	59	47	87	39	120	31	85	33	82	35	66	<1	94	100	34	34	37	24	20	109
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	59	47	87	39	120	31	85	33	82	35	66	<1	94	100	34	34	37	24	20	109
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	7	6	7	5	2	2	4	4	2	3	3	45	2	2	2	2	2	2	13	2
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	18	23	25	5	30	12	28	26	27	16	24	85	26	28	14	8	10	10	8	23
Magnesium (Mg)	1	-	-	49	11	8	5	28	6	11	21	11	9	16	85	18	19	11	4	7	5	7	28
Potassium (K)	1	-	-	10	8	7	6	3	2	1	9	5	3	5	24	6	7	5	4	2	4	4	17
Sodium (Na)	1	-	-	128	24	24	52	16	11	8	62	7	11	33	88	76	65	33	34	8	23	11	146
Chloride (Cl)	1	0.003	-	202	52	27	43	31	18	18	150	15	22	48	119	74	72	48	39	10	20	16	212
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	152	18	19	30	26	14	12	46	22	7	58	683	72	51	41	11	6	38	24	132
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	0.36	0.2	0.08	0.09	0.11	0.32	0.16	0.16	0.07	0.23	<0.01	0.12	<0.01	<0.01	0.25	0.03	<0.01	<0.01	0.43	<0.01
Nitrite as N	0.01	-	-	<0.01	0.03	0.06	0.02	0.03	0.03	0.02	0.02	0.06	0.04	0.03	<0.01	<0.01	<0.01	0.04	0.19	<0.01	0.02	<0.01	0.09
Nitrate as N	0.01	0.7	-	0.19	0.48	0.3	0.19	0.11	0.01	0.09	0.08	0.38	0.35	0.06	0.03	<0.01	<0.01	0.03	0.07	<0.01	0.01	0.08	0.06
Nitrite + Nitrate as N	0.01	-	400	0.19	0.51	0.36	0.21	0.14	0.04	0.11	0.1	0.44	0.39	0.09	0.03	<0.01	<0.01	0.07	0.26	<0.01	0.03	0.08	0.15
Total Kjeldahl Nitrogen as N	0.1	-	-	0.6	0.4	0.2	0.3	0.3	0.4	0.3	0.2	0.2	0.4	0.3	0.7	0.2	0.2	0.4	0.5	0.1	0.2	0.5	0.4
Total Nitrogen as N	0.1	-	-	0.8	0.9	0.6	0.5	0.4	0.4	0.4	0.3	0.6	0.8	0.4	0.7	0.2	0.2	0.5	0.8	0.1	0.2	0.6	0.6
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	<0.01	<0.01	0.01	<0.01	0.02	0.05	0.02	0.02	<0.01	<0.01	<0.01	2.58	0.02	<0.01	<0.01	<0.01	0.01	0.03	<0.01	0.02
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Barium (Ba)	0.001	-	-	0.033	0.064	0.025	0.008	0.004	0.006	0.006	0.013	0.004	0.014	0.044	0.056	0.025	0.032	0.011	0.013	0.02	0.012	0.037	0.021
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.24	0.07	0.07	0.11	<0.05	0.13	<0.05	0.11	<0.05	<0.05	<0.05	0.18	0.15	0.17	0.16	0.13	<0.05	0.11	0.29	0.33
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	0.002	<0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.003	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Cobalt (Co)	0.001	-	1	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.439	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Copper (Cu)	0.001	0.0014	1	0.002	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	0.006	0.014	0.001	<0.001	0.004	0.001	<0.001	0.003
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	0.14	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.56	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.005	<0.001	<0.001	0.001	0.003	0.005	0.004	0.006	0.003	0.003	<0.001	0.005	0.006	0.009	0.009	0.001	0.003	0.028	0.001	0.02
Manganese (Mn)	0.001	1.9	-	0.204	0.066	0.003	0.013	0.005	0.002	0.013	0.002	<0.001	0.002	<0.001	0.213	0.005	0.008	0.001	0.011	0.065	0.005	0.012	0.019
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	<0.001	<0.001	<0.001	0.001	0.011	<0.001	0.021	<0.001	0.003	<0.001	0.007	<0.001	0.007	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.346	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.001
Niobium (Nb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.011	0.013	0.012	0.006	0.008	0.007	0.003	0.022	0.004	0.008	0.005	0.033	0.011	0.012	0.014	0.008	0.004	0.012	0.007	0.007
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.33	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon (Si)	0.05	-	-	25.4	55	43.8	40.5	4.74	7.63	8.48	6.2	7.15	3.01	25.7	14.8	19.5	14.9	13.8	52	25.3	34.9	16.7	40.4
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.217	0.079	0.067	0.026	0.048	0.032	0.034	0.09	0.03	0.04	0.155	0.345	0.129	0.174	0.051	0.035	0.034	0.03	0.073	0.224
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.128	0.01	0.015	<0.005	0.008	0.011	<0.005	0.008	<0.005
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Banded Iron Formation	Hydrated Waste	Shale	Shale	Shale	Cherty Shale	Limonitic Waste	Shale	Detrital Waste	Banded Iron Formation	Banded Iron Formation	Shale	Low Grade Aluminous	Banded Iron Formation	Shale	Low Grade Aluminous	Banded Iron Formation	Shale	Detrital Waste	Shale
	Stratigraphy →			Dales Gorge Member	Detrital	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Wittenoom Formation	Detrital	Wittenoom Formation	Detrital	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Dales Gorge Member	Dales Gorge Member	Mount McRae Shale	Detrital	Mount McRae Shale
	RGS Sample Number →			EB2012967047	EB2012967048	EB2012967049	EB2012967053	EB2012967054	EB2012967055	EB2012967056	EB2012967057	EB2012967059	EB2012967062	EB2012967063	EB2012967064	EB2012967065	EB2012967066	EB2012967067	EB2012967068	EB2012967069	EB2012968001	EB2012968011	EB2012968016
	ALS Laboratory ID →			EB2018669029	EB2018669030	EB2018669031	EB2018669032	EB2018669033	EB2018669034	EB2018669035	EB2018669036	EB2018669037	EB2018669038	EB2018669039	EB2018669040	EB2018669041	EB2018669042	EB2018669043	EB2018669044	EB2018669045	EB2018669046	EB2018669047	EB2018669048
	Client Sample ID →			IUI533	IUJ616	IUK907	IUO164	IUO168	IUO309	IUO422	IUO469	IUO694	IUP204	IUP212	IUP217	IUP669	IUP864	IUV445	IVA003	IVA087	IVA196	IVB619	IVC161
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	8.03	7.63	6.92	7.05	7.96	7.33	7.84	8.08	6.96	5.98	5.16	7.63	7.61	6.97	7.05	6.38	6.57	7.64	7.57	7.69
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	1140	201	170	343	388	260	321	460	250	1390	1090	816	657	190	299	437	406	680	1170	626
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	122	53	11	34	98	38	97	116	28	6	5	64	51	14	21	50	45	76	51	64
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	122	53	11	34	98	38	97	116	28	6	5	64	51	14	21	50	45	76	51	64
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	2	2	2	2	<1	2	2	2	2	3	7	2	<1	2	2	6	7	4	15	2
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	66	13	5	13	23	7	22	30	3	23	20	21	6	9	6	18	22	22	52	23
Magnesium (Mg)	1	-	-	40	7	4	8	14	6	13	18	3	50	46	31	15	6	8	17	17	23	17	24
Potassium (K)	1	-	-	15	4	8	6	7	6	7	7	9	14	9	14	13	3	6	6	3	8	14	15
Sodium (Na)	1	-	-	96	19	16	40	36	31	28	38	39	165	110	82	90	15	36	38	33	72	122	54
Chloride (Cl)	1	0.003	-	236	15	26	48	36	32	21	44	23	332	231	185	131	30	52	56	62	121	188	88
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	88	20	14	40	33	26	26	44	41	139	161	54	45	13	28	41	33	79	210	83
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	<0.01	<0.01	0.03	<0.01	<0.01	<0.10	<0.10	0.01	0.07	0.78	0.56	<0.10	<0.01	<0.01	<0.01	0.36	<0.01	0.11	0.07	0.11
Nitrite as N	0.01	-	-	<0.01	<0.01	<0.01	0.03	0.02	<0.01	0.03	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.01	0.02	<0.01
Nitrate as N	0.01	0.7	-	<0.01	<0.01	0.06	0.01	0.01	<0.01	<0.10	<0.01	0.07	0.09	0.09	<0.01	<0.01	0.01	0.03	0.1	<0.01	<0.01	0.04	<0.01
Nitrite + Nitrate as N	0.01	-	400	<0.01	<0.01	0.06	0.04	0.03	<0.01	<0.10	<0.01	0.07	0.09	0.09	<0.01	<0.01	0.01	0.03	0.13	<0.01	<0.01	0.06	<0.01
Total Kjeldahl Nitrogen as N	0.1	-	-	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.3	0.2	0.9	0.6	0.2	0.1	0.1	0.2	0.6	0.2	0.4	0.5	0.3
Total Nitrogen as N	0.1	-	-	0.2	0.2	0.3	0.2	0.1	0.2	0.1	0.3	0.3	1	0.7	0.2	0.1	0.1	0.2	0.7	0.2	0.4	0.6	0.3
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	<0.01	0.01	<0.01	0.02	<0.01	0.01	0.02	0.02	<0.01	0.06	0.01	0.02	<0.01	<0.01	0.01	<0.01	0.02	0.02	<0.01	0.02
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	<0.001	<0.001	0.003	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002
Barium (Ba)	0.001	-	-	0.045	0.012	0.037	0.016	0.024	0.013	0.01	0.022	0.007	0.033	0.027	0.018	0.01	0.039	0.033	0.022	0.03	0.031	0.025	0.011
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.14	0.1	<0.05	0.15	0.1	0.14	0.15	0.12	0.17	0.32	0.22	0.25	0.24	0.06	0.07	0.14	0.07	0.15	0.25	0.15
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	0.001	<0.001	<0.001	<0.001	0.001	0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	0.001	0.0014	1	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.002	0.001	0.005	0.002	<0.001	0.004	0.001	0.002	<0.001	<0.001	<0.001
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.35	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.01	0.016	0.003	0.002	0.001	0.002	0.002	0.002	0.011	0.002	0.002	<0.001	0.001	0.002	0.009	0.012	0.004	0.009	<0.001	0.006
Manganese (Mn)	0.001	1.9	-	0.011	0.008	0.009	0.005	0.004	0.003	<0.001	0.002	0.002	0.018	0.129	0.002	0.003	0.002	0.006	0.007	0.009	0.002	<0.001	<0.001
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	0.002	<0.001	<0.001	<0.001	0.003	<0.001	0.005	0.002	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.021	0.04
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.007	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Niobium (Nb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.014	0.011	0.007	0.014	0.019	0.016	0.021	0.019	0.006	0.018	0.014	0.021	0.015	0.005	0.005	0.016	0.008	0.013	0.006	0.028
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Silicon (Si)	0.05	-	-	23.7	24.1	25.9	25.9	18	36.9	10.1	13.3	22.8	25.6	15.2	11.8	42.4	10.9	42.7	16.7	11.6	23.3	15.3	8.74
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.244	0.034	0.037	0.041	0.114	0.029	0.054	0.086	0.022	0.323	0.201	0.177	0.062	0.042	0.054	0.07	0.086	0.118	0.32	0.089
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	<0.005	0.006	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.012	0.014	0.008	<0.005	<0.005	0.01	0.007	<0.005	<0.005	<0.005	<0.005
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Hydrated	Shale	Shale	Shale	Low Grade Aluminous	Shale	Shale	Dolomite	Manganiferous Shale	Banded Iron Formation	Shale	Dolomite	Detrital Waste	Calcrete	Calcrete	Low Grade Aluminous	Detrital Waste	Dolomite	Banded Iron Formation	Hydrated Waste
	Stratigraphy →			Dales Gorge Member	Mount Sylvia	Mount McRae Shale	Mount McRae Shale	Dales Gorge Member	Whaleback Shale	Mount Sylvia	Wittenoom Formation	Wittenoom Formation	Marra Mamba	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital	Joffre Member	Detrital	Wittenoom Formation	Marra Mamba	Detrital
	RGS Sample Number →			EB2012968021	EB2012968026	EB2012968029	EB2012968030	EB2012968038	EB2012968047	EB2012968052	EB2012968055	EB2012968057	EB2012968058	EB2012968054	EB2012968060	EB2012969007	EB2012969008	EB2012969009	EB2012969011	EB2012969017	EB2012969023	EB2012969025	EB2012969027
	ALS Laboratory ID →			EB2018669049	EB2018669052	EB2018669054	EB2018669055	EB2018669059	EB2018669060	EB2018669061	EB2018674001	EB2018674002	EB2018674003	EB2018674004	EB2018674005	EB2018674015	EB2018674016	EB2018674017	EB2018674018	EB2018674020	EB2018674021	EB2018674022	EB2018674023
	Client Sample ID →			IVM058	IVN449	IVN891	IWQ038	IWS568	IXA258	IYD745	IYF074	IYF389	IYF442	IYF868	IYF998	IYV175	IYV633	IYV641	IYW225	IYZ407	IYZ931	IZA182	IZA972
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	8	8	9.37	7.84	8.26	6.66	7.23	8.31	8.99	8.35	7.46	9.26	8.41	7.39	7.82	7.17	7.23	9.28	8.05	7.99
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	746	581	831	512	342	565	250	628	347	425	91	308	117	423	307	152	471	370	208	261
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	66	<1	<1	<1	<1	1	25	2	<1	33	2	<1	<1	<1	<1	45	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	86	72	145	46	106	29	33	177	112	144	16	100	41	89	84	12	71	113	71	106
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	86	72	211	46	106	29	33	178	137	146	16	133	43	89	84	12	71	158	71	106
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	9	<1	3	<1	2	<1	<1	<1	<1	<1	<1	<1	1	<1	2	<1	<1	<1	<1
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	44	29	<1	4	12	17	10	56	14	24	4	11	10	24	37	6	25	9	26	30
Magnesium (Mg)	1	-	-	22	21	<1	7	6	20	9	37	29	21	3	34	4	14	7	5	22	41	5	14
Potassium (K)	1	-	-	22	14	14	9	6	7	2	11	6	6	2	2	2	7	9	3	9	6	3	6
Sodium (Na)	1	-	-	65	42	173	84	53	56	23	22	16	33	8	5	6	36	10	13	35	8	8	5
Chloride (Cl)	1	0.003	-	65	96	66	80	22	120	38	44	13	20	12	10	7	51	16	25	60	19	14	11
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	160	48	76	64	43	38	34	33	7	35	5	13	2	39	11	11	39	13	16	17
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	<0.01	0.01	0.03	<0.01	<0.01	0.4	0.03	0.21	0.03	0.03	0.01	0.04	0.06	0.02	0.18	0.08	0.05	0.06	0.15	0.07
Nitrite as N	0.01	-	-	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.03	0.05	0.01	0.06	<0.01	0.02	<0.01	0.04	0.01	<0.01	0.04	0.02	0.02	0.06
Nitrate as N	0.01	0.7	-	<0.01	<0.01	<0.01	0.03	<0.01	0.65	<0.01	0.02	0.01	0.01	0.06	0.01	0.03	0.26	0.21	0.06	0.21	0.03	<0.01	<0.01
Nitrite + Nitrate as N	0.01	-	400	<0.01	<0.01	<0.01	0.03	0.01	0.65	0.03	0.07	0.02	0.07	0.06	0.03	0.03	0.3	0.22	0.06	0.25	0.05	0.02	0.05
Total Kjeldahl Nitrogen as N	0.1	-	-	0.2	0.1	0.2	0.2	0.2	0.6	0.2	0.5	0.2	0.3	0.1	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.3	0.2
Total Nitrogen as N	0.1	-	-	0.2	0.1	0.2	0.2	0.2	1.2	0.2	0.6	0.2	0.4	0.2	0.2	0.2	0.6	0.5	0.3	0.6	0.2	0.3	0.2
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	<0.01	<0.01	0.1	0.02	0.01	<0.01	<0.01	0.01	0.02	<0.01	0.3	0.01	0.02	0.07	0.02	<0.01	<0.01	0.03	<0.01	0.01
Antimony (Sb)	0.001	-	-	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	0.001	0.537	0.008	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium (Ba)	0.001	-	-	0.032	0.006	0.001	0.032	0.028	0.017	0.013	0.006	0.003	0.01	0.001	0.008	0.004	0.012	0.004	0.026	0.007	0.004	0.005	0.007
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.29	0.12	0.12	0.3	0.17	0.13	0.07	<0.05	<0.05	0.13	<0.05	<0.05	<0.05	0.07	<0.05	0.06	0.12	<0.05	<0.05	<0.05
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	0.004	0.003	<0.001	<0.001	<0.001	0.002	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	0.001	0.0014	1	<0.001	0.001	<0.001	0.006	0.002	<0.001	<0.001	0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.45	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.002	0.001	0.002	<0.001	0.001	0.019	0.002	0.004	0.005	0.001	0.001	0.005	0.002	0.006	0.002	0.017	0.014	0.008	0.001	0.016
Manganese (Mn)	0.001	1.9	-	0.002	0.001	<0.001	<0.001	<0.001	0.207	<0.001	0.008	0.008	0.005	0.108	0.005	0.002	0.015	0.003	0.003	0.014	0.008	0.011	0.005
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	<0.001	0.004	0.02	0.002	0.012	<0.001	<0.001	0.012	0.055	0.004	<0.001	0.002	<0.001	0.002	0.009	<0.001	<0.001	0.002	0.035	0.005
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium (Nb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.021	0.017	0.018	0.008	0.005	0.01	0.004	0.014	0.009	0.005	0.008	0.002	0.007	0.019	0.01	0.007	0.015	0.004	0.008	0.006
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon (Si)	0.05	-	-	16	7.31	13.1	28	30.7	13.9	18.2	8.88	7.77	17	1.94	4.21	9.46	13.1	9.02	10	16.1	6.92	28	10.3
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.309	0.081	0.002	0.067	0.094	0.073	0.92	0.05	0.025	0.114	0.007	0.018	0.021	0.055	0.035	0.042	0.068	0.011	0.056	0.049
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.002	0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.002	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	0.002	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Low grade siliceous	Low grade siliceous	Low grade siliceous	Banded Iron Formation	Low grade siliceous	Banded Iron Formation	High Phos High grade	High Grade Detritals	Shale	Banded Iron Formation	Banded Iron Formation	Shale	Banded Iron Formation	Banded Iron Formation	High Phos High grade	Shale	Shale	Detrital Waste	Low Grade Aluminous	Shale
	Stratigraphy →			Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Joffre Member	Detrital	Mount McRae Shale	Marra Mamba	Marra Mamba	Wittenoom Formation	Marra Mamba	Joffre Member	Dales Gorge Member	Dales Gorge Member	Dales Gorge Member	Detrital	Mount McRae Shale	Mount McRae Shale
	RGS Sample Number →			EB2012969033	EB2012969034	EB2012969035	EB2012969040	EB2012969046	EB2012969047	EB2012969050	EB2012969056	EB2012969059	EB2012969064	EB2012969065	EB2012969066	EB2012969067	EB2012969068	EB2012970011	EB2012970014	EB2012970015	EB2012970016	EB2012970019	EB2012970020
	ALS Laboratory ID →			EB2018674024	EB2018674025	EB2018674026	EB2018674027	EB2018674029	EB2018674030	EB2018674032	EB2018674034	EB2018674035	EB2018674036	EB2018674037	EB2018674038	EB2018674039	EB2018674040	EB2018674042	EB2018674044	EB2018674045	EB2018674046	EB2018674048	EB2018674049
	Client Sample ID →			IZR189	IZR191	IZR193	IZR203	IZV226	IZV353	KAC172	KAH259	KAJ336	KAL098	KAL383	KAL432	KAL552	KAM124	KAS713	KAW711	KAW714	KBA863	KBH061	KBH109
	Water Quality Guidelines:																						
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]																				
pH	0.01 pH unit	6 to 9	-	7.98	8.16	8.11	7.08	7.08	8.03	7.16	4.35	8.21	8.24	7.41	7.79	8.52	7.87	6.81	6.95	7.1	8.1	8.09	8.27
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	300	301	349	167	269	236	303	235	630	199	170	908	332	323	270	200	222	314	276	381
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	85	75	104	33	32	75	50	<1	179	81	46	242	142	51	44	14	14	115	106	102
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	85	75	104	33	32	75	50	<1	179	81	46	242	148	51	44	14	14	115	106	102
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	2	2	<1	40	<1	<1	<1	2	<1	2	2	2	2	<1	<1	<1
Major Ions	All units mg/L																						
Calcium (Ca)	1	-	1000	29	25	24	3	11	28	18	9	29	29	10	92	18	6	6	<1	2	35	31	21
Magnesium (Mg)	1	-	-	7	6	5	4	11	6	15	6	32	7	8	38	17	3	9	<1	2	12	7	20
Potassium (K)	1	-	-	8	8	6	5	4	3	4	3	12	2	4	11	8	10	8	3	4	10	3	12
Sodium (Na)	1	-	-	19	25	46	26	22	12	21	14	55	4	8	49	32	50	31	37	38	8	16	24
Chloride (Cl)	1	0.003	-	20	21	20	11	40	22	29	26	60	11	9	77	13	42	28	29	41	13	9	30
Fluoride (F)	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	37	42	45	17	15	23	22	40	36	15	9	38	30	25	13	16	11	16	15	21
Total Organic Carbon	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	0.04	0.04	0.03	0.08	0.14	0.09	0.05	0.38	<0.01	0.21	<0.01	0.02	<0.01	<0.01	0.3	0.13	0.18	<0.01	0.07	0.17
Nitrite as N	0.01	-	-	0.03	0.02	0.07	<0.01	0.02	0.06	0.01	<0.01	<0.01	0.04	0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Nitrate as N	0.01	0.7	-	0.01	0.09	0.02	0.1	0.18	0.01	0.04	0.11	<0.01	<0.01	0.01	<0.01	<0.01	0.11	0.12	0.36	0.13	<0.01	0.18	0.12
Nitrite + Nitrate as N	0.01	-	400	0.04	0.11	0.09	0.1	0.2	0.07	0.05	0.11	<0.01	0.04	0.02	<0.01	0.07	0.11	0.12	0.36	0.13	<0.01	0.18	0.16
Total Kjeldahl Nitrogen as N	0.1	-	-	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.6	0.2	0.4	<0.1	0.3	0.3	0.2	0.4	0.3	0.4	0.3	0.2	0.4
Total Nitrogen as N	0.1	-	-	0.1	0.2	0.3	0.3	0.5	0.3	0.2	0.7	0.2	0.4	<0.1	0.3	0.4	0.3	0.5	0.7	0.5	0.3	0.4	0.6
Total Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L																						
Aluminium (Al)	0.01	0.055	5	0.02	0.03	<0.01	<0.01	<0.01	0.01	<0.01	1.41	<0.01	0.02	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.02	0.01	0.01	0.01
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Barium (Ba)	0.001	-	-	0.06	0.069	0.106	0.107	0.014	0.02	0.164	0.058	0.024	0.005	0.007	0.006	0.006	0.042	0.023	0.006	0.006	0.065	0.115	0.013
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.08	0.12	0.22	0.15	<0.05	0.06	0.08	0.09	0.14	<0.05	0.05	0.06	0.07	0.16	0.12	0.14	0.15	0.07	0.21	0.1
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium (Ce)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001
Cobalt (Co)	0.001	-	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	0.001	0.0014	1	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.002	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.003	0.004	0.008	<0.001	0.004	0.006	0.004	0.002	0.003	0.004	0.002	0.028	<0.001	<0.001	0.002	0.006	0.023	0.002	0.001	0.001
Manganese (Mn)	0.001	1.9	-	0.002	<0.001	<0.001	0.003	0.002	0.003	0.113	3.15	0.003	0.003	0.005	0.117	0.004	0.002	0.231	0.002	0.005	0.021	<0.001	0.002
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	0.005	0.002	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	0.002	0.012	<0.001	0.001	0.013	0.011	<0.001	<0.001	<0.001	0.002	0.002	0.004
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.018	0.004	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium (Nb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.006	0.006	0.007	0.007	0.009	0.007	0.008	0.006	0.008	0.01	0.009	0.026	0.023	0.01	0.011	0.003	0.004	0.006	0.004	0.025
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon (Si)	0.05	-	-	27.2	23	23.8	30.8	21.8	15.3	21.3	37.8	15.1	19.1	14.1	10.9	22.4	28.3	26.6	26.2	18.2	12.1	21.1	7.2
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.187	0.192	0.223	0.037	0.058	0.054	0.149	0.085	0.16	0.03	0.031	0.27	0.08	0.058	0.04	0.008	0.017	0.224	0.213	0.06
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.02	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

Table B4: Multi-Element Test Results for Water Extracts from Rio Tinto Brockman

Parameters	Lithology →			Shale	Shale	Low Grade Detrital	Banded Iron Formation	Shale
	Stratigraphy →			Whaleback Shale	Wittenoom Formation	Detrital	Dales Gorge Member	Mount McRae Shale
	RGS Sample Number →			EB2012970021	EB2012970029	EB2012970031	EB2012970032	EB2012970037
	ALS Laboratory ID →			EB2018674050	EB2018674051	EB2018674053	EB2018674054	EB2018674055
	Client Sample ID →			KBJ443	KBO255	KBO817	KBR002	KCI669
	Water Quality Guidelines:							
	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]					
pH	0.01 pH unit	6 to 9	-	5.36	7.81	6.98	7.17	8.29
Electrical Conductivity	1 µS/cm	<1,000#	3,580^	1340	593	317	274	653
Hydroxide Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1
Carbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	<1	<1	<1	<1	<1
Bicarbonate Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	10	113	73	25	126
Total Alkalinity ($mgCaCO_3/L$)	1 mg/L	-	-	10	113	73	25	126
Acidity ($mgCaCO_3/L$)	1 mg/L	-	-	8	2	2	2	<1
Major Ions	All units mg/L							
Calcium (Ca)	1	-	1000	30	42	19	14	29
Magnesium (Mg)	1	-	-	38	24	17	9	26
Potassium (K)	1	-	-	17	8	5	3	14
Sodium (Na)	1	-	-	137	42	21	20	61
Chloride (Cl)	1	0.003	-	310	67	13	42	79
Fluoride (F)	0.01	-	-	-	-	-	-	-
Sulfate (SO_4)	1	-	1000	143	44	17	23	56
Total Organic Carbon	0.0	-	-	-	-	-	-	-
Ammonia as N	0.01	-	-	0.59	0.17	0.53	0.28	0.02
Nitrite as N	0.01	-	-	<0.01	0.07	0.02	<0.01	<0.01
Nitrate as N	0.01	0.7	-	0.8	0.19	0.08	0.1	<0.01
Nitrite + Nitrate as N	0.01	-	400	0.8	0.26	0.1	0.1	<0.01
Total Kjeldahl Nitrogen as N	0.1	-	-	1	0.5	0.8	0.5	0.2
Total Nitrogen as N	0.1	-	-	1.8	0.8	0.9	0.6	0.2
Total Phosphorus as P	0.1	-	-	-	-	-	-	-
Reactive Phosphorus as P	0.1	-	-	-	-	-	-	-
Trace Metals/Metalloids	All units mg/L							
Aluminium (Al)	0.01	0.055	5	0.01	0.02	<0.01	0.01	0.02
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)**	0.001	0.013	0.5	<0.001	<0.001	<0.001	<0.001	0.012
Barium (Ba)	0.001	-	-	0.032	0.009	0.046	0.017	0.022
Beryllium (Be)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	0.05	0.37	5	0.19	0.08	0.11	0.06	0.16
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caesium (Cs)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Cerium (Ce)	0.001	-	-	0.003	<0.001	<0.001	<0.001	<0.001
Chromium (Cr)*	0.001	0.001	1	<0.001	0.001	0.001	<0.001	0.002
Cobalt (Co)	0.001	-	1	0.194	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	0.001	0.0014	1	0.004	<0.001	<0.001	<0.001	0.001
Gallium (Ga)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium (Hf)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.05	-	-	<0.05	<0.05	<0.05	0.14	0.31
Lanthanum (La)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	0.001	0.0034	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium (Li)	0.001	-	-	0.02	0.017	0.01	0.001	<0.001
Manganese (Mn)	0.001	1.9	-	28	0.003	0.386	0.003	0.003
Mercury (Hg)	0.0001	0.0006	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.001	-	0.15	<0.001	0.002	<0.001	<0.001	0.006
Neodymium (Nd)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	0.001	0.011	1	0.01	<0.001	<0.001	<0.001	<0.001
Niobium (Nb)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Rhenium (Re)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium (Rb)	0.001	-	-	0.022	0.014	0.012	0.008	0.015
Selenium (Se)	0.01	0.011	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon (Si)	0.05	-	-	14	7.23	22.6	9.58	10.6
Silver (Ag)	0.001	0.00005	-	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (Sr)	0.001	-	-	0.127	0.18	0.106	0.168	0.143
Tantalum (Ta)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium (Th)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (Sn)	0.001	-	-	0.001	<0.001	<0.001	0.001	<0.001
Titanium (Ti)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten (W)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	0.002
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium (Y)	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	0.005	0.008	-	0.012	<0.005	<0.005	<0.005	<0.005
Zirconium (Zr)	0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water.
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

ATTACHMENT C

Laboratory Certificates

8 Attachment C

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012964**	Page	: 1 of 16
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-May-2020 20:01
Order number	: ----	Date Analysis Commenced	: 28-May-2020
C-O-C number	: ----	Issue Date	: 23-Jun-2020 10:43
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 69		
No. of samples analysed	: 69		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IKN091	IKN707	IKO454	IKO712	IKO939
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-001	EB2012964-002	EB2012964-003	EB2012964-004	EB2012964-005
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.3	1.6	-24.0	-503	-36.7
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.6	4.9	8.6	8.9	8.7
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	1.8	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	7.9	1.8	24.6	503	38.5
ANC as CaCO3	----	0.1	% CaCO3	0.8	0.2	2.5	51.3	3.9
Fizz Rating	----	0	Fizz Unit	0	0	1	5	2
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	8.1	5.7	6.6	7.5	7.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	809	1400	971	722	438
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.11	0.02	<0.01	0.06

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IKQ120	ILA414	ILA602	ILA658	ILA964
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-006	EB2012964-007	EB2012964-008	EB2012964-009	EB2012964-010
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.0	-3.3	-1.8	-5.9	-3.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.7	6.9	6.4	6.6	4.4
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	0.4
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	1.0	1.6	1.0	4.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.0	3.9	2.1	6.5	3.5
ANC as CaCO3	----	0.1	% CaCO3	0.1	0.4	0.2	0.7	0.4
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.8	6.9	6.9	7.2	6.7
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	496	524	260	340	306
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.02	0.01	0.02	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ILA976	ILB540	ILC560	ILD638	ILD720
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-011	EB2012964-012	EB2012964-013	EB2012964-014	EB2012964-015
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-3.4	-12.2	-0.7	-1.4	-0.8
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.2	7.5	6.9	6.8	7.1
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.2	1.0	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.4	12.2	1.3	2.0	0.8
ANC as CaCO3	----	0.1	% CaCO3	0.3	1.2	0.1	0.2	<0.1
Fizz Rating	----	0	Fizz Unit	0	1	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.0	7.2	7.1	7.5	7.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	544	480	272	303	157
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.02	0.02	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IPM179	IPN302	IPO347	IPP003	IPP032
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-016	EB2012964-017	EB2012964-018	EB2012964-019	EB2012964-020
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-5.7	-0.6	-2.5	-20.8	-47.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.7	6.7	7.1	10.3	11.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	1.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	5.7	1.2	2.5	20.8	47.8
ANC as CaCO3	----	0.1	% CaCO3	0.6	0.1	0.2	2.1	4.9
Fizz Rating	----	0	Fizz Unit	0	0	0	1	2
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.7	7.4	7.1	7.8	8.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	516	355	290	734	431
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.02	<0.01	<0.01	0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IPP152	IPP456	IPP783	IPP791	IPP981
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-021	EB2012964-022	EB2012964-023	EB2012964-024	EB2012964-025
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-0.7**	<0.5	<0.5	**0.9**	<0.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**6.7**	**6.7**	**6.3**	**5.7**	**5.6**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	**1.0**	**0.9**	**1.4**	**1.1**	**3.7**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**2.5**	<0.5	<0.5	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3	**0.2**	<0.1	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**0**	**0**	**0**
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	**7.9**	**6.4**	**5.9**	**5.4**	**7.6**
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	**523**	**612**	**426**	**504**	**414**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.06**	<0.01	**0.01**	**0.03**	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IPU900	IPY508	IPY536	IPY819	IPY877
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-026	EB2012964-027	EB2012964-028	EB2012964-029	EB2012964-030
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.1	-10.0	-4.6	-18.4	-6.6
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.4	7.5	7.3	8.4	7.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.4	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.1	10.9	4.6	20.5	6.6
ANC as CaCO3	----	0.1	% CaCO3	0.1	1.1	0.5	2.1	0.7
Fizz Rating	----	0	Fizz Unit	0	1	0	1	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.9	7.6	7.6	8.0	7.6
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	156	1110	441	683	423
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.03	<0.01	0.07	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IPY893	IPY901	IQP002	IQP120	IQS087
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-031	EB2012964-032	EB2012964-033	EB2012964-034	EB2012964-035
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.9	-1.4	0.5	4.3	17.2
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.2	7.3	5.5	4.8	4.5
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	2.0	2.1	23.6
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.9	1.4	0.7	<0.5	8.8
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.1	<0.1	<0.1	0.9
Fizz Rating	----	0	Fizz Unit	0	0	0	0	1
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.6	7.4	5.8	4.6	6.0
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	686	340	854	769	886
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.04	0.14	0.85

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IQS139	IQS283	IQS289	IQS300	IQS307
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-036	EB2012964-037	EB2012964-038	EB2012964-039	EB2012964-040
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-924	-3.2	47.8	17.7	<0.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	9.9	3.6	4.3	4.5	7.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	3.7	1.6	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	38.0	22.6	22.5	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	924	10.6	8.5	6.8	0.9
ANC as CaCO3	----	0.1	% CaCO3	94.2	1.1	0.9	0.7	<0.1
Fizz Rating	----	0	Fizz Unit	5	1	1	1	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.8	6.1	5.4	5.2	6.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	267	852	1360	1490	187
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.24	1.84	0.80	0.04

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IQS377	IQS406	IQS418	IQS454	IQS493
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-041	EB2012964-042	EB2012964-043	EB2012964-044	EB2012964-045
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.4	-8.2	-2.5	-891	-5.9
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.2	8.0	7.0	11.2	6.8
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	0.7
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.4	8.2	2.5	891	5.9
ANC as CaCO3	----	0.1	% CaCO3	0.2	0.8	0.2	90.8	0.6
Fizz Rating	----	0	Fizz Unit	0	1	0	5	1
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.8	6.8	6.6	7.8	7.1
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	321	787	302	419	259
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IQS554	IQS585	IQS975	IRA551	IRA619
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-046	EB2012964-047	EB2012964-048	EB2012964-049	EB2012964-050
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.3	-95.8	-5.2	-6.4	-10.8
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.3	10.1	7.3	8.2	7.6
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.0	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	4.4	95.8	6.4	6.4	16.0
ANC as CaCO3	----	0.1	% CaCO3	0.4	9.8	0.6	0.6	1.6
Fizz Rating	----	0	Fizz Unit	0	2	1	1	1
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.4	7.9	7.2	7.6	7.7
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	657	559	528	409	958
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.10	<0.01	0.04	<0.01	0.17

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRI357	IRI399	IRI434	IRI603	IRI671
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-051	EB2012964-052	EB2012964-053	EB2012964-054	EB2012964-055
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.5	-3.6	-3.0	-3.8	-580
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.6	6.7	7.4	7.0	10.5
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.3	0.6	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	7.5	3.6	3.3	3.8	580
ANC as CaCO3	----	0.1	% CaCO3	0.8	0.4	0.3	0.4	59.2
Fizz Rating	----	0	Fizz Unit	1	0	0	0	5
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.6	7.0	7.1	6.9	8.0
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	516	300	326	423	678
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRI781	IRI843	IRI876	IRI877	IRI883
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-056	EB2012964-057	EB2012964-058	EB2012964-059	EB2012964-060
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.1	-2.0	-174	-915	-317
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.6	6.9	11.3	10.9	9.4
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	7.1	2.6	174	915	317
ANC as CaCO3	----	0.1	% CaCO3	0.7	0.3	17.7	93.3	32.3
Fizz Rating	----	0	Fizz Unit	1	0	3	5	4
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.4	7.0	8.0	8.1	8.0
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	382	394	425	388	786
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.02	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRI885	IRJ297	IRK561	IRK083	IRK629
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964-061	EB2012964-062	EB2012964-063	EB2012964-064	EB2012964-065
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-294**	**-7.8**	**-2.8**	**10.3**	**-6.0**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**9.5**	**7.3**	**6.9**	**2.8**	**7.5**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	**11.4**	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	**15.3**	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**294**	**7.8**	**2.8**	**5.6**	**6.0**
ANC as CaCO3	----	0.1	% CaCO3	**30.0**	**0.8**	**0.3**	**0.6**	**0.6**
Fizz Rating	----	0	Fizz Unit	**3**	**1**	**0**	**1**	**1**
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	**8.2**	**7.5**	**6.9**	**8.0**	**7.2**
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	**840**	**300**	**286**	**1000**	**925**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	<0.01	<0.01	**0.52**	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRK837	IRL014	IRL163	IRL691	----
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	----
Compound	CAS Number	LOR	Unit	EB2012964-066	EB2012964-067	EB2012964-068	EB2012964-069	--------
				Result	Result	Result	Result	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-3.3	-8.9	-2.9	-2.9	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.7	7.7	6.4	7.9	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.0	<0.1	0.9	<0.1	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.3	8.9	2.9	2.9	----
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.9	0.3	0.3	----
Fizz Rating	----	0	Fizz Unit	0	1	0	0	----
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.6	7.5	7.6	7.8	----
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	352	431	1140	206	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012965**	Page	: 1 of 16
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-May-2020 20:07
Order number	: ----	Date Analysis Commenced	: 28-May-2020
C-O-C number	: ----	Issue Date	: 15-Jun-2020 10:01
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 67		
No. of samples analysed	: 67		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- EA031(pH-Saturated Paste) and EA032 (EC-Saturated Paste) - Unable to perform analysis on #28 due to insufficient sample volume.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRM602	IRM663	IRO039	IRQ039	IRQ201
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-001	EB2012965-002	EB2012965-003	EB2012965-004	EB2012965-005
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-34.6	-1.4	-4.4	-19.2	-3.2
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	11.1	7.5	8.5	0.3	7.7
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	34.9	1.4	4.4	19.2	4.1
ANC as CaCO3	----	0.1	% CaCO3	3.6	0.1	0.4	2.0	0.4
Fizz Rating	----	0	Fizz Unit	2	0	0	1	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.8	7.4	7.6	8.1	7.5
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	457	426	521	833	984
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	<0.01	<0.01	<0.01	0.03

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Client sample ID	IRQ767	IRR109	IRR624	IRR628	IRR651
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2012965-006	EB2012965-007	EB2012965-008	EB2012965-009	EB2012965-010
					Result	Result	Result	Result	Result
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-1.5	-2.8	1.2	1.5	-0.5
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		7.5	7.4	5.3	5.5	7.1
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		<0.1	<0.1	1.2	0.8	<0.1
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		1.8	2.8	<0.5	<0.5	0.5
ANC as CaCO3	----	0.1	% CaCO3		0.2	0.3	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit		0	0	0	0	0
EA031: pH (saturated paste)									
ø pH (Saturated Paste)	----	0.1	pH Unit		7.4	7.6	5.5	5.3	6.7
EA032: Electrical Conductivity (saturated paste)									
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm		359	390	807	713	299
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.01	<0.01	0.04	0.05	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRR653	IRR945	IRR948	IRU033	IRU100
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-011	EB2012965-012	EB2012965-013	EB2012965-014	EB2012965-015
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	-2.7	6.0	3.0	-2.1
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.4	5.8	3.4	6.2	6.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	4.8	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	0.8	2.8	11.4	2.7	0.2
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	3.9	2.6	1.0	2.4
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.4	0.3	0.1	0.2
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.6	6.8	7.5	5.3	6.5
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	380	775	654	859	382
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.04	0.28	0.13	0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IRU451	IRU776	IRZ397	IRZ661	IRZ663
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-016	EB2012965-017	EB2012965-018	EB2012965-019	EB2012965-020
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-10.9	-2.2	-2.0	-1.6	-2.4
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.7	6.6	7.1	6.7	6.8
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	0.8	0.6
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	11.5	2.5	2.0	1.6	2.4
ANC as CaCO3	----	0.1	% CaCO3	1.2	0.2	0.2	0.2	0.2
Fizz Rating	----	0	Fizz Unit	1	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.3	7.1	7.2	6.9	7.0
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	822	178	347	384	319
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ISD283	ISD467	ISD761	ISD892	ISD896
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-021	EB2012965-022	EB2012965-023	EB2012965-024	EB2012965-025
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.1	-123	-6.1	-39.4	-78.4
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.4	8.7	8.1	9.4	11.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	4.1	123	6.1	39.4	78.4
ANC as CaCO3	----	0.1	% CaCO3	0.4	12.5	0.6	4.0	8.0
Fizz Rating	----	0	Fizz Unit	0	3	0	2	2
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.6	7.8	7.8	8.0	8.0
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	143	684	387	756	528
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ISD900	ISD936	ISE024	ISE033	ISE515
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-026	EB2012965-027	EB2012965-028	EB2012965-029	EB2012965-030
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-124	-324	-7.5	-7.3	-1.6
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	10.9	11.6	7.8	8.6	7.1
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	124	324	7.5	7.3	1.6
ANC as CaCO3	----	0.1	% CaCO3	12.6	33.0	0.8	0.7	0.2
Fizz Rating	----	0	Fizz Unit	2	4	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.8	8.0	----	7.2	7.5
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	1070	434	----	628	199
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ISE864	ISI845	ISI859	ISJ051	ISJ062
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-031	EB2012965-032	EB2012965-033	EB2012965-034	EB2012965-035
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.8	-1.2	-1.0	-2.8	-2.7
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.9	7.0	6.6	7.6	6.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	0.3	<0.1	1.0	<0.1	0.2
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	0.8	2.1	1.0	2.8	2.7
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.2	<0.1	0.3	0.3
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.7	7.4	6.6	7.0	6.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	164	404	452	730	472
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.03	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ISJ277	ISJ804	ISL158	ISL365	ISL976
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-036	EB2012965-037	EB2012965-038	EB2012965-039	EB2012965-040
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	1.8	-4.2	-220	-16.1	-5.3
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	5.1	7.1	10.8	8.2	8.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.0	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	4.2	220	16.1	5.9
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.4	22.5	1.6	0.6
Fizz Rating	----	0	Fizz Unit	0	0	3	1	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	5.2	7.0	7.8	7.1	7.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	967	1110	848	1380	583
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.06	<0.01	0.01	<0.01	0.02

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Client sample ID	ITC180	ITC740	ITC748	ITC933	ITD460
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2012965-041	EB2012965-042	EB2012965-043	EB2012965-044	EB2012965-046
					Result	Result	Result	Result	Result
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-0.9	-2.3	-0.7	-2.2	-2.8
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		7.2	7.3	5.9	7.2	7.4
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		<0.1	<0.1	3.7	<0.1	<0.1
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		0.9	2.3	0.7	2.2	3.1
ANC as CaCO3	----	0.1	% CaCO3		<0.1	0.2	<0.1	0.2	0.3
Fizz Rating	----	0	Fizz Unit		0	0	0	0	0
EA031: pH (saturated paste)									
ø pH (Saturated Paste)	----	0.1	pH Unit		7.3	7.4	7.8	7.0	7.1
EA032: Electrical Conductivity (saturated paste)									
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm		443	465	197	148	711
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	<0.01	<0.01	<0.01	0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ITD582	ITD726	ITD748	ITD802	ITD887
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-047	EB2012965-048	EB2012965-049	EB2012965-050	EB2012965-051
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1.5**	**-0.9**	**-17.9**	**2.6**	**-1.7**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**7.5**	**6.3**	**9.0**	**7.7**	**7.6**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	**1.7**	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1.5**	**0.9**	**17.9**	**8.4**	**1.7**
ANC as CaCO3	----	0.1	% CaCO3	**0.2**	<0.1	**1.8**	**0.8**	**0.2**
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**1**	**1**	**0**
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	**7.6**	**7.8**	**7.7**	**7.9**	**7.6**
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	**524**	**287**	**480**	**1090**	**270**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	**0.36**	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ITE611	ITG282	ITG526	ITG535	ITH923
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-052	EB2012965-053	EB2012965-054	EB2012965-055	EB2012965-056
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1.0**	**-2.4**	**-1.4**	**0.6**	<0.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**7.1**	**7.8**	**6.8**	**6.6**	**7.1**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	**0.8**	**1.0**	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1.6**	**2.4**	**1.4**	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3	**0.2**	**0.2**	**0.1**	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**0**	**0**	**0**
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	**7.4**	**7.6**	**7.2**	**7.2**	**7.3**
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	**402**	**319**	**142**	**270**	**626**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	<0.01	<0.01	**0.02**	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ITI334	ITI426	ITI461	ITI551	ITI571
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-057	EB2012965-058	EB2012965-059	EB2012965-060	EB2012965-061
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.8	-1.6	-1.8	-5.0	-3.6
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.8	6.4	6.5	7.4	7.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	0.8	1.4	0.5	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	0.8	1.6	2.1	5.3	3.6
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.2	0.2	0.5	0.4
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.2	7.2	7.1	7.8	7.6
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	186	229	411	1880	861
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.01	0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ITI713	ITI787	ITI951	ITI971	ITJ305
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012965-062	EB2012965-063	EB2012965-064	EB2012965-065	EB2012965-066
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-2.5	-0.7	-3.1	-2.8	-1.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.0	7.0	6.5	7.0	6.1
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.9	<0.1	0.8
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.5	0.7	3.1	2.8	1.8
ANC as CaCO3	----	0.1	% CaCO3	0.2	<0.1	0.3	0.3	0.2
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.5	7.4	7.2	7.6	6.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	752	456	412	326	216
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	ITJ709	ITK609	-----	-----	-----
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2012965-067	EB2012965-068	--------	--------	--------
				Result	Result	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-119**	**-0.3**	----	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.3**	**6.8**	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	**0.3**	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**119**	**0.9**	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**12.2**	<0.1	----	----	----
Fizz Rating	----	0	Fizz Unit	**3**	**0**	----	----	----
EA031: pH (saturated paste)								
ø **pH (Saturated Paste)**	----	0.1	pH Unit	**7.8**	**7.0**	----	----	----
EA032: Electrical Conductivity (saturated paste)								
ø **Electrical Conductivity (Saturated Paste)**	----	1	µS/cm	**762**	**186**	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.02**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012964**	Page	: 1 of 16
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-May-2020 10:30
Order number	: ----	Date Analysis Commenced	: 30-May-2020
C-O-C number	: ----	Issue Date	: 16-Jun-2020 17:05
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 67		
No. of samples analysed	: 67		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- B-ICP69, F-ELE81a AND ME-MS61 + Hg-MS42 analysis was performed by ALS Geochemistry, Brisbane, NATA accreditation no. 825, Site No. 818.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: P5 LP
UMatrix: SOIL(

Compound	CAS Number	LOR	Unit	Client sample ID	ITL213	ITL417	ITL424	ITL4K1	ITLK3K
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2012964)001	EB2012964)002	EB2012964)003	EB2012964)007	EB2012964)00-
					Result	Result	Result	Result	Result
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		)6.6	)7.0	)2.1	)6.2	)2.0
EA011: Net Acid Generation									
p8 UDH(	----	0.1	pH Unit		6.3	6.9	6.9	4.3	6.9
NAG Up8 7.- (	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t		2.0	0.7	0.6	<0.1	0.2
EA013: Acid Neutralising Capacity									
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t		6.6	7.0	2.1	6.-	2.9
ANC as CaCO3	----	0.1	% CaCO3		0.4	0.7	0.2	0.4	0.3
FiXX Rating	----	0	Fizz Unit		1	0	0	1	0
EA031: p8 Usaturated paste(									
ø p8 USaturated Paste(	----	0.1	pH Unit		4.-	4.0	4.1	6.3	6.2
EA032: Electrical Conductivity Usaturated paste(									
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm		1770	416	7K7	4- -	474
ED072T: Total Sulfur by LECO									
Sulfur) Total as S ULECO(	----	0.01	%		<0.01	<0.01	<0.01	0.01	0.03

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITM231	ITM2K7	ITM309	ITM7- K	ITMK1-
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)006	EB2012964)004	EB2012964)00K	EB2012964)009	EB2012964)010
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)K0	)7- 1	)6.-	)K3	)969
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	4.-	9.7	K3	4.6	9.-
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 82SO7	----	0.5	kg H2SO4 equiv./t	K0	7- 1	4.4	K3	969
ANC as CaCO3	----	0.1	% CaCO3	0.K	76.0	0.K	0.K	9K9
FiXX Rating	----	0	Fizz Unit	1	-	1	1	-
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	6.2	4.4	4.7	4.1	4.K
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	K09	636	363	639	- 00
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	<0.01	0.07	<0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITN71K	ITN- 72	ITN4K7	ITN967	ITOK39
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)011	EB2012964)012	EB2012964)013	EB2012964)017	EB2012964)01-
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)1.1	)4.4	)6.4	)2.2	)4.K
EA011: Net Acid Generation								
p8 UOH(	----	0.1	pH Unit	6.2	4.6	4.-	4.3	4.6
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	2.7	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 82SO7	----	0.5	kg H2SO4 equiv./t	1.1	4.4	4.6	2.2	4.K
ANC as CaCO3	----	0.1	% CaCO3	0.1	0.K	0.K	0.2	0.K
FiXX Rating	----	0	Fizz Unit	0	1	1	0	1
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.-	4.-	4.4	6.9	4.-
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	2- 4	199	3- 4	196	702
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	<0.01	0.03	<0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITQ071	ITQ- K6	ITS26K	ITS439	IT5 26K
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)016	EB2012964)014	EB2012964)01K	EB2012964)019	EB2012964)020
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)4.-	)1.9	)2.1	)2.4	)6.9
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	K0	6.9	6.9	6.K	4.-
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	0.1	0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	4.-	2.2	2.4	3.3	6.9
ANC as CaCO3	----	0.1	% CaCO3	0.K	0.2	0.3	0.3	0.4
FiXX Rating	----	0	Fizz Unit	1	0	0	0	1
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.7	4.-	4.K	4.0	6.K
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	K3-	609	106	17K0	- 63
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	0.01	0.02	0.02	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	IT5 333	IT5 361	IT5 34K	IT5 - - K	IT5 4K3
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)021	EB2012964)022	EB2012964)023	EB2012964)027	EB2012964)02-
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)0.4	)6.6	)- 6.0	)3.7	)6.6
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	4.-	4.1	10.2	4.2	4.9
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	0.4	6.6	- 6.0	3.7	6.6
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.4	- .4	0.7	0.4
FiXX Rating	----	0	Fizz Unit	0	1	2	0	1
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	6.K	6.-	4.K	4.-	4.4
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	32-	224	229	103	24-
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITV160	ITV141	ITV14K	ITV1K2	ITV464
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)026	EB2012964)024	EB2012964)02K	EB2012964)029	EB2012964)030
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)1.0	<0.5	<0.5	<0.5	)K00
EA011: Net Acid Generation								
p8 UOH(	----	0.1	pH Unit	6.-	6.3	6.3	6.3	11.3
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	0.2	0.2	0.2	0.2	<0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	1.6	<0.5	<0.5	<0.5	K00
ANC as CaCO3	----	0.1	% CaCO3	0.2	<0.1	<0.1	<0.1	K1.6
FiXX Rating	----	0	Fizz Unit	0	0	0	0	-
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	6.0	- .9	6.0	6.1	4.6
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	- - 9	622	K26	434	76K
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	0.02	0.01	0.01	0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITVK3K	ITV917	ITV916	ITV99-	ITW10K
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)031	EB2012964)033	EB2012964)037	EB2012964)03-	EB2012964)036
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	24.3	)29.K	)2- .2	)4.1	)4.2
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	2.6	9.-	K6	4.2	4.2
NAG Up8 7.- (	----	0.1	kg H2SO4/t	33.4	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	71.2	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 82SO7	----	0.5	kg H2SO4 equiv./t	- .4	29.K	2- .2	4.1	4.2
ANC as CaCO3	----	0.1	% CaCO3	0.6	3.0	2.6	0.4	0.4
FiXX Rating	----	0	Fizz Unit	1	1	1	1	1
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	7.K	4.3	4.-	4.7	6.9
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	1K30	1100	1020	- 0K	400
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	1.0K	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITW37K	ITW- - 6	ITW66K	ITW94-	ITY333
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)034	EB2012964)039	EB2012964)070	EB2012964)071	EB2012964)072
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	0.6	)- .K	)6.-	)- .6	)4.-
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	6.0	4.0	4.2	4.7	4.K
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	0.3	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	<0.5	6.1	6.-	- .6	4.-
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.6	0.4	0.6	0.K
FiXX Rating	----	0	Fizz Unit	0	1	1	1	1
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.6	4.0	4.2	4.7	4.K
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	K1	207	24K	17-	3- 3
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	0.02	0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	ITYK- K	ITY973	I5 I061	I5 I- 22	I5 I- 33
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)073	EB2012964)077	EB2012964)07-	EB2012964)076	EB2012964)074
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)3.K	)4.1	)7.2	)3K3	)9.9
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	6.6	4.1	- .9	K9	K-
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	0.4	<0.1	1.2	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	3.K	4.1	7.K	3K6	9.9
ANC as CaCO3	----	0.1	% CaCO3	0.7	0.4	0.-	3.9	1.0
FiXX Rating	----	0	Fizz Unit	0	0	0	1	0
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.0	4.7	6.6	4.6	4.K
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	101	3K6	19-	1610	1300
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	<0.01	0.02	0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	I5 J616	I5 z 904	I5 z 93-	I5 L174	I5 LK- 4
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)07K	EB2012964)079	EB2012964)0- 0	EB2012964)0- 1	EB2012964)0- 2
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)4.1	)7.7	)2.4	)6.1	)6.6
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	4.6	6.4	6.K	4.6	6.3
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	1.0	0.7	<0.1	1.2
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	4.1	7.7	2.4	6.1	6.6
ANC as CaCO3	----	0.1	% CaCO3	0.4	0.7	0.3	0.6	0.4
FiXX Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.-	4.7	4.4	4.6	4.1
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	309	2K3	19K	3K7	3- K
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	I5 O167	I5 O16K	I5 O309	I5 O722	I5 O769
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)0- 3	EB2012964)0- 7	EB2012964)0- -	EB2012964)0- 6	EB2012964)0- 4
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)17.-	)27.9	)KK	)46.9	)31.6
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	4.3	K4	4.2	K4	9.3
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	17.-	2- .2	9.1	46.9	31.9
ANC as CaCO3	----	0.1	% CaCO3	1.-	2.6	0.9	4.K	3.2
FiXX Rating	----	0	Fizz Unit	1	1	0	2	1
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.4	K1	4.9	K2	4.9
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	K16	- 31	776	711	7- 2
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	0.01	0.01	<0.01	0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	I5 O7K7	I5 O697	I5 O924	I5 O974	I5 P207
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)0- K	EB2012964)0- 9	EB2012964)060	EB2012964)061	EB2012964)062
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)9.-	)7.1	)7.2	)3.K	)3.7
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	K.K	4.-	4.-	6.4	- .9
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	0.6	1.2
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	9.K	- .0	7.K	7.7	7.6
ANC as CaCO3	----	0.1	% CaCO3	1.0	0.-	0.-	0.7	0.-
FiXX Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.9	4.-	4.K	6.6	6.-
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	KK4	2K-	719	632	27- 0
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	0.01	0.03	0.02	0.02	0.07

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	I5 P212	I5 P214	I5 P669	I5 PK67	I5 V77-
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012964)063	EB2012964)067	EB2012964)06-	EB2012964)066	EB2012964)064
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)1.K	)7.4	)4.K	)7.7	)6.6
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	- .3	6.4	4.4	4.0	6.K
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG Up8 4.0(	----	0.1	kg H2SO4/t	0.K	0.-	<0.1	<0.1	0.1
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	3.0	7.4	4.K	7.7	6.9
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.-	0.K	0.7	0.4
FiXX Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	6.0	4.6	4.K	4.K	6.9
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	1920	479	K6-	239	406
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	0.07	<0.01	<0.01	<0.01	0.01

Analytical Results

Sub-Matrix: P5 LP UMatrix: SOIL(			Client sample ID	IVA003	IVA0K4	))))	))))	))))
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2012964)06K	EB2012964)069	))))))))	))))))))	))))))))
				Result	Result	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	)4.1	)- .3	))))	))))	))))
EA011: Net Acid Generation								
p8 UDH(	----	0.1	pH Unit	4.-	4.1	))))	))))	))))
NAG Up8 7.- (	----	0.1	kg H2SO4/t	<0.1	<0.1	))))	))))	))))
NAG Up8 4.0(	----	0.1	kg H2SO4/t	<0.1	<0.1	))))	))))	))))
EA013: Acid Neutralising Capacity								
ANC as 8 2SO7	----	0.5	kg H2SO4 equiv./t	4.1	- .3	))))	))))	))))
ANC as CaCO3	----	0.1	% CaCO3	0.4	0.-	))))	))))	))))
FiXX Rating	----	0	Fizz Unit	0	0	))))	))))	))))
EA031: p8 Usaturated paste(								
ø p8 USaturated Paste(	----	0.1	pH Unit	4.K	4.3	))))	))))	))))
EA032: Electrical Conductivity Usaturated paste(								
ø Electrical Conductivity USaturated Paste(	----	1	µS/cm	772	4- 2	))))	))))	))))
ED072T: Total Sulfur by LECO								
Sulfur) Total as S ULECO(	----	0.01	%	<0.01	<0.01	))))	))))	))))

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012968**	Page	: 1 of 16
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-May-2020 10:30
Order number	: ----	Date Analysis Commenced	: 01-Jun-2020
C-O-C number	: ----	Issue Date	: 25-Jun-2020 10:15
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 69		
No. of samples analysed	: 69		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Client sample ID	IVA196	IVA220	IVA275	IVA504	IVB053
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2012968-001	EB2012968-002	EB2012968-003	EB2012968-004	EB2012968-005
					Result	Result	Result	Result	Result
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-6.7**	<0.5	<0.5	**0.6**	<0.5
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		**7.2**	**7.4**	**7.0**	**6.9**	**7.0**
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	**0.2**	<0.1
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**6.7**	<0.5	<0.5	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3		**0.7**	<0.1	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit		**0**	**0**	**0**	**0**	**0**
EA031: pH (saturated paste)									
ø pH (Saturated Paste)	----	0.1	pH Unit		**7.0**	**7.4**	**7.2**	**5.8**	**7.0**
EA032: Electrical Conductivity (saturated paste)									
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm		**1160**	**760**	**671**	**993**	**179**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	<0.01	<0.01	**0.02**	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IVB275	IVB278	IVB424	IVB481	IVB621
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-006	EB2012968-007	EB2012968-008	EB2012968-009	EB2012968-010
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.2	<0.5	0.6	<0.5	0.6
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.2	7.1	7.3	7.9	8.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1.5	<0.5	<0.5	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3	0.2	<0.1	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.6	7.6	7.1	7.0	7.3
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	126	75	379	1260	1020
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	<0.01	0.02	<0.01	0.02

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IVB619	IVB839	IVB842	IVB921	IVC092
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-011	EB2012968-012	EB2012968-013	EB2012968-014	EB2012968-015
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.0	-1.2	-1.5	0.6	0.9
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	9.4	6.3	6.2	6.0	6.4
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	1.2	1.2	0.9	0.8
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	7.9	1.8	2.1	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3	0.8	0.2	0.2	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.9	7.6	7.3	6.3	7.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	1800	555	757	402	429
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.02	0.02	0.03

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IVC161	IVD337	IVK485	IVL209	IVL225
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-016	EB2012968-017	EB2012968-018	EB2012968-019	EB2012968-020
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	1.0	<0.5	-1.5	<0.5	-0.9
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	3.4	6.8	6.6	6.0	6.6
NAG (pH 4.5)	----	0.1	kg H2SO4/t	2.3	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	8.0	0.4	0.9	1.0	0.7
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.6	<0.5	2.4	<0.5	1.2
ANC as CaCO3	----	0.1	% CaCO3	0.4	<0.1	0.2	<0.1	0.1
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.8	6.9	7.8	5.9	6.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	684	255	134	622	683
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.15	<0.01	0.03	0.01	0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IVM058	IVM080	IVM112	IVM713	IVN356
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-021	EB2012968-022	EB2012968-023	EB2012968-024	EB2012968-025
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.4	0.6	4.8	-1.1	<0.5
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.6	6.9	4.7	6.8	5.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	0.8	2.1	0.6	0.9
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	5.9	<0.5	1.3	1.7	1.5
ANC as CaCO3	----	0.1	% CaCO3	0.6	<0.1	0.1	0.2	0.1
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.5	5.3	4.9	7.1	5.6
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	760	586	464	798	552
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.05	0.02	0.20	0.02	0.06

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IVN449	IVN838	IVN871	IVN891	IWQ038
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-026	EB2012968-027	EB2012968-028	EB2012968-029	EB2012968-030
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-64.0	-1.3	1.3	10.4	-2.4
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	10.1	7.2	4.6	7.0	6.6
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	2.6	<0.1	1.3
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	66.4	1.9	1.8	12.8	3.3
ANC as CaCO3	----	0.1	% CaCO3	6.8	0.2	0.2	1.3	0.3
Fizz Rating	----	0	Fizz Unit	2	0	0	1	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.8	6.0	5.2	8.8	7.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	744	323	549	2080	680
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.08	0.02	0.10	0.76	0.03

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IWQ128	IWQ166	IWQ167	IWR529	IWR632
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-031	EB2012968-032	EB2012968-033	EB2012968-034	EB2012968-035
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**0.6**	<0.5	<0.5	<0.5	**-1.0**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**5.3**	**6.2**	**6.7**	**6.8**	**6.9**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	**3.8**	**1.0**	**0.9**	**0.5**	**0.1**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	**1.8**	**0.7**	<0.5	**1.0**
ANC as CaCO3	----	0.1	% CaCO3	<0.1	**0.2**	<0.1	<0.1	**0.1**
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**0**	**0**	**0**
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	**5.7**	**6.6**	**7.3**	**7.4**	**7.6**
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	**474**	**187**	**143**	**317**	**433**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.06**	**0.03**	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IWS032	IWS038	IWS568	IWS573	IWS575
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-036	EB2012968-037	EB2012968-038	EB2012968-039	EB2012968-040
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	2.8	6.7	-5.4	-0.2	0.6
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.4	4.4	7.7	6.6	6.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	0.2	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.8	5.0	<0.1	0.6	0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.4	<0.5	6.3	1.4	<0.5
ANC as CaCO3	----	0.1	% CaCO3	0.2	<0.1	0.6	0.1	<0.1
Fizz Rating	----	0	Fizz Unit	0	0	1	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	6.2	5.1	8.0	7.6	7.3
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	716	3630	407	353	1370
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.17	0.22	0.03	0.04	0.02

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IWT018	IWT029	IWT048	IWT424	IWT902
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-041	EB2012968-042	EB2012968-043	EB2012968-044	EB2012968-045
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	0.6	-0.8	<0.5	-5.1
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.2	6.6	6.8	6.7	7.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	0.3	<0.1	0.3	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	<0.5	0.8	<0.5	5.1
ANC as CaCO3	----	0.1	% CaCO3	<0.1	<0.1	<0.1	<0.1	0.5
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.3	5.7	6.3	6.9	7.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	184	442	323	834	358
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.02	<0.01	0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IXA209	IXA258	IXW451	IYB792	IYC986
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-046	EB2012968-047	EB2012968-048	EB2012968-049	EB2012968-050
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	<0.5	<0.5	-2.4	0.6
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.1	7.1	7.0	7.1	7.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	<0.5	<0.5	2.7	<0.5
ANC as CaCO3	----	0.1	% CaCO3	<0.1	<0.1	<0.1	0.3	<0.1
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.4	6.9	7.0	7.5	8.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	244	707	108	104	140
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	0.01	0.02

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IYD139	IYD745	IYE845	IYF868	IYF074
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-051	EB2012968-052	EB2012968-053	EB2012968-054	EB2012968-055
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.2	-1.0	-1.6	-8.7	-662
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.6	6.4	6.6	8.4	8.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	0.4	1.2	0.9	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	0.8	1.0	2.2	8.7	662
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.1	0.2	0.9	67.5
Fizz Rating	----	0	Fizz Unit	0	0	0	0	5
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.5	7.8	7.9	8.2	8.2
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	723	417	73	809	577
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	<0.01	0.02	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IYF285	IYF389	IYF442	IYF784	IYF998
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-056	EB2012968-057	EB2012968-058	EB2012968-059	EB2012968-060
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	-923	-60.3	-3.2	-993
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.2	8.9	10.2	8.7	10.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	2.5	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	923	61.8	3.2	993
ANC as CaCO3	----	0.1	% CaCO3	<0.1	94.2	6.3	0.3	101
Fizz Rating	----	0	Fizz Unit	0	5	2	0	5
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	8.2	8.7	8.6	7.9	8.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	39	268	441	1170	166
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.05	<0.01	<0.01

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IYN249	IYN252	IYN256	IYN259	IYN260
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012968-061	EB2012968-062	EB2012968-063	EB2012968-064	EB2012968-065
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**0.6**	**-0.5**	<0.5	<0.5	**1.0**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**7.3**	**6.3**	**5.9**	**5.8**	**5.7**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	**0.7**	**0.6**	**0.6**	**1.0**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	**0.5**	**1.4**	**1.8**	**0.8**
ANC as CaCO3	----	0.1	% CaCO3	<0.1	<0.1	**0.1**	**0.2**	<0.1
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**0**	**0**	**0**
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	**6.9**	**6.3**	**5.8**	**6.2**	**6.2**
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	**568**	**286**	**379**	**312**	**333**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	<0.01	**0.05**	**0.06**	**0.06**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	IYR078	IYU108	IYU160	IYU295	----
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	----
Compound	CAS Number	LOR	Unit	EB2012968-066	EB2012968-067	EB2012968-068	EB2012968-069	--------
				Result	Result	Result	Result	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.8	-1.6	2.4	3.1	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.7	7.6	5.0	4.8	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	0.7	<0.1	1.7	2.5	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	0.8	2.2	<0.5	<0.5	----
ANC as CaCO3	----	0.1	% CaCO3	<0.1	0.2	<0.1	<0.1	----
Fizz Rating	----	0	Fizz Unit	0	0	0	0	----
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	7.6	7.3	4.8	5.3	----
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	427	152	1210	714	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.02	0.08	0.10	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012969**	Page	: 1 of 16
Client	: **R5 S ENGIRONV ENTAL MTY LTP**	Laboratory	: Environmental Division Brisbane
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Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-May-2020 20:21
Order number	: ----	Date Analysis Commenced	: 04-Jun-2020
C-O-C number	: ----	Issue Date	: 29-Jun-2020 09:45
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 69		
No. of samples analysed	: 69		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

AddDDot na Dlorf niDot meriDet i io ipDn remori sDa we lobt d D ipe loæosDu hemrnie niingpf et ih: c bnaDQ Cot iroa Remoriy c A,c C Cof mæDnt ge Ahhehhf et i io nhhDni s Dp c bnaDQRe/ Dos nt d Snf mæ RegeDni NoiDDgniDot v

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
. = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IY^ 29U	IY^ (U(	IY^ 61U	IY^ 629	IY^ 631
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694001	EB20129694002	EB2012969400(	EB20129694008	EB20129694007
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	1vU	1v1	1v0	40v6	40v(
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	8v9	7v0	7vU	6v1	6v9
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	2v0	2v8	1v0	1v0	0v8
EA01(: Ag2l NebirnaDnD u CnmmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	<0.5	0v8	2v1	0v9	2v1
ANC nh CnCO(	----	0.1	% CaCO3	<0.1	<0.1	0v2	<0.1	0v2
FD2z RniD u	----	0	Fizz Unit	0	0	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	7v2	3vU	7v(	6v0	6v7
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	6(1	817	112	128	U6
EP082T: ToinaSbalbr wQLECO								
Sbalbr 4Toinanh S)LECO-	----	0.01	%	0v06	0v06	0v10	0v01	0v06

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IYG0(2	IYG137	IYG6((	IYG681	IYGU99
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694006	EB20129694003	EB20129694 00U	EB20129694009	EB20129694010
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.5	kg H2SO4/t	4(vl	438vl	4632	4U62	42v2
EA011: Nei Ag2l 5 et erni2ot								
mH)OX-	----	0.1	pH Unit	6v9	10v8	10vU	9vU	3v2
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	0vl	<0.1	<0.1	<0.1	<0.1
EA01(: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	(vl	38vl	632	U62	2vU
ANC nh CnCO(	----	0.1	% CaCO3	0v(	3v6	6UvU	UUv0	0v(
F2zz Rni2u	----	0	Fizz Unit	0	2	7	7	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	3v(	3v9	3v9	UvI	3v9
EA0(2: Eægir2gnaCot dbgi2 2Q)hnibrnied mnhie-								
ø Eægir2gnaCot dbgi2 2Q)Snibrnied Mnhie-	----	1	µS/cm	(62	(60	390	((1	121
EP082T: ToinaSbalbr wQLECO								
Sbalbr 4Toinanh S)LECO-	----	0.01	%	<0.01	<0.01	<0.01	<0.01	0v02

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IYW227	IYW(71	IYY2U0	IYY972	IYZ277
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694011	EB20129694012	EB2012969401(	EB20129694018	EB20129694017
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	42v0	42v7	4U(	40v9	42v6
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	3v7	3v2	3vU	6v(	3v2
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	0vU	<0.1
EA01(: Ag2l NebirnaDiD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	2v0	(v1	UV(	2v8	(v2
ANC nh CnCO(	----	0.1	% CaCO3	0v2	0v(	0vU	0v(	0v(
FI2z RniDu	----	0	Fizz Unit	0	0	1	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	3v6	3v6	3v7	7v8	3v0
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	(68	70U	268	6(9	2U9
EP082T: ToinaSbalbr wQLECO								
Sbalbr 4Toinanh S)LECO-	----	0.01	%	<0.01	0v02	<0.01	0v06	0v02

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-	Client sample ID			IYZ29U	IYZ803	IYZ763	IYZ738	IYZ633
	Client sampling date / time			04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694016	EB20129694013	EB20129694U1U	EB20129694019	EB20129694020
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	41v7	42v9	42v1	41v2	4(v1
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	3v7	3v7	3v(	6v8	6v6
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	1v0	1v1
EA01(: Ag2l NebirnaDnD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	2v1	(v7	2v8	1vU	(v8
ANC nh CnCO(	----	0.1	% CaCO3	0v2	0v8	0v(	0v2	0v(
F2z RniD u	----	0	Fizz Unit	0	0	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	6v9	3v2	UvU	UvI	3vU
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	231	701	221	1(60	292
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	0v02	0v02	0v02	0v02	0v01

Analytical Results

Sub-Matrix: M^ LM
)Matrix: SOIL-

Compound	CAS Number	LOR	Unit	Client sample ID	IYZU22	IYZUU3	IYZ9(1	IZA020	IZA1U2
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB20129694021	EB20129694022	EB2012969402(	EB20129694028	EB20129694027
					Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha									
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t		4(v0	42vU	4996	47v(	48v0
EA011: Nei Ag2l 5 et erniDot									
mH)OX-	----	0.1	pH Unit		3v8	3v(	10v8	3v6	Uv6
NA5)mH 8v7-	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
EA01(: Ag2l NebirnaDnD u CnmgDQ									
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t		(v0	2vU	996	7v(	7v2
ANC nh CnCO(	----	0.1	% CaCO3		0v(	0v(	102	0v7	0v7
F2zz RniD u	----	0	Fizz Unit		0	0	7	0	0
EA0(1: mH)hnibrnied mnhie-									
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit		3v9	3vU	UvM	3v9	Uv8
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-									
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm		3(7	23	766	706	176
EP082T: ToinaSbalbr wQLECO									
Sbalbr 4Toinanh S)LECO-	----	0.01	%		<0.01	<0.01	<0.01	<0.01	0v08

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IZA972	IZA932	IZB(07	IZB(11	IZB387
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694026	EB20129694023	EB20129694 02U	EB20129694029	EB20129694(0
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.5	kg H2SO4/t	42v2	428v9	41v8	41v8	40v(
EA011: Nei Ag2l 5 et erni2ot								
mH)OX-	----	0.1	pH Unit	3v1	UvU	6v6	6vU	6v6
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	1v0	2v6	1v0
EA01(: Ag2l Nebirna2hi2 u Cnmmg2Q								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	2v2	28v9	1v8	1v8	0v9
ANC nh CnCO(	----	0.1	% CaCO3	0v2	2v7	0v1	0v1	<0.1
F2zz Rni2u	----	0	Fizz Unit	0	1	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	3v2	UvU	3v9	3vU	3v0
EA0(2: Eægir2gnaCot dbgi2 2Q)hnibrnied mnhie-								
ø Eægir2gnaCot dbgi2 2Q)Snibrnied Mnhie-	----	1	µS/cm	83(	288	670	709	7(U
EP082T: ToinaSbalbr wQLECO								
Sbalbr 4Toinanh S)LECO-	----	0.01	%	<0.01	<0.01	<0.01	<0.01	0v02

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IZB366	IZC328	IZR1U9	IZR191	IZR19(
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694O(1	EB20129694O(2	EB20129694O((	EB20129694O(8	EB20129694O(7
				Result	Result	Result	Result	Result
EA009: Nei AgO Mrodbgi Dt Moiet iDa								
Nei AgO Mrodbgi Dt Moiet iDa	----	0.5	kg H2SO4/t	47v8	46vU	46vU	42v8	42v9
EA011: Nei AgO 5 et erni Dt								
mH)OX-	----	0.1	pH Unit	3v8	UvO	3vU	6v9	3v6
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3vO-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	Ov7	<0.1
EA01(: AgO Nebirna Di u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	6vO	6vU	3v8	(v(	8v1
ANC nh CnCO(	----	0.1	% CaCO3	Ov6	Ov8	OvU	Ov(	Ov8
FDzz RniDu	----	0	Fizz Unit	0	0	1	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	UvO	UvM	Uv(	Uv7	Uv6
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	1UI0	600	216	136	263
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	Ov02	<0.01	Ov0(	Ov0(	Ov08

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IZR198	IZR197	IZR200	IZR202	IZR20(
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694O(6	EB20129694O(3	EB20129694O(U	EB20129694O(9	EB20129694080
				Result	Result	Result	Result	Result
EA009: Nei AgO Mrodbgi Dt Moiet iDa								
Nei AgO Mrodbgi Dt Moiet iDa	----	0.5	kg H2SO4/t	<0.5	4Ov2	4OvU	4Ov6	4Iv8
EA011: Nei AgO 5 et erni Dt								
mH)OX-	----	0.1	pH Unit	3v2	3v2	3v8	6v9	3vI
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	0v6	<0.1
EA01(: AgO Nebirna DiD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	0vU	1vI	1vI	0v6	2v0
ANC nh CnCO(	----	0.1	% CaCO3	<0.1	0vI	0vI	<0.1	0v2
FDzz RniD u	----	0	Fizz Unit	0	0	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	3v6	UvI	UvO	Uv(	Uv2
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	(30	182	137	161	108
EP082T: ToinaSbalbr wQLECO								
Sbalbr 4Toinanh S)LECO-	----	0.01	%	0v0(	0v0(	0v01	<0.01	0v01

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IZR20U	IZR212	IZR21(	IZR218	IZG196
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694081	EB20129694082	EB2012969408(	EB20129694088	EB20129694087
				Result	Result	Result	Result	Result
EA009: Nei AgD mrodbgiDot Moiet iDha								
Nei AgD mrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	41v8	40v0U	0v6	0v6	41v6
EA011: Nei AgD 5 et erniDot								
mH)OX-	----	0.1	pH Unit	7v8	6v9	6v9	6v7	3v2
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	2vU	<0.1	0v8	0v8	<0.1
EA01(: AgD Nebirna DiD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	1v8	1v(	0v9	0v6	1v9
ANC nh CnCO(	----	0.1	% CaCO3	0v1	0v1	<0.1	<0.1	0v2
FDzz RniD u	----	0	Fizz Unit	0	0	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	3vU	3v0	6v7	7v9	3v7
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	20U	U82	69(	786	(9(
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	<0.01	0v08	0v07	0v08	0v01

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	IZG226	IZG(7(	IZG66U	J AC183	J AC132
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694086	EB20129694083	EB20129694 08U	EB20129694089	EB20129694070
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	4(v7	47v(	7v(	41vU	4(vU
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	3v(	UvO	(v9	6v0	6vU
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	1v9	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	7v6	2v0	0v7
EA01(: Ag2l NebirnaDnD u CnmmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	(v7	7v(	(v0	1vU	(vU
ANC nh CnCO(	----	0.1	% CaCO3	0v8	0v7	0v(	0v2	0v8
FD2z RniD u	----	0	Fizz Unit	0	0	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	UvO	UvO	UvO	UvM	3v6
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	8(1	2(7	1020	209	709
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	<0.01	<0.01	0v23	<0.01	<0.01

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	JAC311	JAP139	JAP280	JA50(3	JA5209
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694071	EB20129694072	EB2012969407(	EB20129694078	EB20129694077
				Result	Result	Result	Result	Result
EA009: Nei AgD Mrodbgi Dt Moiet iDa								
Nei AgD Mrodbgi Dt Moiet iDa	----	0.5	kg H2SO4/t	4(v0	42v9	42v2	42v8	41v2
EA011: Nei AgD 5 et erni Dt								
mH)OX-	----	0.1	pH Unit	3v2	3v2	3v2	6v6	3v1
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	0v2	<0.1
EA01(: AgD Nebirna DiD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	(v6	(v7	2vU	(v6	1v2
ANC nh CnCO(	----	0.1	% CaCO3	0v8	0v8	0v(	0v8	0v1
FDzz RniD u	----	0	Fizz Unit	0	0	0	0	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	3v2	3v9	3v6	3v9	UvU
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	612	1110	806	807	28U
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	0v02	0v02	0v02	0v0(	<0.01

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	J AH279	J AI089	J AI37U	J AK((6	J AK627
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694076	EB20129694073	EB20129694 07U	EB20129694079	EB20129694060
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	(vU	40v8	41v6	439v8	42v6
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	8v8	6v6	6vU	UvZ	6vU
NA5)mH 8v7-	----	0.1	kg H2SO4/t	0v1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	(v6	0v2	0v2	<0.1	0v2
EA01(: Ag2l NebirnaDnD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	1v1	1v9	2v7	39v8	2v9
ANC nh CnCO(	----	0.1	% CaCO3	0v1	0v2	0v2	UvI	0v(
FDzz RniDu	----	0	Fizz Unit	0	0	0	2	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	7v8	3v6	UvO	UvS	3v8
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	82U	(1(	(U6	6(7	8U6
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	0v16	0v08	0v0(	<0.01	0v01

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	J AJ 169	J AJ (99	J AJ 868	J AL09U	J AL(U(
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB20129694061	EB20129694062	EB2012969406(	EB20129694068	EB20129694067
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	41v0	4(vU	4(v2	426v0	46v1
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	6v6	3v7	3v8	9v8	3vU
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA5)mH 3v0-	----	0.1	kg H2SO4/t	0v8	<0.1	<0.1	<0.1	<0.1
EA01(: Ag2l NebirnaDnD u CnmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	1v9	8v8	(vU	26v0	6v1
ANC nh CnCO(	----	0.1	% CaCO3	0v2	0v8	0v8	2v6	0v6
FD2z RniD u	----	0	Fizz Unit	0	0	0	1	0
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	UV0	UV8	3v9	UV6	UV1
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	17(	107	268	1UU	206
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	0v0(	0v02	0v02	<0.01	<0.01

Analytical Results

Sub-Matrix: M^ LM)Matrix: SOIL-			Client sample ID	J AL8(2	J AL772	J AV 128	J AV 136	4444
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	----
Compound	CAS Number	LOR	Unit	EB20129694066	EB20129694063	EB20129694 06U	EB20129694069	4444444
				Result	Result	Result	Result	----
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.5	kg H2SO4/t	49v2	4(1v8	4(v2	42v0	4444
EA011: Nei Ag2l 5 et erniDot								
mH)OX-	----	0.1	pH Unit	UV7	10v8	UV0	3v1	4444
NA5)mH 8v7-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	4444
NA5)mH 3v0-	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	4444
EA01(: Ag2l NebirnaDnD u CnmmgDQ								
ANC nh H2SO8	----	0.5	kg H2SO4 equiv./t	9v2	(7v8	(vU	2v(	4444
ANC nh CnCO(	----	0.1	% CaCO3	0v9	(v6	0v8	0v2	4444
FD2z RniD u	----	0	Fizz Unit	1	1	0	0	4444
EA0(1: mH)hnibrnied mnhie-								
ø mH)Snibrnied Mnhie-	----	0.1	pH Unit	UV1	UVU	UV6	3v8	4444
EA0(2: EægirDgnaCot dbgiD DQ)hnibrnied mnhie-								
ø EægirDgnaCot dbgiD DQ)Snibrnied Mnhie-	----	1	µS/cm	UU0	2(0	828	8(6	4444
EP082T: ToinaSbdbr wQLECO								
Sbdbr 4Toinanh S)LECO-	----	0.01	%	<0.01	0v12	0v02	0v01	4444

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012960**	Page	: 1 of 16
Client	: **R4 S ENGIRONV ENTAL MTY LTP**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 6 Byth Street Stafford QLD Australia 4023
Tele5hone	: p+1 07 3344 1666	Tele5hone	: p+1 7 3226 8+1+
Project	: 60190+8 RTIO Brockman	Date Sam5les Received	: 14-May-6060 60:62
Order number	: ----	Date Analysis Commenced	: 09-Jun-6060
C-O-C number	: ----	Issue Date	: 0+-Jul-6060 17:68
Sam5ler	: ----		
Site	: ----		
Quote number	: BN/648/19 A		
No. of sam5les received	: 49		
No. of sam5les analysed	: 49		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This re5ort su5ersedes any 5revious re5ort(s) with this reference. Results a55ly to the sam5le(s) as submitted. This document shall not be re5roduced, exce5t in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

AddDDot na DIlorf niDot meriDet i io ipDn remori sDa we lobt d D ipe loæosDu hemrnie niingpf et ih: c bnaDQ Cot iroa Remoriy c A,c C Cof mæDnt ge Ahhehhf et i io nhhDni s Dp c bnaDQRe/ Dos nt d Snf mæ RegeDni NoiDDgniDot v

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in com5liance with 5rocedures s5ecified in 61 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sul5hate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical 5rocedures used by ALS have been develo5ed from established internationally recognised 5rocedures such as those 5ublished by the USEPA, APHA, AS and NEPM. In house develo5ed 5rocedures are fully validated and are often at the client request.

Where moisture determination has been 5erformed, results are re5orted on a dry weight basis.

Where a re5orted less than (<) result is higher than the LOR, this may be due to 5rimary sam5le extract/digestate dilution and/or insufficient sam5le for analysis.

Where the LOR of a re5orted result differs from standard LOR, this may be due to high moisture content, insufficient sam5le (reduced weight em5loyed) or matrix interference.

When sam5ling time information is not 5rovided by the client, sam5ling dates are shown without a time com5onent. In these instances, the time com5onent has been assumed by the laboratory for 5rocessing 5ur5oses.

Where a result is required to meet com5liance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of re5orting
. = This result is com5uted from individual analyte detections at or above the level of re5orting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA031 (Saturated Paste 5H): NATA accreditation does not cover the 5erformance of this service.
- EA036 (Saturated Paste EC): NATA accreditation does not cover the 5erformance of this service.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 6- Moderate; 3- Strong; 4- Very Strong; 2- Lime.

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ AN052	^ AN037	^ AN070	^ AN063	^ AOK31
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-001	EB2012960-002	EB2012960-00K	EB2012960-005	EB2012960-003
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-K\6	-K\8	-2\2	-5\6	-10\7
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	7\8	7\K	7\6	7\9	9\2
NA4 (mH 5\8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6\0)	----	0.1	kg H6SO4/t	0\7	2\0	0\8	0\2	<0.1
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	5\K	K\8	2\8	5\6	10\9
ANC nh CnCOK	----	0.1	% CaCO3	0\5	0\5	0\K	0\8	1\1
F2zz Rni2u	----	0	Fizz Unit	0	0	0	0	1
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	6\1	6\K	6\2	7\9	8\1
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	37K	568	603	3K5	679
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0\02	0\01	0\02	<0.01	0\01

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ AOK79	^ AO706	^ AM753	^ AM756	^ AS612
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-007	EB2012960-006	EB2012960-008	EB2012960-009	EB2012960-010
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-3vK	-5v5	-1v9	-2v7	-3v7
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	7v7	7v9	7v0	7v5	6v2
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	0v8	0v5	1vK	0v9	<0.1
EA01K: Ag2l Nebirna2i2 u Cnmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	3v7	3v9	2v2	2v7	7v2
ANC nh CnCOK	----	0.1	% CaCO3	0v7	0v7	0v2	0vK	0v7
F2zz Rni2u	----	0	Fizz Unit	1	1	0	0	1
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	6v9	6v7	6v8	6v7	6v0
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	582	9K	217	K01	239
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v01	0v03	0v01	<0.01	0v02

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ AS61K	^ AS6K1	^ AW128	^ AW611	^ AW615
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-011	EB2012960-012	EB2012960-01K	EB2012960-015	EB2012960-013
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-0v8	-1vK	-0v9	-3v7	-5v9
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	6v0	6v1	3v6	6vK	6v1
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	<0.1	<0.1	2v9	<0.1	<0.1
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	2vK	1vK	3v8	7v2	3v2
ANC nh CnCOK	----	0.1	% CaCO3	0v2	0v1	0v7	0v7	0v8
F2zz Rni2u	----	0	Fizz Unit	0	0	1	1	1
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	7v9	6v1	6v2	6vK	6v8
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	K89	2K0	5K0	2K0	K71
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v07	<0.01	0v13	0v02	0v01

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ BA87K	^ B4 315	^ B4 777	^ BH071	^ BH109
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-017	EB2012960-016	EB2012960-018	EB2012960-019	EB2012960-020
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-7vK	-2v9	<0.2	-7v8	-157
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	8v0	7v8	5v5	6v2	8v6
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	0v2	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	<0.1	1v0	1v9	<0.1	<0.1
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	8v1	2v9	3v6	6v6	157
ANC nh CnCOK	----	0.1	% CaCO3	0v8	0vK	0v7	0v8	15v9
F2zz Rni2u	----	0	Fizz Unit	1	0	1	1	K
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	8v0	8v1	3v5	6v9	8v0
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	279	K77	K8K	18K	KKK
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v07	<0.01	0v19	0v0K	<0.01

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ BJ55K	^ BJ711	^ BL616	^ BL673	^ BL678
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-021	EB2012960-022	EB2012960-02K	EB2012960-025	EB2012960-023
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	3v9	-2vK	-2v8	-1vK	-Kv0
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	7v2	6v8	7v9	6v0	7v5
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	1vl	<0.1	0v6	<0.1	1v0
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	2v6	2v7	2v8	2v2	Kv0
ANC nh CnCOK	----	0.1	% CaCO3	0vK	0vK	0vK	0v2	0vK
F2zz Rni2u	----	0	Fizz Unit	0	0	0	0	0
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	3v9	6v0	7v8	7v6	6vl
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	1750	K69	53K	667	KKK
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v28	0v01	<0.01	0v0K	<0.01

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ BL665	^ BL818	^ BO225	^ BO233	^ BOK59
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-027	EB2012960-026	EB2012960-028	EB2012960-029	EB2012960-0K0
				Result	Result	Result	Result	Result
EA009: Nei Ag2l MrodbgiDot Moiet iDha								
Nei Ag2l MrodbgiDot Moiet iDha	----	0.2	kg H6SO4/t	-2v8	-2v1	-2vK	-30vK	-1Kv5
EA011: Nei Ag2l 4 et erniDot								
mH (OX)	----	0.1	5H Unit	7v5	6v2	7v6	8v9	10v1
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	1v2	<0.1	1v0	<0.1	<0.1
EA01K: Ag2l NebirnaDnD u CnmgDQ								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	2v8	2v6	2vK	30v9	15v0
ANC nh CnCOK	----	0.1	% CaCO3	0vK	0vK	0v2	3v2	1v5
FD2z RniD u	----	0	Fizz Unit	0	0	0	2	1
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	6v5	6v2	6v0	6v8	8v0
EA0K2: EægirDgnaCot dbgiD DQ(hnibrnied mnhie)								
ø EægirDgnaCot dbgiD DQ(Snibrnied Mnhie)	----	1	µS/cm	K10	15K0	261	305	K88
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	<0.01	0v02	<0.01	0v02	0v02

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ BO816	^ BR002	^ BR00K	^ CH572	^ CH835
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-0K1	EB2012960-0K2	EB2012960-0KK	EB2012960-0K5	EB2012960-0K3
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-7v5	-8v6	-2vK	-2v2	-5v8
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	7v8	7v8	7v1	7v6	6v6
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	0v5	1v9	Kv6	2v0	<0.1
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	6v0	9v0	2vK	2v8	3v1
ANC nh CnCOK	----	0.1	% CaCO3	0v6	0v9	0v2	0vK	0v8
F2zz Rni2u	----	0	Fizz Unit	1	1	0	0	0
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	7v8	6v2	6v0	6v2	6vK
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	279	K18	516	533	K85
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v02	0v01	<0.01	0v02	0v02

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ CI118	^ CI779	^ CI918	^ CJ122	^ CJ186
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-0K7	EB2012960-0K6	EB2012960-0K8	EB2012960-0K9	EB2012960-050
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-1v8	-27v0	1vK	-5v2	0v8
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	3v7	6v5	5v8	7vK	3v8
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	1v2	<0.1	2v8	1v5	0v9
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	2v1	27v9	1v8	5v8	2v0
ANC nh CnCOK	----	0.1	% CaCO3	0v2	2v6	0v2	0v8	0v2
F2zz Rni2u	----	0	Fizz Unit	0	1	0	0	0
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	7v2	6v6	3vK	7v6	3v8
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	239	1220	1260	6K7	K3K
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v01	0v0K	0v10	0v02	0v09

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ CJ215	^ CJ261	^ CJK08	^ CJK65	^ CJ550
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00
Compound	CAS Number	LOR	Unit	EB2012960-051	EB2012960-052	EB2012960-05K	EB2012960-055	EB2012960-053
				Result	Result	Result	Result	Result
EA009: Nei Ag2l Mrodbgi2ot Moiet i2ha								
Nei Ag2l Mrodbgi2ot Moiet i2ha	----	0.2	kg H6SO4/t	-2v1	-0v9	-2v1	-0v8	-1v8
EA011: Nei Ag2l 4 et erni2ot								
mH (OX)	----	0.1	5H Unit	7vK	3v8	3v8	7vK	7v5
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	0vK	0v8	1vK	1v0	0v7
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	2v1	2v5	2v6	KvK	Kv0
ANC nh CnCOK	----	0.1	% CaCO3	0v2	0v2	0vK	0vK	0vK
F2zz Rni2u	----	0	Fizz Unit	0	0	0	0	0
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	3v7	7v0	7v7	6v1	6v0
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	80	13K	K72	218	1K9
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	<0.01	0v03	0v02	0v08	0v05

Analytical Results

Sub-Matrix: MULM (Matrix: SOIL)			Client sample ID	^ CJ359	^ PP700	^ PRK01	^ PR569	----
			Client sampling date / time	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	04-May-6060 00:00	----
Compound	CAS Number	LOR	Unit	EB2012960-057	EB2012960-056	EB2012960-058	EB2012960-059	--------
				Result	Result	Result	Result	----
EA009: Nei Ag2l Mrodbgi2t Moiet iDha								
Nei Ag2l Mrodbgi2t Moiet iDha	----	0.2	kg H6SO4/t	5vK	-2v2	-0v8	-3vK	----
EA011: Nei Ag2l 4 et erni2t								
mH (OX)	----	0.1	5H Unit	5v7	3v0	3v9	6v7	----
NA4 (mH 5v8)	----	0.1	kg H6SO4/t	<0.1	<0.1	<0.1	<0.1	----
NA4 (mH 6v0)	----	0.1	kg H6SO4/t	1v1	0v9	0v5	<0.1	----
EA01K: Ag2l Nebirna2i2 u Cnmmg2Q								
ANC nh H2SO5	----	0.2	kg H6SO4 equiv./t	1v2	2v8	2v0	7v2	----
ANC nh CnCOK	----	0.1	% CaCO3	0v1	0v2	0v2	0v7	----
F2zz Rni2u	----	0	Fizz Unit	0	0	0	0	----
EA0K1: mH (hnibrnied mnhie)								
ø mH (Snibrnied Mnhie)	----	0.1	5H Unit	5v8	3v5	3v7	8v0	----
EA0K2: Eægir2gnaCot dbgi2 2Q(hnibrnied mnhie)								
ø Eægir2gnaCot dbgi2 2Q(Snibrnied Mnhie)	----	1	µS/cm	107	177	808	215	----
EP052T: ToinaSbalbr wQLECO								
Sbalbr - Toinanh S (LECO)	----	0.01	%	0v18	0v01	0v05	0v0K	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2018669**	Page	: 1 of 41
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-Jul-2020 09:08
Order number	: ----	Date Analysis Commenced	: 29-Jul-2020
C-O-C number	: ----	Issue Date	: 19-Aug-2020 17:03
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 62		
No. of samples analysed	: 62		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK055G (Ammonia as N) / EK059G (Nitrite and Nitrate as N): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- ALS is not NATA accredited for the performance of EN35: Miscellaneous Leaching procedure.
- It is recognised that EK059G (Nitrite + Nitrate) is less than EK057G (Nitrite) for some samples . However, the difference is within experimental variation of the methods.
- EG020-W (Water Leachable Metals by ICP-MS): The high failing laboratory control standard for Antimony and Tantalum is deemed acceptable as all associated results are less than the limit of reporting.
- EA046 ABCC: NATA Acreditation does not cover the performance of this service.

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITI551 EB2012965060	ITI571 EB2012965061	ITI951 EB2012965064	ITI971 EB2012965065	ITJ709 EB2012965067
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-001	EB2018669-002	EB2018669-003	EB2018669-004	EB2018669-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.62	6.55	4.92	6.80	7.92
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		800	537	112	200	354
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		99	26	1	34	93
Total Alkalinity as CaCO3	----	1	mg/L		99	26	1	34	93
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		5	6	14	6	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		108	41	17	17	15
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		116	117	10	25	31
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		6	18	1	7	23
Magnesium	7439-95-4	1	mg/L		12	18	<1	7	13
Sodium	7440-23-5	1	mg/L		129	53	14	21	30
Potassium	7440-09-7	1	mg/L		22	8	7	4	6
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.02
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		0.005	0.002	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.022	0.019	0.005	0.006	0.013
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	0.001	0.002
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	0.001	<0.001

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITI551 EB2012965060	ITI571 EB2012965061	ITI951 EB2012965064	ITI971 EB2012965065	ITJ709 EB2012965067
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-001	EB2018669-002	EB2018669-003	EB2018669-004	EB2018669-005
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.020**	**0.008**	**0.019**	**0.005**	**0.007**
Manganese	7439-96-5	0.001	mg/L		**0.010**	**0.012**	**0.002**	**0.002**	**0.001**
Molybdenum	7439-98-7	0.001	mg/L		**0.010**	<0.001	<0.001	<0.001	**0.004**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.014**	**0.014**	**0.003**	**0.008**	**0.019**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.048**	**0.070**	**0.009**	**0.029**	**0.042**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.009**	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.19**	**0.09**	**0.14**	**0.29**	**0.07**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**14.5**	**19.0**	**33.8**	**19.1**	**13.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.21**	**0.27**	**0.10**	**0.17**	**0.12**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	**0.01**	<0.01	**0.03**	**0.03**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITI551 EB2012965060	ITI571 EB2012965061	ITI951 EB2012965064	ITI971 EB2012965065	ITJ709 EB2012965067
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-001	EB2018669-002	EB2018669-003	EB2018669-004	EB2018669-005
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		1.65	0.10	0.08	0.05	0.48
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		1.66	0.11	0.08	0.08	0.51
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.6	0.3	0.2	0.2	0.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		2.3	0.4	0.3	0.3	0.7

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITL213 EB2012967001	ITL714 EB2012967002	ITL781 EB2012967004	ITL838 EB2012967005	ITM231 EB2012967006
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-006	EB2018669-007	EB2018669-008	EB2018669-009	EB2018669-010
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.16	7.02	6.21	6.28	7.17
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		1050	529	557	1090	345
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		46	89	156	59	47
Total Alkalinity as CaCO3	----	1	mg/L		46	89	156	59	47
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		4	5	17	7	6
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		101	35	20	152	18
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		257	59	34	202	52
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		32	22	37	18	23
Magnesium	7439-95-4	1	mg/L		45	30	21	49	11
Sodium	7440-23-5	1	mg/L		96	44	24	128	24
Potassium	7440-09-7	1	mg/L		16	7	6	10	8
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.01	0.02	0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		0.002	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.023	0.129	0.010	0.033	0.064
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	0.002	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	0.013	<0.001	0.001
Copper	7440-50-8	0.001	mg/L		0.001	0.002	0.001	0.002	0.001

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITL213 EB2012967001	ITL714 EB2012967002	ITL781 EB2012967004	ITL838 EB2012967005	ITM231 EB2012967006
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-006	EB2018669-007	EB2018669-008	EB2018669-009	EB2018669-010
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.005**	**0.006**	**0.001**	**0.005**	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.008**	**0.537**	**43.0**	**0.204**	**0.066**
Molybdenum	7439-98-7	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	**0.001**	**0.003**	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.014**	**0.011**	**0.008**	**0.011**	**0.013**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.141**	**0.186**	**0.063**	**0.217**	**0.079**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.008**	<0.005	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.18**	**0.13**	**0.09**	**0.24**	**0.07**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	**0.14**	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**9.50**	**23.9**	**12.7**	**25.4**	**55.0**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.21**	**0.22**	**0.24**	**0.36**	**0.20**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.02**	**0.01**	<0.01	<0.01	**0.03**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITL213 EB2012967001	ITL714 EB2012967002	ITL781 EB2012967004	ITL838 EB2012967005	ITM231 EB2012967006
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-006	EB2018669-007	EB2018669-008	EB2018669-009	EB2018669-010
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.05	0.17	1.27	0.19	0.48
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.07	0.18	1.27	0.19	0.51
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.4	0.4	0.4	0.6	0.4
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.5	0.6	1.7	0.8	0.9

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITM284 EB2012967007	ITM458 EB2012967009	ITM815 EB2012967010	ITN542 EB2012967012	ITN784 EB2012967013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-011	EB2018669-012	EB2018669-013	EB2018669-014	EB2018669-015
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.44**	**7.06**	**8.16**	**7.12**	**7.54**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**310**	**328**	**410**	**173**	**259**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**87**	**39**	**120**	**31**	**85**
Total Alkalinity as CaCO3	----	1	mg/L		**87**	**39**	**120**	**31**	**85**
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		**7**	**5**	**2**	**2**	**4**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**19**	**30**	**26**	**14**	**12**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**27**	**43**	**31**	**18**	**18**
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		**25**	**5**	**30**	**12**	**28**
Magnesium	7439-95-4	1	mg/L		**8**	**5**	**28**	**6**	**11**
Sodium	7440-23-5	1	mg/L		**24**	**52**	**16**	**11**	**8**
Potassium	7440-09-7	1	mg/L		**7**	**6**	**3**	**2**	**1**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	<0.01	**0.02**	**0.05**	**0.02**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.025**	**0.008**	**0.004**	**0.006**	**0.006**
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		**0.001**	**0.001**	**0.001**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	<0.001

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITM284 EB2012967007	ITM458 EB2012967009	ITM815 EB2012967010	ITN542 EB2012967012	ITN784 EB2012967013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-011	EB2018669-012	EB2018669-013	EB2018669-014	EB2018669-015
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.001**	**0.003**	**0.005**	**0.004**
Manganese	7439-96-5	0.001	mg/L		**0.003**	**0.013**	**0.005**	**0.002**	**0.013**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.001**	**0.011**	<0.001	**0.021**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.012**	**0.006**	**0.008**	**0.007**	**0.003**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.067**	**0.026**	**0.048**	**0.032**	**0.034**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.07**	**0.11**	<0.05	**0.13**	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**43.8**	**40.5**	**4.74**	**7.63**	**8.48**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.08**	**0.09**	**0.11**	**0.32**	**0.16**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.06**	**0.02**	**0.03**	**0.03**	**0.02**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITM284 EB2012967007	ITM458 EB2012967009	ITM815 EB2012967010	ITN542 EB2012967012	ITN784 EB2012967013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-011	EB2018669-012	EB2018669-013	EB2018669-014	EB2018669-015
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.30	0.19	0.11	0.01	0.09
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.36	0.21	0.14	0.04	0.11
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.2	0.3	0.3	0.4	0.3
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.6	0.5	0.4	0.4	0.4

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITQ041 EB2012967016	ITU378 EB2012967023	ITU783 EB2012967025	ITV767 EB2012967030	ITV838 EB2012967031
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-016	EB2018669-017	EB2018669-018	EB2018669-019	EB2018669-020
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.11**	**7.84**	**7.09**	**7.88**	**4.19**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**672**	**253**	**219**	**423**	**1580**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**33**	**82**	**35**	**66**	<1
Total Alkalinity as CaCO3	----	1	mg/L		**33**	**82**	**35**	**66**	<1
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		**4**	**2**	**3**	**3**	**45**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**46**	**22**	**7**	**58**	**683**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**150**	**15**	**22**	**48**	**119**
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		**26**	**27**	**16**	**24**	**85**
Magnesium	7439-95-4	1	mg/L		**21**	**11**	**9**	**16**	**85**
Sodium	7440-23-5	1	mg/L		**62**	**7**	**11**	**33**	**88**
Potassium	7440-09-7	1	mg/L		**9**	**5**	**3**	**5**	**24**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	**2.58**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	**0.002**	**0.006**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.003**
Barium	7440-39-3	0.001	mg/L		**0.013**	**0.004**	**0.014**	**0.044**	**0.056**
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	**0.0004**
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	**0.003**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.439**
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.050**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITQ041 EB2012967016	ITU378 EB2012967023	ITU783 EB2012967025	ITV767 EB2012967030	ITV838 EB2012967031
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-016	EB2018669-017	EB2018669-018	EB2018669-019	EB2018669-020
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.010**
Lithium	7439-93-2	0.001	mg/L		**0.006**	**0.003**	**0.003**	<0.001	**0.005**
Manganese	7439-96-5	0.001	mg/L		**0.002**	<0.001	**0.002**	<0.001	**0.213**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.003**	<0.001	**0.007**	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.346**
Rubidium	7440-17-7	0.001	mg/L		**0.022**	**0.004**	**0.008**	**0.005**	**0.033**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.33**
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.090**	**0.030**	**0.040**	**0.155**	**0.345**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	**0.002**	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.006**
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**0.128**
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.11**	<0.05	<0.05	<0.05	**0.18**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	**0.56**
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**6.20**	**7.15**	**3.01**	**25.7**	**14.8**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.16**	**0.07**	**0.23**	<0.01	**0.12**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.02**	**0.06**	**0.04**	**0.03**	<0.01

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITQ041 EB2012967016	ITU378 EB2012967023	ITU783 EB2012967025	ITV767 EB2012967030	ITV838 EB2012967031
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-016	EB2018669-017	EB2018669-018	EB2018669-019	EB2018669-020
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.08**	**0.38**	**0.35**	**0.06**	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.10**	**0.44**	**0.39**	**0.09**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.4**	**0.3**	**0.7**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**0.8**	**0.4**	**0.7**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITV914 EB2012967033	ITV916 EB2012967034	ITV995 EB2012967035	ITW108 EB2012967036	ITY858 EB2012967043
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-021	EB2018669-022	EB2018669-023	EB2018669-024	EB2018669-025
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.88**	**7.95**	**6.89**	**7.39**	**6.97**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**609**	**578**	**328**	**245**	**132**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**94**	**100**	**34**	**34**	**37**
Total Alkalinity as CaCO3	----	1	mg/L		**94**	**100**	**34**	**34**	**37**
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		**2**	**2**	**2**	**2**	**2**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**72**	**51**	**41**	**11**	**6**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**74**	**72**	**48**	**39**	**10**
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		**26**	**28**	**14**	**8**	**10**
Magnesium	7439-95-4	1	mg/L		**18**	**19**	**11**	**4**	**7**
Sodium	7440-23-5	1	mg/L		**76**	**65**	**33**	**34**	**8**
Potassium	7440-09-7	1	mg/L		**6**	**7**	**5**	**4**	**2**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	**0.01**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.025**	**0.032**	**0.011**	**0.013**	**0.020**
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.006**	**0.014**	**0.001**	<0.001	**0.004**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITV914 EB2012967033	ITV916 EB2012967034	ITV995 EB2012967035	ITW108 EB2012967036	ITY858 EB2012967043
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-021	EB2018669-022	EB2018669-023	EB2018669-024	EB2018669-025
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.006**	**0.009**	**0.009**	**0.001**	**0.003**
Manganese	7439-96-5	0.001	mg/L		**0.005**	**0.008**	**0.001**	**0.011**	**0.065**
Molybdenum	7439-98-7	0.001	mg/L		**0.007**	**0.007**	<0.001	<0.001	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Rubidium	7440-17-7	0.001	mg/L		**0.011**	**0.012**	**0.014**	**0.008**	**0.004**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.129**	**0.174**	**0.051**	**0.035**	**0.034**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.010**	**0.015**	<0.005	**0.008**	**0.011**
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.15**	**0.17**	**0.16**	**0.13**	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**19.5**	**14.9**	**13.8**	**52.0**	**25.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	<0.01	**0.25**	**0.03**	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.04**	**0.19**	<0.01

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITV914 EB2012967033	ITV916 EB2012967034	ITV995 EB2012967035	ITW108 EB2012967036	ITY858 EB2012967043
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-021	EB2018669-022	EB2018669-023	EB2018669-024	EB2018669-025
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	**0.03**	**0.07**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.07**	**0.26**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.4**	**0.5**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.5**	**0.8**	**0.1**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITY943 EB2012967044	IUI061 EB2012967045	IUI522 EB2012967046	IUI533 EB2012967047	IUJ616 EB2012967048
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-026	EB2018669-027	EB2018669-028	EB2018669-029	EB2018669-030
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.31**	**5.75**	**7.95**	**8.03**	**7.63**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**206**	**173**	**1060**	**1140**	**201**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**24**	**20**	**109**	**122**	**53**
Total Alkalinity as CaCO3	----	1	mg/L		**24**	**20**	**109**	**122**	**53**
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		**2**	**13**	**2**	**2**	**2**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**38**	**24**	**132**	**88**	**20**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**20**	**16**	**212**	**236**	**15**
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		**10**	**8**	**23**	**66**	**13**
Magnesium	7439-95-4	1	mg/L		**5**	**7**	**28**	**40**	**7**
Sodium	7440-23-5	1	mg/L		**23**	**11**	**146**	**96**	**19**
Potassium	7440-09-7	1	mg/L		**4**	**4**	**17**	**15**	**4**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.03**	<0.01	**0.02**	<0.01	**0.01**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.003**	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.012**	**0.037**	**0.021**	**0.045**	**0.012**
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.001**	**0.001**	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	**0.002**	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	**0.003**	**0.002**	**0.002**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	ITY943 EB2012967044	IUI061 EB2012967045	IUI522 EB2012967046	IUI533 EB2012967047	IUJ616 EB2012967048
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-026	EB2018669-027	EB2018669-028	EB2018669-029	EB2018669-030
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.028**	**0.001**	**0.020**	**0.010**	**0.016**
Manganese	7439-96-5	0.001	mg/L		**0.005**	**0.012**	**0.019**	**0.011**	**0.008**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	**0.001**	**0.002**	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.012**	**0.007**	**0.007**	**0.014**	**0.011**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.030**	**0.073**	**0.224**	**0.244**	**0.034**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.008**	<0.005	<0.005	**0.006**
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.11**	**0.29**	**0.33**	**0.14**	**0.10**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**34.9**	**16.7**	**40.4**	**23.7**	**24.1**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.43**	<0.01	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.02**	<0.01	**0.09**	<0.01	<0.01

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	ITY943 EB2012967044	IUI061 EB2012967045	IUI522 EB2012967046	IUI533 EB2012967047	IUJ616 EB2012967048
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-026	EB2018669-027	EB2018669-028	EB2018669-029	EB2018669-030
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.01**	**0.08**	**0.06**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.03**	**0.08**	**0.15**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.5**	**0.4**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.2**	**0.6**	**0.6**	**0.2**	**0.2**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IUK907 EB2012967049	IUO164 EB2012967053	IUO168 EB2012967054	IUO309 EB2012967055	IUO422 EB2012967056
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-031	EB2018669-032	EB2018669-033	EB2018669-034	EB2018669-035
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.92	7.05	7.96	7.33	7.84
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		170	343	388	260	321
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		11	34	98	38	97
Total Alkalinity as CaCO3	----	1	mg/L		11	34	98	38	97
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		2	2	<1	2	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		14	40	33	26	26
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		26	48	36	32	21
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		5	13	23	7	22
Magnesium	7439-95-4	1	mg/L		4	8	14	6	13
Sodium	7440-23-5	1	mg/L		16	40	36	31	28
Potassium	7440-09-7	1	mg/L		8	6	7	6	7
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	0.02	<0.01	0.01	0.02
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	0.003	0.002	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.037	0.016	0.024	0.013	0.010
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	0.001	0.001	0.003
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	IUK907 EB2012967049	IUO164 EB2012967053	IUO168 EB2012967054	IUO309 EB2012967055	IUO422 EB2012967056
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-031	EB2018669-032	EB2018669-033	EB2018669-034	EB2018669-035
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.003**	**0.002**	**0.001**	**0.002**	**0.002**
Manganese	7439-96-5	0.001	mg/L		**0.009**	**0.005**	**0.004**	**0.003**	<0.001
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	**0.003**	<0.001	**0.005**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.007**	**0.014**	**0.019**	**0.016**	**0.021**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.037**	**0.041**	**0.114**	**0.029**	**0.054**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.005**	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.15**	**0.10**	**0.14**	**0.15**
Iron	7439-89-6	0.05	mg/L		**0.07**	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**25.9**	**25.9**	**18.0**	**36.9**	**10.1**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	<0.01	<0.01	<0.10	<0.10
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.03**	**0.02**	<0.01	**0.03**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IUK907 EB2012967049	IUO164 EB2012967053	IUO168 EB2012967054	IUO309 EB2012967055	IUO422 EB2012967056
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-031	EB2018669-032	EB2018669-033	EB2018669-034	EB2018669-035
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.06**	**0.01**	**0.01**	<0.01	<0.10
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.06**	**0.04**	**0.03**	<0.01	<0.10
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.1**	**0.2**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.3**	**0.2**	**0.1**	**0.2**	**0.1**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IUO469 EB2012967057	IUO694 EB2012967059	IUP204 EB2012967062	IUP212 EB2012967063	IUP217 EB2012967064
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-036	EB2018669-037	EB2018669-038	EB2018669-039	EB2018669-040
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.08	6.96	5.98	5.16	7.63
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		460	250	1390	1090	816
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		116	28	6	5	64
Total Alkalinity as CaCO3	----	1	mg/L		116	28	6	5	64
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		2	2	3	7	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		44	41	139	161	54
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		44	23	332	231	185
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		30	3	23	20	21
Magnesium	7439-95-4	1	mg/L		18	3	50	46	31
Sodium	7440-23-5	1	mg/L		38	39	165	110	82
Potassium	7440-09-7	1	mg/L		7	9	14	9	14
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.02	<0.01	0.06	0.01	0.02
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.022	0.007	0.033	0.027	0.018
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.002	<0.001	0.002	0.001	0.005

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	IUO469 EB2012967057	IUO694 EB2012967059	IUP204 EB2012967062	IUP212 EB2012967063	IUP217 EB2012967064
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-036	EB2018669-037	EB2018669-038	EB2018669-039	EB2018669-040
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.002**	**0.011**	**0.002**	**0.002**	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.002**	**0.002**	**0.018**	**0.129**	**0.002**
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	**0.002**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	**0.002**	**0.007**	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.019**	**0.006**	**0.018**	**0.014**	**0.021**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.086**	**0.022**	**0.323**	**0.201**	**0.177**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.012**	**0.014**	**0.008**
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.12**	**0.17**	**0.32**	**0.22**	**0.25**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.35**	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**13.3**	**22.8**	**25.6**	**15.2**	**11.8**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.01**	**0.07**	**0.78**	**0.56**	<0.10
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.04**	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IUO469 EB2012967057	IUO694 EB2012967059	IUP204 EB2012967062	IUP212 EB2012967063	IUP217 EB2012967064
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-036	EB2018669-037	EB2018669-038	EB2018669-039	EB2018669-040
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.07**	**0.09**	**0.09**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.07**	**0.09**	**0.09**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.3**	**0.2**	**0.9**	**0.6**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.3**	**0.3**	**1.0**	**0.7**	**0.2**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	IUP669 EB2012967065	IUP864 EB2012967066	IUV445 EB2012967067	IVA003 EB2012967068	IVA087 EB2012967069
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-041	EB2018669-042	EB2018669-043	EB2018669-044	EB2018669-045
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.61**	**6.97**	**7.05**	**6.38**	**6.57**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**657**	**190**	**299**	**437**	**406**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**51**	**14**	**21**	**50**	**45**
Total Alkalinity as CaCO3	----	1	mg/L		**51**	**14**	**21**	**50**	**45**
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	**2**	**2**	**6**	**7**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**45**	**13**	**28**	**41**	**33**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**131**	**30**	**52**	**56**	**62**
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		**6**	**9**	**6**	**18**	**22**
Magnesium	7439-95-4	1	mg/L		**15**	**6**	**8**	**17**	**17**
Sodium	7440-23-5	1	mg/L		**90**	**15**	**36**	**38**	**33**
Potassium	7440-09-7	1	mg/L		**13**	**3**	**6**	**6**	**3**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	**0.01**	<0.01	**0.02**
Antimony	7440-36-0	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.010**	**0.039**	**0.033**	**0.022**	**0.030**
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	<0.001	**0.004**	**0.001**	**0.002**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IUP669 EB2012967065	IUP864 EB2012967066	IUV445 EB2012967067	IVA003 EB2012967068	IVA087 EB2012967069
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-041	EB2018669-042	EB2018669-043	EB2018669-044	EB2018669-045
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.001**	**0.002**	**0.009**	**0.012**	**0.004**
Manganese	7439-96-5	0.001	mg/L		**0.003**	**0.002**	**0.006**	**0.007**	**0.009**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	**0.001**
Rubidium	7440-17-7	0.001	mg/L		**0.015**	**0.005**	**0.005**	**0.016**	**0.008**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.062**	**0.042**	**0.054**	**0.070**	**0.086**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.010**	**0.007**	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.24**	**0.06**	**0.07**	**0.14**	**0.07**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**42.4**	**10.9**	**42.7**	**16.7**	**11.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	<0.01	<0.01	**0.36**	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	**0.03**	<0.01

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IUP669 EB2012967065	IUP864 EB2012967066	IUV445 EB2012967067	IVA003 EB2012967068	IVA087 EB2012967069
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-041	EB2018669-042	EB2018669-043	EB2018669-044	EB2018669-045
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.01**	**0.03**	**0.10**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.01**	**0.03**	**0.13**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.1**	**0.1**	**0.2**	**0.6**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.1**	**0.1**	**0.2**	**0.7**	**0.2**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IVA196 EB2012968001	IVB619 EB2012968011	IVC161 EB2012968016	IVM058 EB2012968021	IVN449 EB2012968026
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-046	EB2018669-047	EB2018669-048	EB2018669-049	EB2018669-052
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.64	7.57	7.69	8.00	8.00
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		680	1170	626	746	581
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		76	51	64	86	72
Total Alkalinity as CaCO3	----	1	mg/L		76	51	64	86	72
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		4	15	2	<1	9
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		79	210	83	160	48
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		121	188	88	65	96
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		22	52	23	44	29
Magnesium	7439-95-4	1	mg/L		23	17	24	22	21
Sodium	7440-23-5	1	mg/L		72	122	54	65	42
Potassium	7440-09-7	1	mg/L		8	14	15	22	14
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.02	<0.01	0.02	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.002	0.002	<0.001	0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.031	0.025	0.011	0.032	0.006
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.001

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	IVA196 EB2012968001	IVB619 EB2012968011	IVC161 EB2012968016	IVM058 EB2012968021	IVN449 EB2012968026
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-046	EB2018669-047	EB2018669-048	EB2018669-049	EB2018669-052
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.009**	<0.001	**0.006**	**0.002**	**0.001**
Manganese	7439-96-5	0.001	mg/L		**0.002**	<0.001	<0.001	**0.002**	**0.001**
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	**0.021**	**0.040**	<0.001	**0.004**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.013**	**0.006**	**0.028**	**0.021**	**0.017**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	**0.02**	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.118**	**0.320**	**0.089**	**0.309**	**0.081**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.15**	**0.25**	**0.15**	**0.29**	**0.12**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**23.3**	**15.3**	**8.74**	**16.0**	**7.31**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.11**	**0.07**	**0.11**	<0.01	**0.01**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	**0.02**	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IVA196 EB2012968001	IVB619 EB2012968011	IVC161 EB2012968016	IVM058 EB2012968021	IVN449 EB2012968026
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-046	EB2018669-047	EB2018669-048	EB2018669-049	EB2018669-052
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.04**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.06**	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	**0.5**	**0.3**	**0.2**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.4**	**0.6**	**0.3**	**0.2**	**0.1**

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	IVN891 EB2012968029	IWQ038 EB2012968030	IWS568 EB2012968038	IXA258 EB2012968047	IYD745 EB2012968052
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-054	EB2018669-055	EB2018669-059	EB2018669-060	EB2018669-061
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**9.37**	**7.84**	**8.26**	**6.66**	**7.23**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**831**	**512**	**342**	**565**	**250**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		**66**	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**145**	**46**	**106**	**29**	**33**
Total Alkalinity as CaCO3	----	1	mg/L		**211**	**46**	**106**	**29**	**33**
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	**3**	<1	**2**	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**76**	**64**	**43**	**38**	**34**
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**66**	**80**	**22**	**120**	**38**
ED093W: Water Leachable Major Cations									
Calcium	7440-70-2	1	mg/L		<1	**4**	**12**	**17**	**10**
Magnesium	7439-95-4	1	mg/L		<1	**7**	**6**	**20**	**9**
Sodium	7440-23-5	1	mg/L		**173**	**84**	**53**	**56**	**23**
Potassium	7440-09-7	1	mg/L		**14**	**9**	**6**	**7**	**2**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.10**	**0.02**	**0.01**	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L		**0.004**	<0.001	<0.001	<0.001	<0.001
Niobium	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		**0.537**	**0.008**	<0.001	<0.001	**0.003**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.001**	**0.032**	**0.028**	**0.017**	**0.013**
Rhenium	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		**0.001**	**0.002**	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	**0.006**	**0.002**	<0.001	<0.001

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	IVN891 EB2012968029	IWQ038 EB2012968030	IWS568 EB2012968038	IXA258 EB2012968047	IYD745 EB2012968052
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB2018669-054	EB2018669-055	EB2018669-059	EB2018669-060	EB2018669-061
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.002**	<0.001	**0.001**	**0.019**	**0.002**
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	<0.001	**0.207**	<0.001
Molybdenum	7439-98-7	0.001	mg/L		**0.020**	**0.002**	**0.012**	<0.001	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	**0.005**	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.018**	**0.008**	**0.005**	**0.010**	**0.004**
Selenium	7782-49-2	0.01	mg/L		**0.01**	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.002**	**0.067**	**0.094**	**0.073**	**0.920**
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		**0.06**	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	**0.008**	<0.005
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.12**	**0.30**	**0.17**	**0.13**	**0.07**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		**0.010**	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L		**13.1**	**28.0**	**30.7**	**13.9**	**18.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	<0.01	<0.01	**0.40**	**0.03**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.04**	<0.01	**0.03**

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	IVN891 EB2012968029	IWQ038 EB2012968030	IWS568 EB2012968038	IXA258 EB2012968047	IYD745 EB2012968052
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-054	EB2018669-055	EB2018669-059	EB2018669-060	EB2018669-061
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.03**	<0.01	**0.65**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.03**	**0.01**	**0.65**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.6**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.2**	**0.2**	**0.2**	**1.2**	**0.2**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Client sample ID	IVM112 EB2012968023	IVN356 EB2012968025	IVN871 EB2012968028	IWQ166 EB2012968032	IWS032 EB2012968036
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-050	EB2018669-051	EB2018669-053	EB2018669-056	EB2018669-057
					Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.008**	**0.011**	**0.011**	**0.008**	**0.008**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**2380**	**1020**	**1430**	**330**	**890**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Client sample ID	IWS038 EB2012968037	----	----	----	----
				Client sampling date / time	04-May-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2018669-058	--------	--------	--------	--------
					Result	----	----	----	----
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.011**	**----**	**----**	**----**	**----**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**4490**	**----**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ITI551 EB2012965060	ITL781 EB2012967004	ITM284 EB2012967007	ITM815 EB2012967010	ITN784 EB2012967013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-001	EB2018669-008	EB2018669-011	EB2018669-013	EB2018669-015
					Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**----**	**0.005**	**----**	**----**	**0.035**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**----**	<100	**----**	**----**	<100
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.13**	**0.08**	**0.08**	**0.20**	**----**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TC	0.02	%		**0.14**	**0.09**	**5.26**	**11.8**	**----**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		<0.02	<0.02	**5.18**	**11.6**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ITV767 EB2012967030	ITV838 EB2012967031	ITV914 EB2012967033	ITV916 EB2012967034	IUI061 EB2012967045
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-019	EB2018669-020	EB2018669-021	EB2018669-022	EB2018669-027
					Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		----	1.09	----	----	----
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		----	1980	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		0.21	----	0.11	0.12	0.08
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TC	0.02	%		9.64	----	0.39	0.32	0.09
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		9.43	----	0.28	0.20	<0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	IUI522 EB2012967046	IUI533 EB2012967047	IVB619 EB2012968011	IVC161 EB2012968016	IVM058 EB2012968021
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018669-028	EB2018669-029	EB2018669-047	EB2018669-048	EB2018669-049
					Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**----**	**----**	**0.008**	**0.117**	**0.009**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**----**	**----**	**490**	**200**	**380**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.19**	**0.07**	**----**	**----**	**----**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TC	0.02	%		**0.58**	**0.10**	**----**	**----**	**----**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**0.39**	**0.03**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	IVN449 EB2012968026	IVN891 EB2012968029	pH and EC of DI water	----	----
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	23-Jul-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EB2018669-052	EB2018669-054	EB2018669-062	--------	--------
					Result	Result	Result	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**----**	**----**	**5.2**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**----**	**----**	<1	**----**	**----**
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.027**	**0.014**	**----**	**----**	**----**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**200**	**510**	**----**	**----**	**----**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**3.91**	**4.47**	**----**	**----**	**----**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TC	0.02	%		**4.51**	**4.48**	**----**	**----**	**----**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**0.60**	<0.02	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2018655**	Page	: 1 of 4L
l ineEy	: **RGS ENVIRONMENTAL PTY LTD**	bat orayorC	: v EmroED eEyai s mmBroE c rnBt aEe
l oEyaMy	: RA RNTT bNSs v Ah	l oEyaMy	: l arByeE v D rnMd
NCOreBB	: PX c X3 L091 hUSSYc NSK hXUTH Qbs , NUhTANbIN 4109	NCOreBB	: 2 c Oyd hyreeyhyafforOQbs NuByraina 405L
TeiepdoEe	: +61 07 LL44 1222	TeiepdoEe	: +61 7 L552 8616
ProjeMy	: 2019068 ATIX c roMkD aE	s aye haD pieB AeMemmeO	: 14-Jui-2020 19:48
XrOer EuD t er	: ----	s aye NEaiCBnBl oDD eEMeO	: 0L-Nug-2020
l -X-l EuD t er	: ----	IBBue s aye	: 21-Nug-2020 17:10
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So. of BaD pieB aEaiCBeO	: 59		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

TdnB reporyBuperBeOeB aEC prenmouB repory(B) wnd ydnB refereEMe. AeBuiyB appiCyo yde BaD pie(B) aB But DnyeO. TdnB CoMuD eEyBdaii Eoyt e reproOuMeO, exMepynE fuii.

TdnB l eryfnMaye of NEaiCBnB MoEyanEB yde foiiownEg nEforD ayroE:

- GeEerai l oDD eEyB
- NEaiCynMai AeBuiyB

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

TdnB CoMuD eEydaBt eeE eieMyroEnMaiiCBngEeOt Cyde auydornzeOBngEayorneBt eiow. v ieMyroEnMBngEnEg nB MarrneOouynE MoD pinaEMe wnd proMeOureB BpeMfineOnE 21 l FA Pary11.

Signatories	*Position*	*Accreditation Category*
c eE FeigeEOrejemB	heEnor NMkOhuifaye hon l deDnBy	c rnBt aEe NMkOhuipdaye honiB, hyafforO, Qbs
KnD RMl at e	heEnor lEorgaEnMl deDnBy	c rnBt aEe NMkOhuipdaye honiB, hyafforO, Qbs
Rark HaiiaB	heEnor lEorgaEnMl deDnBy	c rnBt aEe lEorgaEnMB, hyafforO, Qbs

General Comments

Tde aEaiOyMai proMeOureB uBeO t C Nbh dame t eeE OemeiopeO froD eByat inBdeO nEyerEaymoEaiiC reMogEnBeO proMeOureB BuMd aB ydoBe put inBdeO t C yde Uh v PN, NPHN, Nh aEO Sv PR. IE douBe OemeiopeO proMeOureB are fuiiCmainOayeOaEOare ofyeE ayyde MmeEyrequeBy.

Wdere DonByure OeyerDnEaymoE daBt eeE perforDeO, reBuiyBare reporyeOoE a OrCwemgdyt aBnB.

Wdere a reporyeOieBByda E (<) reBuiynBdmgder ydaE yde bXA, ydnBDaCt e Oue yo prnDarCBaDpie exyraMyOmgeByaye OniuymoE aEO'or nEBuffrMeEyBaDpie for aEaiOBnB.

Wdere yde bXA of a reporyeOreBuiyOffer BfroD ByaEOarObXA, ydnBDaCt e Oue yo drngd DonByure MoEyeEy, nEBuffrMeEyBaDpie (reOuMeOwemgdyeDpioOeO) or Daymx nEyerfereEMe.

WdeE BaDpinEg ynDe nEforDaymoE nBEoypromnOeOt Cyde MmeEy, BaDpinEg OayeBare BdowE wnydouya ynDe MoDpoEeEy. IE ydeBe nEByaEMeB, yde ynDe MoDpoEeEydaBt eeE aBBuDeOt Cyde iat orayorCfor proMeBBnEg purpoBeB.

Wdere a reBuiynBrequmeOyo DeeyMoDpinaEMe inDnyByde aBBoMayeOuEMeryanEyCDuByt e MoEBnOereO. Aefer yo yde Nbh l oEyaMyfor OeyamB.

KeC: l Nh SuDt er = l Nh regnByrCEuDt er froD Oayat aBe DarEyamEeOt Cl deDnMai Nt ByraMyB hermMeB. Tde l deDnMai Nt ByraMyB hermMe nBa OmnBnoE of yde NDermMaE l deDnMai hoMeyC.
bXA = bnDnyof reporynEg
^ = TdnBreBuiynB MoDpuyeOfroD nEOmnOuai aEaiOye OeyeMynoEBayor at ome yde iemei of reporynEg
ø = Nbh nBEoySNTN aMMeOnyeOfor ydeBe yeByB.
~ = lEOnMayeBaE eByDayeOmaiue.

- v K061G (Toyai KjeiOadi Snyrogee aBS): hoDe BaDpieBwere OniuyeOOue yo Daymx nEyerfereEMe. bXA aOuByeOaMMorOfEgiC.
- lydaBt eeE EoyeOydayv K057G (Snynye aBS) nBgreayer ydaE v K059G (Snynye aEOSnyraye aBS) for BoDe BaDpieB, dowemer ydnBOffereEMe nBwnydnEyde inDnyBof experDeEyai narrayoE.
- Nbh nBEoySNTN aMMeOnyeOfor yde perforDaEMe of v SL5: RnBMeiiaEeouBbeaMdnEg proMeOure.
- v s 0L8 (NMOnyC) - IEBuffrMeEyBaDpie waBprommOeOfor ByaEOarOaEaiOBnB.
- v G0L5W (Wayer beaMdat ie RerMurC): PoBnynne DerMurCreBuiyBdame t eeE MoEfnDeOt Cre-exyraMynoE aEOre-aEaiOBnB.
- v N046 NcI I : SNTN NMeOnyeynoE OoeBEoyMonner yde perforDaEMe of ydnBBermMe.

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IKN091 EB2012964001	IKN707 EB2012964002	IKO454 EB2012964003	IKO712 EB2012964004	IKO939 EB2012964005
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-001	EB2018655-002	EB2018655-003	EB2018655-004	EB2018655-005
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	7.44	4.93	7.06	8.09	8.23
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	386	859	450	607	351
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	s RX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	65	2	138	137	123
Total Alkalinity as CaCO3	----	1	Dg/b	65	2	138	137	123
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	2	13	4	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	44	74	15	34	15
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	42	222	16	40	24
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	22	22	38	42	12
Magnesium	74L9-95-4	1	Dg/b	15	25	20	31	24
Sodium	7440-2L-5	1	Dg/b	33	90	22	28	20
Potassium	7440-09-7	1	Dg/b	6	12	12	8	9
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	<0.01	0.03	0.02	<0.01	<0.01
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	0.002	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.021	0.029	0.006	0.003	0.062
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	0.002	<0.001
Copper	7440-50-8	0.001	Dg/b	<0.001	0.002	0.002	0.004	0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IKN091 EB2012964001	IKN707 EB2012964002	IKO454 EB2012964003	IKO712 EB2012964004	IKO939 EB2012964005
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-001	EB2018655-002	EB2018655-003	EB2018655-004	EB2018655-005
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b	<0.001	**0.001**	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b	**0.004**	**0.005**	**0.019**	**0.006**	**0.004**
Manganese	74L9-96-5	0.001	Dg/b	**0.005**	**0.797**	**0.293**	**0.355**	**0.003**
Molybdenum	74L9-98-7	0.001	Dg/b	**0.001**	<0.001	<0.001	<0.001	**0.006**
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b	<0.001	**0.003**	**0.002**	**0.003**	<0.001
Rubidium	7440-17-7	0.001	Dg/b	**0.019**	**0.013**	**0.040**	**0.013**	**0.023**
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b	**0.120**	**0.087**	**0.053**	**0.046**	**0.052**
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b	<0.005	**0.011**	**0.007**	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b	**0.16**	**0.31**	**0.07**	<0.05	<0.05
Iron	74L9-89-6	0.05	Dg/b	<0.05	<0.05	**0.32**	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	**0.003**
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	**0.0002**	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**36.4**	**13.2**	**11.5**	**6.18**	**16.4**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.06**	**0.45**	**0.10**	**0.42**	**0.04**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	**0.09**	<0.01	**0.02**	**0.02**	**0.01**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	IKN091 EB2012964001	IKN707 EB2012964002	IKO454 EB2012964003	IKO712 EB2012964004	IKO939 EB2012964005
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number / LOR / Unit	EB2018655-001	EB2018655-002	EB2018655-003	EB2018655-004	EB2018655-005
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N	14797-55-8 / 0.01 / Dg/b	**0.23**	**0.12**	**0.34**	**0.34**	**0.41**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N	---- / 0.01 / Dg/b	**0.32**	**0.12**	**0.36**	**0.36**	**0.42**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N	---- / 0.1 / Dg/b	**0.3**	**0.5**	**0.2**	**0.6**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ Total Nitrogen as N	---- / 0.1 / Dg/b	**0.6**	**0.6**	**0.6**	**1.0**	**0.6**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ILA658 EB2012964009	ILA964 EB2012964010	ILA976 EB2012964011	ILB540 EB2012964012	IP003 EB2012964019
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-006	EB2018655-007	EB2018655-008	EB2018655-009	EB2018655-010
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	7.66	6.52	5.28	6.83	7.87
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	203	182	512	275	500
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	s RX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	45	47	20	31	70
Total Alkalinity as CaCO3	----	1	Dg/b	45	47	20	31	70
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	<1	3	22	2	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	13	10	64	23	37
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	17	43	93	37	85
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	13	8	20	8	44
Magnesium	74L9-95-4	1	Dg/b	8	8	20	8	9
Sodium	7440-2L-5	1	Dg/b	11	16	40	29	30
Potassium	7440-09-7	1	Dg/b	3	4	7	6	3
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	<0.01	0.02	<0.01	<0.01	0.02
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.006	0.010	0.018	0.003	0.009
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	0.002
Cobalt	7440-48-4	0.001	Dg/b	<0.001	0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	Dg/b	<0.001	<0.001	0.003	0.001	<0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ILA658 EB2012964009	ILA964 EB2012964010	ILA976 EB2012964011	ILB540 EB2012964012	IP003 EB2012964019
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-006	EB2018655-007	EB2018655-008	EB2018655-009	EB2018655-010
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b	**0.006**	**0.004**	**0.005**	**0.009**	**0.023**
Manganese	74L9-96-5	0.001	Dg/b	**0.004**	**0.026**	**0.010**	**0.009**	**0.001**
Molybdenum	74L9-98-7	0.001	Dg/b	**0.001**	<0.001	<0.001	<0.001	**0.001**
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b	<0.001	<0.001	<0.001	**0.001**	<0.001
Rubidium	7440-17-7	0.001	Dg/b	**0.006**	**0.010**	**0.013**	**0.033**	**0.008**
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b	**0.047**	**0.037**	**0.099**	**0.025**	**0.128**
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b	<0.001	**0.001**	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b	<0.05	**0.08**	**0.10**	**0.06**	**0.14**
Iron	74L9-89-6	0.05	Dg/b	<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**10.3**	**15.8**	**17.8**	**10.8**	**6.08**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.26**	**0.20**	**0.38**	**0.16**	**0.18**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	<0.01	<0.01	<0.01	**0.02**	**0.10**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	ILA658 EB2012964009	ILA964 EB2012964010	ILA976 EB2012964011	ILB540 EB2012964012	IP003 EB2012964019
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound / CAS Number / LOR / Unit		EB2018655-006	EB2018655-007	EB2018655-008	EB2018655-009	EB2018655-010
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N / 14797-55-8 / 0.01 / Dg/b		**0.04**	**0.38**	**0.10**	**0.25**	**0.80**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N / ---- / 0.01 / Dg/b		**0.04**	**0.38**	**0.10**	**0.27**	**0.90**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N / ---- / 0.1 / Dg/b		**0.3**	**0.4**	**0.6**	**0.3**	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ Total Nitrogen as N / ---- / 0.1 / Dg/b		**0.3**	**0.8**	**0.7**	**0.6**	**1.3**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IPP032 EB2012964020	IPY819 EB2012964029	IPY877 EB2012964030	IQS087 EB2012964035	IQS139 EB2012964036
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-011	EB2018655-013	EB2018655-014	EB2018655-016	EB2018655-017
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	8.00	8.03	6.66	6.59	8.20
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	369	291	539	840	259
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	sRX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	66	86	34	50	100
Total Alkalinity as CaCO3	----	1	Dg/b	66	86	34	50	100
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	2	2	----	15	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	20	19	41	273	16
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	54	17	104	34	9
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	17	16	21	48	16
Magnesium	74L9-95-4	1	Dg/b	4	8	20	53	22
Sodium	7440-2L-5	1	Dg/b	46	30	44	44	6
Potassium	7440-09-7	1	Dg/b	5	6	6	7	2
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	0.06	<0.01	<0.01	0.40	0.04
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	0.006	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	<0.001	0.028	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.004	0.011	0.006	0.007	0.002
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	0.004	0.005	<0.001	0.012	0.004
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	0.006	<0.001
Copper	7440-50-8	0.001	Dg/b	<0.001	0.004	0.001	0.003	0.002

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IPP032 EB2012964020	IPY819 EB2012964029	IPY877 EB2012964030	IQS087 EB2012964035	IQS139 EB2012964036
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-011	EB2018655-013	EB2018655-014	EB2018655-016	EB2018655-017
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b	**0.014**	<0.001	<0.001	**0.004**	**0.004**
Manganese	74L9-96-5	0.001	Dg/b	**0.002**	**0.001**	**0.008**	**1.11**	**0.005**
Molybdenum	74L9-98-7	0.001	Dg/b	**0.006**	**0.005**	<0.001	**0.018**	**0.002**
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b	**0.001**	<0.001	<0.001	**0.009**	<0.001
Rubidium	7440-17-7	0.001	Dg/b	**0.007**	**0.016**	**0.013**	**0.024**	**0.006**
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	<0.01	**0.03**	<0.01
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b	**0.036**	**0.065**	**0.068**	**0.124**	**0.028**
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	**0.002**
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	**0.001**
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	<0.01	**0.03**	<0.01
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b	**0.05**	**0.14**	**0.09**	**0.68**	<0.05
Iron	74L9-89-6	0.05	Dg/b	<0.05	<0.05	<0.05	**0.21**	**0.08**
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**6.44**	**23.9**	**6.79**	**10.5**	**4.52**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.07**	**0.11**	**0.20**	**1.39**	**0.12**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	**0.03**	**0.07**	**0.03**	<0.01	**0.02**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	IPP032 EB2012964020	IPY819 EB2012964029	IPY877 EB2012964030	IQS087 EB2012964035	IQS139 EB2012964036
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number / LOR / Unit	EB2018655-011	EB2018655-013	EB2018655-014	EB2018655-016	EB2018655-017
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N	14797-55-8 / 0.01 / Dg/b	**0.33**	**0.64**	**0.01**	**0.37**	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N	---- / 0.01 / Dg/b	**0.36**	**0.71**	**0.04**	**0.37**	**0.04**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N	---- / 0.1 / Dg/b	**0.2**	**0.3**	**0.4**	**2.1**	**0.5**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ **Total Nitrogen as N**	---- / 0.1 / Dg/b	**0.6**	**1.0**	**0.4**	**2.5**	**0.5**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IQS283 EB2012964037	IQS289 EB2012964038	IQS300 EB2012964039	IQS454 EB2012964044	IQS554 EB2012964046
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-018	EB2018655-019	EB2018655-020	EB2018655-021	EB2018655-022
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	6.05	6.54	5.65	7.66	6.52
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	982	1490	1700	367	481
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	sRX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	94	33	21	88	67
Total Alkalinity as CaCO3	----	1	Dg/b	94	33	21	88	67
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	18	43	50	4	5
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	190	712	822	68	108
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	68	11	13	29	10
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	57	172	174	22	33
Magnesium	74L9-95-4	1	Dg/b	67	94	122	24	31
Sodium	7440-2L-5	1	Dg/b	49	13	18	15	11
Potassium	7440-09-7	1	Dg/b	8	6	7	4	7
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	0.23	0.54	0.70	<0.01	<0.01
Antimony	7440-L6-0	0.001	Dg/b	0.012	<0.001	0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	0.140	0.003	0.003	0.002	0.002
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.010	0.012	0.014	0.009	0.009
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	0.0012	0.0008	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	0.001	0.001	0.002	<0.001	0.001
Chromium	7440-47-L	0.001	Dg/b	0.071	0.025	0.018	<0.001	0.002
Cobalt	7440-48-4	0.001	Dg/b	0.004	0.163	0.272	<0.001	0.002
Copper	7440-50-8	0.001	Dg/b	0.009	0.014	0.013	<0.001	0.002

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)				Client sample ID	IQS283 EB2012964037	IQS289 EB2012964038	IQS300 EB2012964039	IQS454 EB2012964044	IQS554 EB2012964046
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-018	EB2018655-019	EB2018655-020	EB2018655-021	EB2018655-022
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-L	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b		**0.003**	**0.001**	**0.002**	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b		**0.002**	**0.012**	**0.014**	<0.001	**0.024**
Manganese	74L9-96-5	0.001	Dg/b		**0.923**	**24.2**	**24.7**	**0.003**	**0.082**
Molybdenum	74L9-98-7	0.001	Dg/b		**0.014**	<0.001	<0.001	**0.004**	<0.001
Neodymium	7440-00-8	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b		**0.008**	**0.226**	**0.365**	<0.001	**0.005**
Rubidium	7440-17-7	0.001	Dg/b		**0.042**	**0.045**	**0.055**	**0.010**	**0.038**
Selenium	7782-49-2	0.01	Dg/b		**0.10**	**0.02**	**0.02**	<0.01	**0.12**
Silver	7440-22-4	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b		**0.147**	**0.231**	**0.306**	**0.062**	**0.072**
Thallium	7440-28-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	**0.001**
Thorium	7440-29-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b		**0.02**	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b		<0.001	**0.002**	**0.003**	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b		**0.017**	**0.292**	**0.841**	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b		**1.54**	**0.37**	**0.64**	<0.05	**0.19**
Iron	74L9-89-6	0.05	Dg/b		**0.08**	**2.86**	**3.87**	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	74L9-97-6	0.0001	Dg/b		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	Dg/b		**17.4**	**6.60**	**7.38**	**11.5**	**21.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	Dg/b		**1.54**	**0.99**	**1.46**	**0.19**	**0.52**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	Dg/b		<0.01	<0.01	<0.01	**0.06**	<0.01

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	IQS283 EB2012964037	IQS289 EB2012964038	IQS300 EB2012964039	IQS454 EB2012964044	IQS554 EB2012964046
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number / LOR / Unit	EB2018655-018	EB2018655-019	EB2018655-020	EB2018655-021	EB2018655-022
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N	14797-55-8 / 0.01 / Dg/b	1.15	0.30	0.27	0.03	0.62
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N	---- / 0.01 / Dg/b	1.15	0.30	0.27	0.09	0.62
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N	---- / 0.1 / Dg/b	3.1	1.2	1.8	0.4	0.7
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ Total Nitrogen as N	---- / 0.1 / Dg/b	4.2	1.5	2.1	0.5	1.3

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IQS585 EB2012964047	IRA551 EB2012964049	IRA619 EB2012964050	IRI671 EB2012964055	IRI876 EB2012964058
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-023	EB2018655-024	EB2018655-025	EB2018655-026	EB2018655-027
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	8.08	8.04	8.20	8.12	8.21
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	440	311	831	419	312
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	s RX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	102	89	143	86	88
Total Alkalinity as CaCO3	----	1	Dg/b	102	89	143	86	88
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	2	2	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	27	17	130	29	13
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	35	28	56	37	22
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	31	28	27	22	20
Magnesium	74L9-95-4	1	Dg/b	18	11	23	16	12
Sodium	7440-2L-5	1	Dg/b	26	16	86	32	21
Potassium	7440-09-7	1	Dg/b	6	4	52	6	5
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	0.01	<0.01	0.02	<0.01	0.02
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	0.002	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	0.002	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.014	0.011	0.137	0.032	0.017
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	0.003	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	0.003	0.006	0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	0.004	<0.001	<0.001
Copper	7440-50-8	0.001	Dg/b	<0.001	<0.001	0.009	0.001	<0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IQS585 EB2012964047	IRA551 EB2012964049	IRA619 EB2012964050	IRI671 EB2012964055	IRI876 EB2012964058
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-023	EB2018655-024	EB2018655-025	EB2018655-026	EB2018655-027
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b	**0.031**	**0.009**	**0.003**	**0.004**	**0.013**
Manganese	74L9-96-5	0.001	Dg/b	**0.002**	**0.002**	**0.009**	<0.001	<0.001
Molybdenum	74L9-98-7	0.001	Dg/b	**0.003**	<0.001	**0.017**	**0.002**	**0.002**
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b	<0.001	<0.001	**0.006**	<0.001	<0.001
Rubidium	7440-17-7	0.001	Dg/b	**0.012**	**0.011**	**0.190**	**0.019**	**0.013**
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b	**0.080**	**0.067**	**0.088**	**0.079**	**0.066**
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b	<0.001	<0.001	**0.001**	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b	**0.06**	<0.05	**0.06**	**0.08**	**0.08**
Iron	74L9-89-6	0.05	Dg/b	**0.07**	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	**0.005**	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**18.3**	**9.27**	**9.21**	**14.0**	**17.1**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.01**	**0.44**	**0.06**	**0.12**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	**0.11**	**0.02**	**0.02**	**0.05**	**0.04**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	IQS585 EB2012964047	IRA551 EB2012964049	IRA619 EB2012964050	IRI671 EB2012964055	IRI876 EB2012964058
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound / CAS Number / LOR / Unit		EB2018655-023	EB2018655-024	EB2018655-025	EB2018655-026	EB2018655-027
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N / 14797-55-8 / 0.01 / Dg/b		0.05	0.25	0.16	0.02	0.11
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N / ---- / 0.01 / Dg/b		0.16	0.27	0.18	0.07	0.15
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N / ---- / 0.1 / Dg/b		0.4	0.5	0.9	0.3	0.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ Total Nitrogen as N / ---- / 0.1 / Dg/b		0.6	0.8	1.1	0.4	0.4

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IRI877 EB2012964059	IRI883 EB2012964060	IRI885 EB2012964061	IRJ297 EB2012964062	IRK083 EB2012964064
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-028	EB2018655-029	EB2018655-030	EB2018655-031	EB2018655-032
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	8.26	8.17	8.08	7.39	8.88
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	309	414	580	127	1280
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	sRX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	197
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	70	88	91	27	66
Total Alkalinity as CaCO3	----	1	Dg/b	70	88	91	27	263
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	<1	<1	2	2	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	16	24	35	6	261
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	28	35	80	8	71
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	11	23	32	3	60
Magnesium	74L9-95-4	1	Dg/b	22	17	22	3	46
Sodium	7440-2L-5	1	Dg/b	16	34	42	15	147
Potassium	7440-09-7	1	Dg/b	3	6	7	7	17
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	0.03	<0.01	<0.01	0.03	0.13
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	0.001	0.002	0.002	<0.001	0.005
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.013	0.019	0.131	0.027	0.094
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	0.002	0.001	0.002	<0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	0.002
Copper	7440-50-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)				Client sample ID	IRI877 EB2012964059	IRI883 EB2012964060	IRI885 EB2012964061	IRJ297 EB2012964062	IRK083 EB2012964064
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-028	EB2018655-029	EB2018655-030	EB2018655-031	EB2018655-032
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-L	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b		**0.003**	**0.002**	<0.001	<0.001	**0.006**
Manganese	74L9-96-5	0.001	Dg/b		**0.002**	**0.001**	**0.002**	**0.003**	**0.007**
Molybdenum	74L9-98-7	0.001	Dg/b		**0.004**	**0.004**	**0.002**	<0.001	**0.003**
Neodymium	7440-00-8	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	**0.007**
Rubidium	7440-17-7	0.001	Dg/b		**0.008**	**0.018**	**0.020**	**0.013**	**0.018**
Selenium	7782-49-2	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	**0.16**
Silver	7440-22-4	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b		**0.054**	**0.071**	**0.148**	**0.029**	**0.233**
Thallium	7440-28-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b		<0.005	<0.005	<0.005	**0.024**	**0.089**
Zirconium	7440-67-7	0.005	Dg/b		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b		<0.05	**0.09**	**0.11**	**2.50**	**92.8**
Iron	74L9-89-6	0.05	Dg/b		**0.08**	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	74L9-97-6	0.0001	Dg/b		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	Dg/b		**14.3**	**10.0**	**4.25**	**41.9**	**9.96**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	Dg/b		**0.15**	**0.02**	**0.07**	**0.01**	**0.52**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	Dg/b		**0.02**	<0.01	**0.03**	<0.01	**0.01**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	IRI877 EB2012964059	IRI883 EB2012964060	IRI885 EB2012964061	IRJ297 EB2012964062	IRK083 EB2012964064
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number / LOR / Unit	EB2018655-028	EB2018655-029	EB2018655-030	EB2018655-031	EB2018655-032
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N	14797-55-8 / 0.01 / Dg/b	**0.04**	**0.02**	**0.60**	**0.04**	**11.7**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N	---- / 0.01 / Dg/b	**0.06**	**0.02**	**0.63**	**0.04**	**11.7**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N	---- / 0.1 / Dg/b	**0.3**	**0.2**	**0.3**	**0.1**	<0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ **Total Nitrogen as N**	---- / 0.1 / Dg/b	**0.4**	**0.2**	**0.9**	**0.1**	**11.7**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IRK629 EB2012964065	IRL014 EB2012964067	IRL163 EB2012964068	IRM602 EB2012965001	IRO039 EB2012965003
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-033	EB2018655-034	EB2018655-035	EB2018655-036	EB2018655-037
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	7.02	7.30	7.11	8.10	7.36
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	707	364	1020	360	359
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	sRX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	85	54	32	102	42
Total Alkalinity as CaCO3	----	1	Dg/b	85	54	32	102	42
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	3	2	2	2	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	58	18	80	17	38
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	93	47	256	24	48
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	35	14	25	48	13
Magnesium	74L9-95-4	1	Dg/b	37	11	31	4	12
Sodium	7440-2L-5	1	Dg/b	50	42	96	12	32
Potassium	7440-09-7	1	Dg/b	6	6	24	6	6
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	<0.01	0.02	<0.01	0.02	<0.01
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.014	0.037	0.011	0.019	0.007
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	0.001	0.002	<0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	Dg/b	0.004	0.007	0.001	0.001	<0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)				Client sample ID	IRK629 EB2012964065	IRL014 EB2012964067	IRL163 EB2012964068	IRM602 EB2012965001	IRO039 EB2012965003
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-033	EB2018655-034	EB2018655-035	EB2018655-036	EB2018655-037
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-L	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b		**0.003**	**0.006**	<0.001	<0.001	**0.007**
Manganese	74L9-96-5	0.001	Dg/b		**0.003**	**0.004**	**0.003**	**0.003**	**0.001**
Molybdenum	74L9-98-7	0.001	Dg/b		<0.001	<0.001	**0.002**	<0.001	<0.001
Neodymium	7440-00-8	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b		**0.001**	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	Dg/b		**0.016**	**0.012**	**0.013**	**0.006**	**0.016**
Selenium	7782-49-2	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b		**0.162**	**0.052**	**0.269**	**0.140**	**0.057**
Thallium	7440-28-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b		<0.005	**0.026**	<0.005	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b		**1.44**	**1.32**	**0.40**	**0.22**	**0.24**
Iron	74L9-89-6	0.05	Dg/b		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	74L9-97-6	0.0001	Dg/b		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	Dg/b		**9.79**	**27.0**	**14.8**	**5.63**	**11.4**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	Dg/b		**0.10**	**0.17**	**0.44**	**0.38**	**0.20**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	Dg/b		**0.03**	**0.01**	**0.01**	**0.09**	**0.02**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	IRK629 EB2012964065	IRL014 EB2012964067	IRL163 EB2012964068	IRM602 EB2012965001	IRO039 EB2012965003
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound / CAS Number / LOR / Unit		EB2018655-033	EB2018655-034	EB2018655-035	EB2018655-036	EB2018655-037
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N / 14797-55-8 / 0.01 / Dg/b		0.20	0.74	0.41	0.02	0.04
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N / ---- / 0.01 / Dg/b		0.23	0.75	0.42	0.11	0.06
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N / ---- / 0.1 / Dg/b		0.3	0.4	0.7	0.8	0.4
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ Total Nitrogen as N / ---- / 0.1 / Dg/b		0.5	1.2	1.1	0.9	0.5

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	IRQ039 EB2012965004	IRQ201 EB2012965005	IRR945 EB2012965012	IRU451 EB2012965016	IRU776 EB2012965017
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-038	EB2018655-039	EB2018655-041	EB2018655-044	EB2018655-045
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	8.02	7.16	7.71	7.28	7.29
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	407	731	537	771	125
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	s RX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	68	34	53	95	30
Total Alkalinity as CaCO3	----	1	Dg/b	68	34	53	95	30
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	<1	2	<1	3	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	49	121	61	72	14
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	42	125	77	96	8
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	17	9	14	46	4
Magnesium	74L9-95-4	1	Dg/b	10	16	18	38	5
Sodium	7440-2L-5	1	Dg/b	45	103	55	44	12
Potassium	7440-09-7	1	Dg/b	6	7	12	8	4
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.036	0.009	0.007	0.020	0.023
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	Dg/b	<0.001	0.002	<0.001	<0.001	0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)				Client sample ID	IRQ039 EB2012965004	IRQ201 EB2012965005	IRR945 EB2012965012	IRU451 EB2012965016	IRU776 EB2012965017
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-038	EB2018655-039	EB2018655-041	EB2018655-044	EB2018655-045
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued									
Gallium	7440-55-L	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b		**0.004**	**0.002**	**0.009**	**0.006**	<0.001
Manganese	74L9-96-5	0.001	Dg/b		**0.002**	**0.001**	<0.001	**0.006**	**0.005**
Molybdenum	74L9-98-7	0.001	Dg/b		**0.004**	<0.001	**0.004**	<0.001	<0.001
Neodymium	7440-00-8	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	**0.002**
Rubidium	7440-17-7	0.001	Dg/b		**0.009**	**0.007**	**0.016**	**0.024**	**0.004**
Selenium	7782-49-2	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b		**0.083**	**0.091**	**0.068**	**0.170**	**0.036**
Thallium	7440-28-0	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b		<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b		<0.005	<0.005	<0.005	<0.005	**0.024**
Zirconium	7440-67-7	0.005	Dg/b		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b		**0.21**	**0.46**	**0.21**	**0.19**	**0.14**
Iron	74L9-89-6	0.05	Dg/b		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	74L9-97-6	0.0001	Dg/b		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	Dg/b		**10.8**	**31.0**	**8.85**	**7.88**	**22.9**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	Dg/b		**0.14**	**0.08**	**0.18**	**0.37**	**0.16**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	Dg/b		**0.02**	**0.04**	**0.05**	**0.14**	<0.01

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)				Client sample ID	IRQ039 EB2012965004	IRQ201 EB2012965005	IRR945 EB2012965012	IRU451 EB2012965016	IRU776 EB2012965017
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-038	EB2018655-039	EB2018655-041	EB2018655-044	EB2018655-045
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	Dg/b		**0.01**	**0.12**	<0.01	**1.02**	**0.21**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	Dg/b		**0.03**	**0.16**	**0.05**	**1.16**	**0.21**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	Dg/b		**0.3**	**0.3**	**0.3**	**0.8**	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	Dg/b		**0.3**	**0.5**	**0.4**	**2.0**	**0.6**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ISD283 EB2012965021	ISD467 EB2012965022	ISD892 EB2012965024	ISD896 EB2012965025	ISD936 EB2012965027
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-046	EB2018655-047	EB2018655-048	EB2018655-049	EB2018655-051
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	7.14	7.97	8.08	8.04	7.98
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	156	288	431	371	349
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	sRX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	36	74	102	94	76
Total Alkalinity as CaCO3	----	1	Dg/b	36	74	102	94	76
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	2	<1	2	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	10	19	43	34	26
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	8	24	37	28	30
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	10	20	32	34	22
Magnesium	74L9-95-4	1	Dg/b	7	11	17	13	13
Sodium	7440-2L-5	1	Dg/b	10	23	31	24	27
Potassium	7440-09-7	1	Dg/b	3	5	5	6	5
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.026	0.020	0.014	0.003	0.014
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	Dg/b	0.002	0.003	0.005	<0.001	<0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ISD283 EB2012965021	ISD467 EB2012965022	ISD892 EB2012965024	ISD896 EB2012965025	ISD936 EB2012965027
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-046	EB2018655-047	EB2018655-048	EB2018655-049	EB2018655-051
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b	**0.003**	**0.006**	**0.003**	**0.006**	**0.003**
Manganese	74L9-96-5	0.001	Dg/b	**0.004**	<0.001	**0.002**	**0.014**	<0.001
Molybdenum	74L9-98-7	0.001	Dg/b	<0.001	**0.007**	**0.003**	**0.006**	**0.013**
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	Dg/b	**0.008**	**0.014**	**0.013**	**0.019**	**0.014**
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b	**0.030**	**0.070**	**0.062**	**0.060**	**0.069**
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b	**0.012**	**0.005**	**0.011**	<0.005	<0.005
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b	**0.06**	**0.06**	<0.05	<0.05	<0.05
Iron	74L9-89-6	0.05	Dg/b	<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**11.7**	**15.5**	**8.63**	**8.20**	**20.8**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.16**	**0.14**	<0.01	**0.22**	**0.12**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	**0.07**	**0.04**	**0.09**	**0.08**	**0.03**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ISD283 EB2012965021	ISD467 EB2012965022	ISD892 EB2012965024	ISD896 EB2012965025	ISD936 EB2012965027
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-046	EB2018655-047	EB2018655-048	EB2018655-049	EB2018655-051
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	Dg/b	**0.01**	<0.01	<0.01	<0.01	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	Dg/b	**0.08**	**0.03**	**0.07**	**0.07**	**0.05**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	Dg/b	**0.4**	**0.4**	**0.4**	**0.4**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	Dg/b	**0.5**	**0.4**	**0.5**	**0.5**	**0.2**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ISE033 EB2012965029	ISI845 EB2012965032	ISL158 EB2012965038	ISL365 EB2012965039	ITD748 EB2012965049
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-053	EB2018655-054	EB2018655-056	EB2018655-057	EB2018655-058
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	7.08	7.19	8.16	7.59	8.17
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	438	226	492	382	397
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	s RX-210-001	1	Dg/b	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	88	13	116	60	92
Total Alkalinity as CaCO3	----	1	Dg/b	88	13	116	60	92
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	3	2	<1	2	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	7	28	22	32	44
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	26	33	46	55	40
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	34	5	33	19	26
Magnesium	74L9-95-4	1	Dg/b	24	6	15	15	12
Sodium	7440-2L-5	1	Dg/b	18	28	46	34	39
Potassium	7440-09-7	1	Dg/b	6	3	7	4	4
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	0.01
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	0.002	<0.001	<0.001
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-L9-L	0.001	Dg/b	0.005	0.024	0.017	0.007	0.015
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-L	0.001	Dg/b	<0.001	<0.001	0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	Dg/b	<0.001	0.001	0.002	<0.001	<0.001

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ISE033 EB2012965029	ISI845 EB2012965032	ISL158 EB2012965038	ISL365 EB2012965039	ITD748 EB2012965049
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-053	EB2018655-054	EB2018655-056	EB2018655-057	EB2018655-058
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	74L9-92-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	74L9-9L-2	0.001	Dg/b	**0.014**	**0.001**	<0.001	**0.001**	**0.009**
Manganese	74L9-96-5	0.001	Dg/b	**0.123**	<0.001	**0.014**	**0.051**	<0.001
Molybdenum	74L9-98-7	0.001	Dg/b	<0.001	<0.001	**0.002**	<0.001	**0.006**
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	Dg/b	**0.008**	**0.003**	**0.018**	<0.001	**0.008**
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	Dg/b	**0.138**	**0.036**	**0.163**	**0.028**	**0.091**
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-L1-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	<0.01	<0.01	<0.01
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	Dg/b	<0.005	<0.005	<0.005	**0.017**	<0.005
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	Dg/b	<0.05	**0.08**	**0.13**	**0.07**	**0.15**
Iron	74L9-89-6	0.05	Dg/b	<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**8.33**	**8.82**	**36.1**	**19.0**	**15.4**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.42**	**0.06**	**0.13**	**0.02**	**0.02**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	**0.02**	<0.01	**0.06**	**0.02**	**0.05**

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)	Client sample ID	ISE033 EB2012965029	ISI845 EB2012965032	ISL158 EB2012965038	ISL365 EB2012965039	ITD748 EB2012965049
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound / CAS Number / LOR / Unit		EB2018655-053	EB2018655-054	EB2018655-056	EB2018655-057	EB2018655-058
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EK058G: Nitrate as N by Discrete Analyser						
Nitrate as N / 14797-55-8 / 0.01 / Dg/b		1.27	0.09	0.66	0.54	0.30
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Nitrite + Nitrate as N / ---- / 0.01 / Dg/b		1.29	0.09	0.72	0.56	0.35
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Total Kjeldahl Nitrogen as N / ---- / 0.1 / Dg/b		0.6	0.1	0.4	0.2	0.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser						
^ Total Nitrogen as N / ---- / 0.1 / Dg/b		1.9	0.2	1.1	0.8	0.6

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ITD802 EB2012965050	ITI461 EB2012965059	----	----	----
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2018655-059	EB2018655-060	--------	--------	--------
				AeBuiy	AeBuiy	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH UEry	**7.68**	**6.33**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µh/MD	**2610**	**261**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	sRX-210-001	1	Dg/b	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	L812-L2-6	1	Dg/b	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-L	1	Dg/b	**47**	**25**	----	----	----
Total Alkalinity as CaCO3	----	1	Dg/b	**47**	**25**	----	----	----
ED038A: Acidity								
Acidity as CaCO3	----	1	Dg/b	**2**	**3**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	Dg/b	**1490**	**23**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	Dg/b	**58**	**41**	----	----	----
ED093W: Water Leachable Major Cations								
Calcium	7440-70-2	1	Dg/b	**628**	**9**	----	----	----
Magnesium	74L9-95-4	1	Dg/b	**29**	**10**	----	----	----
Sodium	7440-2L-5	1	Dg/b	**55**	**22**	----	----	----
Potassium	7440-09-7	1	Dg/b	**8**	**5**	----	----	----
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	Dg/b	<0.01	<0.01	----	----	----
Antimony	7440-L6-0	0.001	Dg/b	<0.001	<0.001	----	----	----
Niobium	7440-0L-1	0.001	Dg/b	<0.001	<0.001	----	----	----
Arsenic	7440-L8-2	0.001	Dg/b	<0.001	<0.001	----	----	----
Beryllium	7440-41-7	0.001	Dg/b	<0.001	<0.001	----	----	----
Barium	7440-L9-L	0.001	Dg/b	**0.051**	**0.023**	----	----	----
Rhenium	7440-15-5	0.001	Dg/b	<0.001	<0.001	----	----	----
Bismuth	7440-69-9	0.001	Dg/b	<0.001	<0.001	----	----	----
Cadmium	7440-4L-9	0.0001	Dg/b	<0.0001	<0.0001	----	----	----
Cerium	7440-45-1	0.001	Dg/b	<0.001	<0.001	----	----	----
Caesium	7440-46-2	0.001	Dg/b	<0.001	<0.001	----	----	----
Chromium	7440-47-L	0.001	Dg/b	**0.004**	<0.001	----	----	----
Cobalt	7440-48-4	0.001	Dg/b	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	Dg/b	<0.001	**0.001**	----	----	----

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ITD802 EB2012965050	ITI461 EB2012965059	----	----	----
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2018655-059	EB2018655-060	--------	--------	--------
				AeBuiy	AeBuiy	----	----	----
EG020W: Water Leachable Metals by ICP-MS - Continued								
Gallium	7440-55-L	0.001	Dg/b	<0.001	<0.001	----	----	----
Hafnium	7440-58-6	0.01	Dg/b	<0.01	<0.01	----	----	----
Lanthanum	74L9-91-0	0.001	Dg/b	<0.001	<0.001	----	----	----
Lead	74L9-92-1	0.001	Dg/b	<0.001	<0.001	----	----	----
Lithium	74L9-9L-2	0.001	Dg/b	**0.002**	**0.007**	----	----	----
Manganese	74L9-96-5	0.001	Dg/b	**0.003**	**0.002**	----	----	----
Molybdenum	74L9-98-7	0.001	Dg/b	**0.008**	<0.001	----	----	----
Neodymium	7440-00-8	0.001	Dg/b	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	Dg/b	**0.001**	<0.001	----	----	----
Rubidium	7440-17-7	0.001	Dg/b	**0.012**	**0.010**	----	----	----
Selenium	7782-49-2	0.01	Dg/b	<0.01	<0.01	----	----	----
Silver	7440-22-4	0.001	Dg/b	<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	Dg/b	**4.03**	**0.061**	----	----	----
Thallium	7440-28-0	0.001	Dg/b	<0.001	<0.001	----	----	----
Thorium	7440-29-1	0.001	Dg/b	<0.001	<0.001	----	----	----
Tin	7440-L1-5	0.001	Dg/b	<0.001	<0.001	----	----	----
Titanium	7440-L2-6	0.01	Dg/b	<0.01	<0.01	----	----	----
Uranium	7440-61-1	0.001	Dg/b	**0.002**	<0.001	----	----	----
Vanadium	7440-62-2	0.01	Dg/b	<0.01	<0.01	----	----	----
Yttrium	7440-65-5	0.001	Dg/b	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	Dg/b	<0.005	<0.005	----	----	----
Zirconium	7440-67-7	0.005	Dg/b	<0.005	<0.005	----	----	----
Boron	7440-42-8	0.05	Dg/b	**0.17**	**0.06**	----	----	----
Iron	74L9-89-6	0.05	Dg/b	<0.05	<0.05	----	----	----
Tungsten	7440-LL-7	0.001	Dg/b	<0.001	<0.001	----	----	----
Tantalum	7440-25-7	0.001	Dg/b	<0.001	<0.001	----	----	----
EG035W: Water Leachable Mercury by FIMS								
Mercury	74L9-97-6	0.0001	Dg/b	<0.0001	<0.0001	----	----	----
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	Dg/b	**25.8**	**16.8**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	Dg/b	**0.14**	**0.30**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	Dg/b	**0.06**	<0.01	----	----	----

Analytical Results

hut-Rayrnx: LEACHATE (Rayrnx: WATER)			Client sample ID	ITD802 EB2012965050	ITI461 EB2012965059	----	----	----
			Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2018655-059	EB2018655-060	--------	--------	--------
				AeBuiy	AeBuiy	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	Dg/b	**3.26**	**0.12**	**----**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	Dg/b	**3.32**	**0.12**	**----**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	Dg/b	**0.8**	<0.5	**----**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	Dg/b	**4.1**	<0.5	**----**	**----**	**----**

Analytical Results

hut-Rayrnx: PULP (Rayrnx: SOIL)				Client sample ID	IPP152 EB2012964021	IQP120 EB2012964034	IRR628 EB2012965009	IRR948 EB2012965013	IRU033 EB2012965014
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-012	EB2018655-015	EB2018655-040	EB2018655-042	EB2018655-043
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.007**	**0.006**	**0.008**	**0.248**	**0.005**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	Dg/kg		<100	**2400**	**1050**	**240**	**2190**

Analytical Results

hut-Rayrnx: PULP (Rayrnx: SOIL)				Client sample ID	ISJ277 EB2012965036	----	----	----	----
				Client sampling date / time	04-RaC-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2018655-055	--------	--------	--------	--------
					AeBuiy	----	----	----	----
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.007**	**----**	**----**	**----**	**----**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	Dg/kg		**1100**	**----**	**----**	**----**	**----**

Analytical Results

hut-Rayrx: SOIL (Rayrx: SOIL)				Client sample ID	IKN707 EB2012964002	IKO939 EB2012964005	IPY819 EB2012964029	IQS087 EB2012964035	IQS139 EB2012964036
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-002	EB2018655-005	EB2018655-013	EB2018655-016	EB2018655-017
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.007**	**0.057**	**0.009**	**0.590**	**----**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	Dg/kg		**1700**	<100	<100	**730**	**----**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**----**	**0.12**	**----**	**----**	**0.29**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TI	0.02	%		**----**	**0.81**	**----**	**----**	**11.8**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**----**	**0.69**	**----**	**----**	**11.5**

Analytical Results

hut-Rayrx: SOIL (Rayrx: SOIL)				Client sample ID	IQS283 EB2012964037	IQS289 EB2012964038	IQS300 EB2012964039	IQS454 EB2012964044	IQS554 EB2012964046
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-018	EB2018655-019	EB2018655-020	EB2018655-021	EB2018655-022
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.118**	**1.16**	**0.566**	**----**	**0.076**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	Dg/kg		**460**	**2070**	**2310**	**----**	**230**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**----**	**----**	**----**	**0.38**	**----**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TI	0.02	%		**----**	**----**	**----**	**11.0**	**----**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**----**	**----**	**----**	**10.6**	**----**

Analytical Results

hut-Rayrx: SOIL (Rayrx: SOIL)	Client sample ID	IRA619 EB2012964050	IRI671 EB2012964055	IRI876 EB2012964058	IRI885 EB2012964061	IRK083 EB2012964064
	Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound / CAS Number	LOR / Unit	EB2018655-025	EB2018655-026	EB2018655-027	EB2018655-030	EB2018655-032
		AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA026 : Chromium Reducible Sulfur						
Chromium Reducible Sulphur ----	0.005 %	**0.152**	**----**	**----**	**----**	**0.440**
ED040: Sulfur as SO4 2-						
Sulfate as SO4 2- 14808-79-8	100 Dg/kg	**230**	**----**	**----**	**----**	**580**
EP003: Total Organic Carbon (TOC) in Soil						
Total Organic Carbon ----	0.02 %	**----**	**0.11**	**0.10**	**0.09**	**----**
EP003TC: Total Carbon (TC) in Soil						
Total Carbon TI	0.02 %	**----**	**6.86**	**1.92**	**4.65**	**----**
EP003TIC: Total inorganic Carbon (TIC) in Soil						
Total Inorganic Carbon ----	0.02 %	**----**	**6.75**	**1.82**	**4.56**	**----**

Analytical Results

hut-Rayrnx: SOIL (Rayrnx: SOIL)	Client sample ID			IRL014 EB2012964067	IRL163 EB2012964068	IRQ039 EB2012965004	IRU451 EB2012965016	ISD467 EB2012965022
	Client sampling date / time			04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018655-034	EB2018655-035	EB2018655-038	EB2018655-044	EB2018655-047
				AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.26**	**0.14**	**0.08**	**0.11**	**0.12**
EP003TC: Total Carbon (TC) in Soil								
Total Carbon	TI	0.02	%	**0.29**	**0.15**	**0.27**	**0.16**	**1.40**
EP003TIC: Total inorganic Carbon (TIC) in Soil								
Total Inorganic Carbon	----	0.02	%	**0.03**	<0.02	**0.19**	**0.05**	**1.28**

Analytical Results

hut-Rayrx: SOIL (Rayrx: SOIL)				Client sample ID	ISD936 EB2012965027	ISI845 EB2012965032	ISL158 EB2012965038	ITD748 EB2012965049	ITD802 EB2012965050
				Client sampling date / time	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00	04-RaC-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018655-051	EB2018655-054	EB2018655-056	EB2018655-058	EB2018655-059
					AeBuiy	AeBuiy	AeBuiy	AeBuiy	AeBuiy
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**----**	**0.005**	**----**	**----**	**0.009**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	Dg/kg		**----**	**130**	**----**	**----**	**12300**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.16**	**----**	**0.16**	**0.15**	**----**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TI	0.02	%		**3.93**	**----**	**2.46**	**0.30**	**----**
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		**3.77**	**----**	**2.30**	**0.15**	**----**

Analytical Results

hut -Rayrnx: SOIL (Rayrnx: SOIL)			Client sample ID	pH and EC of DI water	----	----	----	----
			Client sampling date / time	21-Jui-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2018655-061	--------	--------	--------	--------
				AeBuiy	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH UEry	**5.3**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µh/MD	<1	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB201865G**	Page	: 1 of 34
Client	: **RVS ENMRONP ENTAL DTY LTi**	Laboratory	: Environmental Division Brisbane
Contact	: MR MATT LANDERS	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019068 RTIO Brockman	Date Samples Received	: 14-Jul-2020 09:55
Order number	: ----	Date Analysis Commenced	: 03-Aug-2020
C-O-C number	: ----	Issue Date	: 24-Aug-2020 17:04
Sampler	: ----		
Site	: ----		
Quote number	: BN/248/19 A		
No. of samples received	: 62		
No. of samples analysed	: 59		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Addtrtoal f tarorp lrtoa herrtaean ro rstw rehorn btff ue rogad ta rse roffobtac wehl rl re lrrl Qsp earw: y gl ftn Coarrof Rehorn/ y Aw C Cop hftl aQe Awwewwp ean ro lwwtwn btns y gl ftn Re. teb l ad Sl p hfe ReQethnNorrtrtQl rtoa^

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
K = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It has been noted that EK057G (Nitrite as N) is greater than EK059G (Nitrite and Nitrate as N) for sample EB2018674_023 (IZA972), however this difference is within the limits of experimental variation.
- It has been noted that EK057G (Nitrite as N) is greater than EK059G (Nitrite and Nitrate as N) for sample EB2018674_039 (KAL552), however this difference is within the limits of experimental variation.
- ALS is not NATA accredited for the performance of EN35: Miscellaneous Leaching procedure.
- EA046 ABCC: NATA Acreditation does not cover the performance of this service.

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(			Client sample ID	IYF05G EB2012968033	IYF489 EB2012968035	IYFGG2 EB2012968038	IYF868 EB201296803G	IYF998 EB2012968060
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G001	EB201865G002	EB201865G004	EB201865G00G	EB201865G003
				Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror								
h7 Mlfge	----	0.01	pH Unit	8'41	8'99	8'43	5'G6	9'26
EA010D: CoadgQrt. tn u, DC Ttrrl ror								
EfeQrrtQl f CoadgQrt. tn - 23@C	----	1	µS/cm	628	4G5	G23	91	408
Ei 045D: Afkl ftatn u, DC Ttrrl ror								
7, dro°tde Afkl ftatn lwCl CO4	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn lwCl CO4	3812-32-6	1	mg/L	1	23	2	<1	44
BtQl ruoal re Afkl ftatn lwCl CO4	71-52-3	1	mg/L	155	112	1GG	16	100
Torl f Afkl ftatn lwCl CO4	----	1	mg/L	158	145	1G6	16	144
Ei 048A: AQtdtn								
AQtdtn lwCl CO4	----	1	mg/L	<1	<1	<1	<1	<1
Ei 0G1V: Sgfrhre HTgrutdtp enrtQ(lwSOG2) u, i A								
Sgfrhre lwSOG) Tgrutdtp enrtQ	14808-79-8	1	mg/L	44	5	43	3	14
Ei 0G3V: Csfortde u, i twQrere Aal f, wer								
Csfortde	16887-00-6	1	mg/L	GG	14	20	12	10
Ei 094W: Wl rer Lel Qsl ufe Pl xor Cl rtoaw								
Cl fQtgp	7440-70-2	1	mg/L	36	1G	2G	G	11
Pl caewtgp	7439-95-4	1	mg/L	45	29	21	4	4G
Sodtgp	7440-23-5	1	mg/L	22	16	44	8	3
Dorl wwtgp	7440-09-7	1	mg/L	11	6	6	2	2
EV020W: Wl rer Lel Qsl ufe Perl fwu, ICD)P S								
Afgp tatgp	7429-90-5	0.01	mg/L	0'01	0'02	<0.01	0'40	0'01
Aartp oa,	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0'001
Ntoutgp	7440-03-1	0.001	mg/L	0'001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L	0'006	0'004	0'010	0'001	0'008
Rseatgp	7440-15-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L	0'00G	0'004	<0.001	<0.001	<0.001
Coul fn	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cohher	7440-50-8	0.001	mg/L	0'001	<0.001	0'001	<0.001	0'002

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	IYF05G EB2012968033	IYF489 EB2012968035	IYFGG2 EB2012968038	IYF868 EB201296803G	IYF998 EB2012968060
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G001	EB201865G002	EB201865G004	EB201865G00G	EB201865G003
					Result	Result	Result	Result	Result
EV020W: WI rer Lel QsI ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI arsI agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		0'00G	0'003	0'001	0'001	0'003
P I acI aewe	7439-96-5	0.001	mg/L		0'008	0'008	0'003	0'108	0'003
P of, udeagp	7439-98-7	0.001	mg/L		0'012	0'033	0'00G	<0.001	0'002
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	0'001	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		0'01G	0'009	0'003	0'008	0'002
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		0'030	0'023	0'11G	0'005	0'018
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		<0.001	0'002	<0.001	<0.001	0'002
Ttrl atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rl atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
MI al dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		<0.05	<0.05	0'14	<0.05	<0.05
Iroa	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	0'G3	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
TI arl fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel QsI ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere Aal f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		8'88	5'55	15'0	1'9G	G'21
EZ033V: Ap p oatI I wN u, i twQrere Aal f, wer									
Ap p oatI I wN	7664-41-7	0.01	mg/L		0'21	0'04	0'04	0'01	0'0G
EZ035V: Ntrrtre I wN u, i twQrere Aal f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		0'03	0'01	0'06	<0.01	0'02

Analytical Results

Sub-Matrix: LEAC7 ATE / Matrix: WATER(				Client sample ID	IYF05G EB2012968033	IYF489 EB2012968035	IYFGG2 EB2012968038	IYF868 EB201296803G	IYF998 EB2012968060
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G001	EB201865G002	EB201865G004	EB201865G00G	EB201865G003
					Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer									
Ntrrl re l wN	14797-55-8	0.01	mg/L		0^02	0^01	0^01	0^06	0^01
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer									
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L		0^05	0^02	0^05	0^06	0^04
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer									
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L		0^3	0^2	0^4	0^1	0^2
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer									
^ Torl f Ntrrocea l wN	----	0.1	mg/L		0^6	0^2	0^G	0^2	0^2

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	IYM153 EB2012969005	IYM644 EB2012969008	IYM6G1 EB2012969009	IYW223 EB2012969011	IYUG05 EB2012969015
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G013	EB201865G016	EB201865G015	EB201865G018	EB201865G020
					Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror									
h7 Mlfge	----	0.01	pH Unit		8'G1	5'49	5'82	5'15	5'24
EA010D: CoadgQrt. tn u, DC Ttrrl ror									
EfeQrrtQl f CoadgQrt. tn - 23@C	----	1	µS/cm		115	G24	405	132	G51
Ei 045D: Afkl ftatn u, DC Ttrrl ror									
7, dro°tde Afkl ftatn lwCl CO4	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn lwCl CO4	3812-32-6	1	mg/L		2	<1	<1	<1	<1
BtQl ruoal re Afkl ftatn lwCl CO4	71-52-3	1	mg/L		G1	89	8G	12	51
Torl f Afkl ftatn lwCl CO4	----	1	mg/L		G4	89	8G	12	51
Ei 048A: AQtdtn									
AQtdtn lwCl CO4	----	1	mg/L		<1	1	<1	2	<1
Ei 0G1V: Sgfrhre HTgrutdtp enrtQ(lwSOG2) u, i A									
Sgfrhre lwSOG) Tgrutdtp enrtQ	14808-79-8	1	mg/L		2	49	11	11	49
Ei 0G3V: Csfortde u, i twQrere Aal f, wer									
Csfortde	16887-00-6	1	mg/L		5	31	16	23	60
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw									
Cl fQtgp	7440-70-2	1	mg/L		10	2G	45	6	23
P l caewtgp	7439-95-4	1	mg/L		G	1G	5	3	22
Sodtgp	7440-23-5	1	mg/L		6	46	10	14	43
Dorl wwtgp	7440-09-7	1	mg/L		2	5	9	4	9
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S									
Afgp tatgp	7429-90-5	0.01	mg/L		0'02	0'05	0'02	<0.01	<0.01
Aartp oa,	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ntoutgp	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L		0'00G	0'012	0'00G	0'026	0'005
Rseatgp	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L		0'002	0'001	0'003	<0.001	<0.001
Coul fn	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cohher	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0'001

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	IYM153 EB2012969005	IYM644 EB2012969008	IYM6G1 EB2012969009	IYW223 EB2012969011	IYUG05 EB2012969015
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G013	EB201865G016	EB201865G015	EB201865G018	EB201865G020
					Result	Result	Result	Result	Result
EV020W: WI rer Lel QsI ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI ansI agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		**0'002**	**0'006**	**0'002**	**0'015**	**0'01G**
P I acI aewe	7439-96-5	0.001	mg/L		**0'002**	**0'013**	**0'004**	**0'004**	**0'01G**
P of, udeagp	7439-98-7	0.001	mg/L		<0.001	**0'002**	**0'009**	<0.001	<0.001
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		**0'005**	**0'019**	**0'010**	**0'005**	**0'013**
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		**0'021**	**0'033**	**0'043**	**0'0G2**	**0'068**
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		**0'001**	<0.001	<0.001	**0'002**	<0.001
Ttrl atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rl atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
MI al dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		<0.05	**0'05**	<0.05	**0'06**	**0'12**
Iroa	7439-89-6	0.05	mg/L		<0.05	**0'09**	<0.05	<0.05	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
TI arl fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel QsI ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere Aal f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		**9'G6**	**14'1**	**9'02**	**10'0**	**16'1**
EZ033V: Ap p oatI I wN u, i twQrere Aal f, wer									
Ap p oatI I wN	7664-41-7	0.01	mg/L		**0'06**	**0'02**	**0'18**	**0'08**	**0'03**
EZ035V: Ntrrtre I wN u, i twQrere Aal f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		<0.01	**0'0G**	**0'01**	<0.01	**0'0G**

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	IYM153 EB2012969005	IYM644 EB2012969008	IYM6G1 EB2012969009	IYW223 EB2012969011	IYUG05 EB2012969015
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G013	EB201865G016	EB201865G015	EB201865G018	EB201865G020
					Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer									
Ntrrl re l wN	14797-55-8	0.01	mg/L		0'04	0'26	0'21	0'06	0'21
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer									
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L		0'04	0'40	0'22	0'06	0'23
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer									
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L		0'2	0'4	0'4	0'2	0'4
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer									
^ Torl f Ntrrocea l wN	----	0.1	mg/L		0'2	0'6	0'3	0'4	0'6

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(			Client sample ID	IYU941 EB2012969024	IUA182 EB2012969023	IUA952 EB2012969025	IUR189 EB2012969044	IUR191 EB201296904G
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G021	EB201865G022	EB201865G024	EB201865G02G	EB201865G023
				Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror								
h7 Mlfge	----	0.01	pH Unit	9'28	8'03	5'99	5'98	8'16
EA010D: CoadgQrt. tn u, DC Ttrrl ror								
EfeQrrtQl f CoadgQrt. tn - 23@	----	1	µS/cm	450	208	261	400	401
Ei 045D: Afkl ftatn u, DC Ttrrl ror								
7, dro°tde Afkl ftatn l wCl CO4	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn l wCl CO4	3812-32-6	1	mg/L	G3	<1	<1	<1	<1
BtQl ruoal re Afkl ftatn l wCl CO4	71-52-3	1	mg/L	114	51	106	83	53
Torl f Afkl ftatn l wCl CO4	----	1	mg/L	138	51	106	83	53
Ei 048A: AQtdtn								
AQtdtn l wCl CO4	----	1	mg/L	<1	<1	<1	<1	<1
Ei 0G1V: Sgfrhre HTgrutdtp enrtQl wSOG2) u, i A								
Sgfrhre l wSOG) Tgrutdtp enrtQ	14808-79-8	1	mg/L	14	16	15	45	G2
Ei 0G3V: Csfortde u, i twQrere Aal f, wer								
Csfortde	16887-00-6	1	mg/L	19	1G	11	20	21
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw								
Cl fQtgp	7440-70-2	1	mg/L	9	26	40	29	23
P l caewtgp	7439-95-4	1	mg/L	G1	3	1G	5	6
Sodtgp	7440-23-5	1	mg/L	8	8	3	19	23
Dorl wwtgp	7440-09-7	1	mg/L	6	4	6	8	8
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S								
Afgp tatgp	7429-90-5	0.01	mg/L	0'04	<0.01	0'01	0'02	0'04
Aartp oa,	7440-36-0	0.001	mg/L	0'001	<0.001	<0.001	<0.001	<0.001
Ntoutgp	7440-03-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L	0'00G	0'003	0'005	0'060	0'069
Rseatgp	7440-15-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Coul fn	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cohher	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	0'001	<0.001

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(				Client sample ID	IYU941 EB2012969024	IUA182 EB2012969023	IUA952 EB2012969025	IUR189 EB2012969044	IUR191 EB201296904G
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G021	EB201865G022	EB201865G024	EB201865G02G	EB201865G023
					Result	Result	Result	Result	Result
EV020W: WI rer Lel Qsl ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI arsI agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		0.008	0.001	0.016	0.004	0.00G
P I acI aewe	7439-96-5	0.001	mg/L		0.008	0.011	0.003	0.002	<0.001
P of, udeagp	7439-98-7	0.001	mg/L		0.002	0.043	0.003	0.003	0.002
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		0.00G	0.008	0.006	0.006	0.006
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		0.011	0.036	0.0G9	0.185	0.192
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		<0.001	0.002	<0.001	0.001	0.001
Ttrl atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rl atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
MI al dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	0.08	0.12
Iroa	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
TI arl fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel Qsl ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere Aal f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		692	280	104	252	240
EZ033V: Ap p oatl I wN u, i twQrere Aal f, wer									
Ap p oatl I wN	7664-41-7	0.01	mg/L		0.06	0.13	0.05	0.0G	0.0G
EZ035V: Ntrrtre I wN u, i twQrere Aal f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		0.02	0.02	0.06	0.04	0.02

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(				Client sample ID	IYU941 EB2012969024	IUA182 EB2012969023	IUA952 EB2012969025	IUR189 EB2012969044	IUR191 EB201296904G
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G021	EB201865G022	EB201865G024	EB201865G02G	EB201865G023
					Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer									
Ntrrl re l wN	14797-55-8	0.01	mg/L		0^04	<0.01	<0.01	0^01	0^09
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer									
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L		0^03	0^02	0^03	0^0G	0^11
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer									
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L		0^2	0^4	0^2	0^1	0^1
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer									
^ Torl f Ntrrocea l wN	----	0.1	mg/L		0^2	0^4	0^2	0^1	0^2

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(			Client sample ID	IUR194 EB2012969043	IUR204 EB20129690G0	IUM226 EB20129690G6	IUM434 EB20129690G5	ZAC152 EB2012969030
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G026	EB201865G025	EB201865G029	EB201865G040	EB201865G042
				Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror								
h7 Mlfge	----	0.01	pH Unit	8^11	5^08	5^08	8^04	5^16
EA010D: CoadgQrt. tn u, DC Ttrrl ror								
EfeQrrtQl f CoadgQrt. tn - 23@C	----	1	µS/cm	4G9	165	269	246	404
Ei 045D: Afkl ftatn u, DC Ttrrl ror								
7, dro°tde Afkl ftatn lwCl CO4	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn lwCl CO4	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
BtQl ruoal re Afkl ftatn lwCl CO4	71-52-3	1	mg/L	10G	44	42	53	30
Torl f Afkl ftatn lwCl CO4	----	1	mg/L	10G	44	42	53	30
Ei 048A: AQtdtn								
AQtdtn lwCl CO4	----	1	mg/L	<1	<1	2	2	<1
Ei 0G1V: Sgfrhre HTgrutdtp enrtQ(lwSOG2) u, i A								
Sgfrhre lwSOG) Tgrutdtp enrtQ	14808-79-8	1	mg/L	G3	15	13	24	22
Ei 0G3V: Csfortde u, i twQrere Aal f, wer								
Csfortde	16887-00-6	1	mg/L	20	11	G0	22	29
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw								
Cl fQtgp	7440-70-2	1	mg/L	2G	4	11	28	18
P l caewtgp	7439-95-4	1	mg/L	3	G	11	6	13
Sodtgp	7440-23-5	1	mg/L	G6	26	22	12	21
Dorl wwtgp	7440-09-7	1	mg/L	6	3	G	4	G
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S								
Afgp tatgp	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	0^01	<0.01
Aartp oa,	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Ntoutgp	7440-03-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L	0^106	0^105	0^01G	0^020	0^16G
Rseatgp	7440-15-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0^001
Coul fn	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cohher	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	IUR194 EB2012969043	IUR204 EB20129690G0	IUM226 EB20129690G6	IUM434 EB20129690G5	ZAC152 EB2012969030
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G026	EB201865G025	EB201865G029	EB201865G040	EB201865G042
					Result	Result	Result	Result	Result
EV020W: WI rer Lel QsI ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI ansI agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		0'008	<0.001	0'00G	0'006	0'00G
P I acI aewe	7439-96-5	0.001	mg/L		<0.001	0'004	0'002	0'004	0'114
P of, udeagp	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	0'00G	<0.001
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		0'005	0'005	0'009	0'005	0'008
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		0'224	0'045	0'038	0'03G	0'1G9
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		<0.001	<0.001	0'001	0'001	<0.001
Ttrl atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rl atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
MI al dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		0'22	0'13	<0.05	0'06	0'08
Iroa	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
TI arl fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel QsI ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere Aal f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		24'8	40'8	21'8	13'4	21'4
EZ033V: Ap p oatI I wN u, i twQrere Aal f, wer									
Ap p oatI I wN	7664-41-7	0.01	mg/L		0'04	0'08	0'1G	0'09	0'03
EZ035V: Ntrrtre I wN u, i twQrere Aal f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		0'05	<0.01	0'02	0'06	0'01

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(			Client sample ID	IUR194 EB2012969043	IUR204 EB20129690G0	IUM226 EB20129690G6	IUM434 EB20129690G5	ZAC152 EB2012969030
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G026	EB201865G025	EB201865G029	EB201865G040	EB201865G042
				Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer								
Ntrrl re l wN	14797-55-8	0.01	mg/L	0^02	0^10	0^18	0^01	0^0G
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer								
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L	0^09	0^10	0^20	0^05	0^03
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer								
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L	0^2	0^2	0^4	0^2	0^2
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer								
^ Torl f Ntrrocea l wN	----	0.1	mg/L	0^4	0^4	0^3	0^4	0^2

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	ZA7 239 EB2012969036	ZAJ446 EB2012969039	ZAL098 EB201296906G	ZAL484 EB2012969063	ZALG42 EB2012969066
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G)04G	EB201865G)043	EB201865G)046	EB201865G)045	EB201865G)048
					Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror									
h7 Mlfge	----	0.01	pH Unit		G%43	8%21	8%2G	5%G1	5%59
EA010D: CoadgQrt. tn u, DC Ttrrl ror									
EfeQrrtQl f CoadgQrt. tn - 23@C	----	1	µS/cm		243	640	199	150	908
Ei 045D: Afkl ftatn u, DC Ttrrl ror									
7, dro°tde Afkl ftatn l wCl CO4	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn l wCl CO4	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
BtQl ruoal re Afkl ftatn l wCl CO4	71-52-3	1	mg/L		<1	159	81	G6	2G2
Torl f Afkl ftatn l wCl CO4	----	1	mg/L		<1	159	81	G6	2G2
Ei 048A: AQtdtn									
AQtdtn l wCl CO4	----	1	mg/L		G0	<1	<1	<1	2
Ei 0G1V: Sgfrhre HTgrutdtp errtQ(l wSOG2) u, i A									
Sgfrhre l wSOG) Tgrutdtp errtQ	14808-79-8	1	mg/L		G0	46	13	9	48
Ei 0G3V: Csfortde u, i twQrere Aal f, wer									
Csfortde	16887-00-6	1	mg/L		26	60	11	9	55
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw									
Cl fQtgp	7440-70-2	1	mg/L		9	29	29	10	92
P l caewtgp	7439-95-4	1	mg/L		6	42	5	8	48
Sodtgp	7440-23-5	1	mg/L		1G	33	G	8	G9
Dorl wwtgp	7440-09-7	1	mg/L		4	12	2	G	11
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S									
Afgp tatgp	7429-90-5	0.01	mg/L		1%G1	<0.01	0%02	<0.01	0%01
Aartp oa,	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ntoutgp	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L		<0.001	0%001	<0.001	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L		0%038	0%02G	0%003	0%005	0%006
Rseatgp	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L		0%005	<0.001	<0.001	<0.001	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L		<0.001	0%001	0%001	<0.001	<0.001
Coul fn	7440-48-4	0.001	mg/L		0%006	<0.001	<0.001	<0.001	<0.001
Cohher	7440-50-8	0.001	mg/L		0%003	0%002	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(				Client sample ID	ZA7 239 EB2012969036	ZAJ446 EB2012969039	ZAL098 EB201296906G	ZAL484 EB2012969063	ZALG42 EB2012969066
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G)04G	EB201865G)043	EB201865G)046	EB201865G)045	EB201865G)048
					Result	Result	Result	Result	Result
EV020W: WI rer Lel QsI ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI arsI agp	7439-91-0	0.001	mg/L		**0'00G**	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		**0'006**	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		**0'002**	**0'004**	**0'00G**	**0'002**	**0'028**
P I acI aewe	7439-96-5	0.001	mg/L		**4'13**	**0'004**	**0'004**	**0'003**	**0'115**
P of, udeagp	7439-98-7	0.001	mg/L		<0.001	**0'002**	**0'012**	<0.001	**0'001**
Neod, p tgp	7440-00-8	0.001	mg/L		**0'002**	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		**0'018**	**0'00G**	<0.001	<0.001	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		**0'006**	**0'008**	**0'010**	**0'009**	**0'026**
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		**0'083**	**0'160**	**0'040**	**0'041**	**0'250**
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
TtrI atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rI atgp	7440-61-1	0.001	mg/L		<0.001	**0'002**	<0.001	<0.001	<0.001
MI aI dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		**0'005**	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		**0'020**	<0.005	<0.005	<0.005	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		**0'09**	**0'1G**	<0.05	**0'03**	**0'06**
Iroa	7439-89-6	0.05	mg/L		**0'20**	<0.05	<0.05	<0.05	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	**0'002**	<0.001	<0.001
TI arI fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel QsI ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere AaI f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		**45'8**	**13'1**	**19'1**	**1G'1**	**10'9**
EZ033V: Ap p oatI I wN u, i twQrere AaI f, wer									
Ap p oatI I wN	7664-41-7	0.01	mg/L		**0'48**	<0.01	**0'21**	<0.01	**0'02**
EZ035V: Ntrrtre I wN u, i twQrere AaI f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		<0.01	<0.01	**0'0G**	**0'01**	<0.01

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(				Client sample ID	ZA7 239 EB2012969036	ZAJ446 EB2012969039	ZAL098 EB201296906G	ZAL484 EB2012969063	ZALG42 EB2012969066
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G)04G	EB201865G)043	EB201865G)046	EB201865G)045	EB201865G)048
					Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer									
Ntrrl re l wN	14797-55-8	0.01	mg/L		0^11	<0.01	<0.01	0^01	<0.01
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer									
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L		0^11	<0.01	0^0G	0^02	<0.01
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer									
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L		0^6	0^2	0^G	<0.1	0^4
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer									
^ Torl f Ntrrocea l wN	----	0.1	mg/L		0^5	0^2	0^G	<0.1	0^4

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

				Client sample ID	ZAL332 EB2012969065	ZAP 12G EB2012969068	ZAS514 EB2012950011	ZAW511 EB201295001G	ZAW51G EB2012950013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G049	EB201865G0G0	EB201865G0G2	EB201865G0GG	EB201865G0G3
					Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror									
h7 Mlfge	----	0.01	pH Unit		8'32	5'85	6'81	6'93	5'10
EA010D: CoadgQrt. tn u, DC Ttrrl ror									
EfeQrrtQl f CoadgQrt. tn - 23@	----	1	µS/cm		442	424	250	200	222
Ei 045D: Afkl ftatn u, DC Ttrrl ror									
7, dro°tde Afkl ftatn l wCl CO4	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn l wCl CO4	3812-32-6	1	mg/L		6	<1	<1	<1	<1
BtQl ruoal re Afkl ftatn l wCl CO4	71-52-3	1	mg/L		1G2	31	GG	1G	1G
Torl f Afkl ftatn l wCl CO4	----	1	mg/L		1G8	31	GG	1G	1G
Ei 048A: AQtdtn									
AQtdtn l wCl CO4	----	1	mg/L		<1	2	2	2	2
Ei 0G1V: Sgfrhre HTgrutdtp errtQ(l wSOG2) u, i A									
Sgfrhre l wSOG) Tgrutdtp errtQ	14808-79-8	1	mg/L		40	23	14	16	11
Ei 0G3V: Csfortde u, i twQrere Aal f, wer									
Csfortde	16887-00-6	1	mg/L		14	G2	28	29	G1
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw									
Cl fQtgp	7440-70-2	1	mg/L		18	6	6	<1	2
P l caewtgp	7439-95-4	1	mg/L		15	4	9	<1	2
Sodtgp	7440-23-5	1	mg/L		42	30	41	45	48
Dorl wwtgp	7440-09-7	1	mg/L		8	10	8	4	G
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S									
Afgp tatgp	7429-90-5	0.01	mg/L		<0.01	0'01	<0.01	<0.01	0'02
Aartp oa,	7440-36-0	0.001	mg/L		0'001	<0.001	<0.001	<0.001	<0.001
Ntoutgp	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L		0'006	0'0G2	0'024	0'006	0'006
Rseatgp	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0'001
Coul fn	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cohher	7440-50-8	0.001	mg/L		0'002	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

Compound	CAS Number	LOR	Unit	Client sample ID	ZAL332 EB2012969065	ZAP 12G EB2012969068	ZAS514 EB2012950011	ZAW511 EB201295001G	ZAW51G EB2012950013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
					EB201865G049	EB201865G0G0	EB201865G0G2	EB201865G0GG	EB201865G0G3
					Result	Result	Result	Result	Result
EV020W: WI rer Lel Qsl ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI arsI agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		<0.001	<0.001	**0'002**	**0'006**	**0'024**
P I acI aewe	7439-96-5	0.001	mg/L		**0'00G**	**0'002**	**0'241**	**0'002**	**0'003**
P of, udeagp	7439-98-7	0.001	mg/L		**0'014**	**0'011**	<0.001	<0.001	<0.001
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		**0'002**	<0.001	<0.001	<0.001	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		**0'024**	**0'010**	**0'011**	**0'004**	**0'00G**
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		**0'080**	**0'038**	**0'0G0**	**0'008**	**0'015**
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	**0'001**	<0.001
Ttrl atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rl atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
MI al dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		**0'05**	**0'16**	**0'12**	**0'1G**	**0'13**
Iroa	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	**0'09**	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		**0'006**	<0.001	<0.001	<0.001	<0.001
TI arl fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel Qsl ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere Aal f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		**22'G**	**28'4**	**26'6**	**26'2**	**18'2**
EZ033V: Ap p oatI I wN u, i twQrere Aal f, wer									
Ap p oatI I wN	7664-41-7	0.01	mg/L		<0.01	<0.01	**0'40**	**0'14**	**0'18**
EZ035V: Ntrrtre I wN u, i twQrere Aal f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		**0'08**	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(				Client sample ID	ZAL332 EB2012969065	ZAP 12G EB2012969068	ZAS514 EB2012950011	ZAW511 EB201295001G	ZAW51G EB2012950013
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G049	EB201865G0G0	EB201865G0G2	EB201865G0GG	EB201865G0G3
					Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer									
Ntrrl re l wN	14797-55-8	0.01	mg/L		<0.01	0^11	0^12	0^46	0^14
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer									
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L		0^05	0^11	0^12	0^46	0^14
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer									
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L		0^4	0^2	0^G	0^4	0^G
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer									
^ Torl f Ntrrocea l wN	----	0.1	mg/L		0^G	0^4	0^3	0^5	0^3

Analytical Results

Sub-Matrix: LEAC7 ATE
HMatrix: WATER(

				Client sample ID	ZBA864 EB2012950016	ZB7 061 EB2012950019	ZB7 109 EB2012950020	ZBJGG4 EB2012950021	ZBO233 EB2012950029
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G)0G6	EB201865G)0G8	EB201865G)0G9	EB201865G)030	EB201865G)031
					Result	Result	Result	Result	Result
EA003D: h7 u, DC Ttrrl ror									
h7 Mlfge	----	0.01	pH Unit		8^10	8^09	8^25	3^46	5^81
EA010D: CoadgQrt. tn u, DC Ttrrl ror									
EfeQrrtQl f CoadgQrt. tn - 23@C	----	1	µS/cm		41G	256	481	14G0	394
Ei 045D: Afkl ftatn u, DC Ttrrl ror									
7, dro°tde Afkl ftatn l wCl CO4	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Cl ruoal re Afkl ftatn l wCl CO4	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
BtQl ruoal re Afkl ftatn l wCl CO4	71-52-3	1	mg/L		113	106	102	10	114
Torl f Afkl ftatn l wCl CO4	----	1	mg/L		113	106	102	10	114
Ei 048A: AQtdtn									
AQtdtn l wCl CO4	----	1	mg/L		<1	<1	<1	8	2
Ei 0G1V: Sgfrhre HTgrutdtp errtQ(l wSOG2) u, i A									
Sgfrhre l wSOG) Tgrutdtp errtQ	14808-79-8	1	mg/L		16	13	21	1G4	GG
Ei 0G3V: Csfortde u, i twQrere Aal f, wer									
Csfortde	16887-00-6	1	mg/L		14	9	40	410	65
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw									
Cl fQtgp	7440-70-2	1	mg/L		43	41	21	40	G2
P l caewtgp	7439-95-4	1	mg/L		12	5	20	48	2G
Sodtgp	7440-23-5	1	mg/L		8	16	2G	145	G2
Dorl wwtgp	7440-09-7	1	mg/L		10	4	12	15	8
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S									
Afgp tatgp	7429-90-5	0.01	mg/L		0^01	0^01	0^01	0^01	0^02
Aartp oa,	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ntoutgp	7440-03-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
ArweatQ	7440-38-2	0.001	mg/L		<0.001	<0.001	0^004	<0.001	<0.001
Ber, fftgp	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bl rtgp	7440-39-3	0.001	mg/L		0^063	0^113	0^014	0^042	0^009
Rseatgp	7440-15-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Btwp grs	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cl dp tgp	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Certgp	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	0^004	<0.001
Cl ewtgp	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Csrop tgp	7440-47-3	0.001	mg/L		<0.001	<0.001	0^001	<0.001	0^001
Coul fn	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	0^19G	<0.001
Cohher	7440-50-8	0.001	mg/L		<0.001	<0.001	0^001	0^00G	<0.001

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(				Client sample ID	ZBA864 EB2012950016	ZB7 061 EB2012950019	ZB7 109 EB2012950020	ZBJGG4 EB2012950021	ZBO233 EB2012950029
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G)0G6	EB201865G)0G8	EB201865G)0G9	EB201865G)030	EB201865G)031
					Result	Result	Result	Result	Result
EV020W: WI rer Lel Qsl ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
LI arsI agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Ltrstgp	7439-93-2	0.001	mg/L		0'002	0'001	0'001	0'020	0'015
P I acI aewe	7439-96-5	0.001	mg/L		0'021	<0.001	0'002	28'0	0'004
P of, udeagp	7439-98-7	0.001	mg/L		0'002	0'002	0'00G	<0.001	0'002
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
NtQkef	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	0'010	<0.001
Rgutdtgp	7440-17-7	0.001	mg/L		0'006	0'00G	0'023	0'022	0'01G
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Srroartgp	7440-24-6	0.001	mg/L		0'22G	0'214	0'060	0'125	0'180
TsI fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tta	7440-31-5	0.001	mg/L		<0.001	<0.001	0'001	0'001	<0.001
TtrI atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
j rI atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
MI aI dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	0'012	<0.005
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boroa	7440-42-8	0.05	mg/L		0'05	0'21	0'10	0'19	0'08
Iroa	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
TI arI fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EV043W: WI rer Lel Qsl ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EV032V: StftQI u, i twQrere AaI f, wer									
Rel Qt. e StftQI	----	0.05	mg/L		12'1	21'1	5'20	1G'0	5'24
EZ033V: Ap p oatI I wN u, i twQrere AaI f, wer									
Ap p oatI I wN	7664-41-7	0.01	mg/L		<0.01	0'05	0'15	0'39	0'15
EZ035V: Ntrrtre I wN u, i twQrere AaI f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		<0.01	<0.01	0'0G	<0.01	0'05

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(			Client sample ID	ZBA864 EB2012950016	ZB7 061 EB2012950019	ZB7 109 EB2012950020	ZBJGG4 EB2012950021	ZBO233 EB2012950029
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G)0G6	EB201865G)0G8	EB201865G)0G9	EB201865G)030	EB201865G)031
				Result	Result	Result	Result	Result
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer								
Ntrrl re l wN	14797-55-8	0.01	mg/L	<0.01	0^18	0^12	0^80	0^19
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer								
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L	<0.01	0^18	0^16	0^80	0^26
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer								
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L	0^4	0^2	0^G	1^0	0^3
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer								
^ Torl f Ntrrocea l wN	----	0.1	mg/L	0^4	0^G	0^6	1^8	0^8

Analytical Results

Sub-Matrix: LEAC7 ATE HMatrix: WATER(			Client sample ID	ZBO815 EB2012950041	ZBR002 EB2012950042	ZCI669 EB2012950045	))))	))))
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	EB201865G)034	EB201865G)03G	EB201865G)033	)))))))	)))))))
				Result	Result	Result	----	----
EA003D: h7 u, DC Ttrrl ror								
h7 Mi fge	----	0.01	pH Unit	6'98	5'15	8'29	))))	))))
EA010D: CoadgQt. tn u, DC Ttrrl ror								
EfeQrrtQ f CoadgQt. tn - 23@	----	1	µS/cm	415	25G	634	))))	))))
Ei 045D: Afkl ftatn u, DC Ttrrl ror								
7, dro°tde Afkl ftatn l wCl CO4	DMO-210-001	1	mg/L	<1	<1	<1	))))	))))
Cl ruoal re Afkl ftatn l wCl CO4	3812-32-6	1	mg/L	<1	<1	<1	))))	))))
BtQl ruoal re Afkl ftatn l wCl CO4	71-52-3	1	mg/L	54	23	126	))))	))))
Torl f Afkl ftatn l wCl CO4	----	1	mg/L	54	23	126	))))	))))
Ei 048A: AQtdtn								
AQtdtn l wCl CO4	----	1	mg/L	2	2	<1	))))	))))
Ei 0G1V: Sgfrhre HTgrutdtp enrtQ(l wSOG2) u, i A								
Sgfrhre l wSOG) Tgrutdtp enrtQ	14808-79-8	1	mg/L	15	24	36	))))	))))
Ei 0G3V: Csfortde u, i twQrere Aal f, wer								
Csfortde	16887-00-6	1	mg/L	14	G2	59	))))	))))
Ei 094W: Wl rer Lel Qsl ufe P l xor Cl rtoaw								
Cl fQtgp	7440-70-2	1	mg/L	19	1G	29	))))	))))
P l caewtgp	7439-95-4	1	mg/L	15	9	26	))))	))))
Sodtgp	7440-23-5	1	mg/L	21	20	61	))))	))))
Dorl wwtgp	7440-09-7	1	mg/L	3	4	1G	))))	))))
EV020W: Wl rer Lel Qsl ufe P erl fwu, ICD)P S								
Afgp tatgp	7429-90-5	0.01	mg/L	<0.01	0'01	0'02	))))	))))
Aartp oa,	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Ntoutgp	7440-03-1	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
ArweatQ	7440-38-2	0.001	mg/L	<0.001	<0.001	0'012	))))	))))
Ber, fftgp	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Bl rtgp	7440-39-3	0.001	mg/L	0'0G6	0'015	0'022	))))	))))
Rseatgp	7440-15-5	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Btwp grs	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Cl dp tgp	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	))))	))))
Certgp	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Cl ewtgp	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Csrop tgp	7440-47-3	0.001	mg/L	0'001	<0.001	0'002	))))	))))
Coul fn	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	))))	))))
Cohher	7440-50-8	0.001	mg/L	<0.001	<0.001	0'001	))))	))))

Analytical Results

Sub-Matrix: LEAC7 ATE / HMatrix: WATER(				Client sample ID	ZBO815 EB2012950041	ZBR002 EB2012950042	ZCI669 EB2012950045	))))	))))
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EB201865G)034	EB201865G)03G	EB201865G)033	))))))))	))))))))
					Result	Result	Result	----	----
EV020W: WI rer Lel Qsl ufe P erl fwu, ICD)P S) Coartaged									
VI fftgp	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
7I ratgp	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	))))	))))
LI ansl agp	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Lel d	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Ltrstgp	7439-93-2	0.001	mg/L		**0'010**	**0'001**	<0.001	))))	))))
P l acl aewe	7439-96-5	0.001	mg/L		**0'486**	**0'004**	**0'004**	))))	))))
P of, udeagp	7439-98-7	0.001	mg/L		<0.001	<0.001	**0'006**	))))	))))
Neod, p tgp	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
NtQkef	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Rgutdtgp	7440-17-7	0.001	mg/L		**0'012**	**0'008**	**0'013**	))))	))))
Sefeatgp	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	))))	))))
Stf. er	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Srroartgp	7440-24-6	0.001	mg/L		**0'106**	**0'168**	**0'1G4**	))))	))))
Tsl fftgp	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Tsortgp	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Tta	7440-31-5	0.001	mg/L		<0.001	**0'001**	<0.001	))))	))))
Ttrl atgp	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	))))	))))
j rl atgp	7440-61-1	0.001	mg/L		<0.001	<0.001	**0'002**	))))	))))
Ml al dtgp	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	))))	))))
Ymrtgp	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
UtaQ	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	))))	))))
UtrQoatgp	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	))))	))))
Boroa	7440-42-8	0.05	mg/L		**0'11**	**0'06**	**0'16**	))))	))))
Iroa	7439-89-6	0.05	mg/L		<0.05	**0'1G**	**0'41**	))))	))))
Tgacwrea	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
Tl arl fgp	7440-25-7	0.001	mg/L		<0.001	<0.001	<0.001	))))	))))
EV043W: WI rer Lel Qsl ufe P erQgr, u, FIP S									
P erQgr,	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	))))	))))
EV032V: StftQl u, i twQrere Aal f, wer									
Rel Qt. e StftQl	----	0.05	mg/L		**22'6**	**9'38**	**10'6**	))))	))))
EZ033V: Ap p oatl I wN u, i twQrere Aal f, wer									
Ap p oatl I wN	7664-41-7	0.01	mg/L		**0'34**	**0'28**	**0'02**	))))	))))
EZ035V: Ntrrtre I wN u, i twQrere Aal f, wer									
Ntrrtre I wN	14797-65-0	0.01	mg/L		**0'02**	<0.01	<0.01	))))	))))

Analytical Results

Sub-Matrix: LEAC7 ATE / HMatrix: WATER(				Client sample ID	ZBO815 EB2012950041	ZBR002 EB2012950042	ZCI669 EB2012950045	))))	))))
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EB201865G)034	EB201865G)03G	EB201865G)033	))))))))	))))))))
					Result	Result	Result	----	----
EZ038V: Ntrrl re l wN u, i twQrere Aal f, wer									
Ntrrl re l wN	14797-55-8	0.01	mg/L		0^08	0^10	<0.01	))))	))))
EZ039V: Ntrrtre hfgwNtrrl re l wN HNO° (u, i twQrere Aal f, wer									
Ntrrtre + Ntrrl re l wN	----	0.01	mg/L		0^10	0^10	<0.01	))))	))))
EZ061V: Torl f Zxefdl sf Ntrrocea B, i twQrere Aal f, wer									
Torl f Zxefdl sf Ntrrocea l wN	----	0.1	mg/L		0^8	0^3	0^2	))))	))))
EZ062V: Torl f Ntrrocea l wN HTZN + NO° (u, i twQrere Aal f, wer									
^ Torl f Ntrrocea l wN	----	0.1	mg/L		0^9	0^6	0^2	))))	))))

Analytical Results

Sub-Matrix: Dj LD / HMatrix: SOIL(				Client sample ID	IYN236 EB2012968064	IYN239 EB201296806G	IYN260 EB2012968063	IYj 160 EB2012968068	IYj 293 EB2012968069
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G)006	EB201865G)005	EB201865G)008	EB201865G)009	EB201865G)010
					Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr									
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%		0'008	<0.005	0'006	0'008	0'008
Ei 0G0: Sgfrgr l wSOG2)									
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg		940	8G0	1020	1510	2140

Analytical Results

Sub-Matrix: Dj LD HMatrix: SOIL(				Client sample ID	IYj 298 EB2012969001	IYj 484 EB2012969002	IYj 618 EB2012969004	IYj 651 EB2012969003	IYY932 EB201296901G
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G011	EB201865G012	EB201865G014	EB201865G01G	EB201865G019
					Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr									
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%		0'010	0'005	0'008	<0.005	0'003
Ei 0G0: Sgfrgr l wSOG2)									
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg		1090	850	910	480	550

Analytical Results

Sub-Matrix: Dj LD / HMatrix: SOIL(				Client sample ID	IUR214 EB20129690G4	IUM668 EB20129690G8	ZAO605 EB2012950005	ZAW128 EB2012950014	ZBV666 EB2012950018
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G028	EB201865G041	EB201865G0G1	EB201865G0G4	EB201865G0G5
					Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr									
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%		0'005	0'210	0'008	0'011	0'008
Ei 0G0: Sgfrgr l wSOG2)									
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg		380	G80	<100	<100	2600

Analytical Results

Sub-Matrix: Dj LD / HMatrix: SOIL(			Client sample ID	ZCI918 EB2012950048	ZCJ185 EB20129500G0	ZCJ251 EB20129500G2	ZCJ45G EB20129500GG	ZCJ3G9 EB20129500G6
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G)036	EB201865G)035	EB201865G)038	EB201865G)039	EB201865G)060
				Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr								
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%	0'008	0'012	0'011	0'012	0'013
Ei 0G0: Sgfrgr l wSOG2)								
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg	1G40	680	<100	120	1660

Analytical Results

Sub-Matrix: SOIL HMatrix: SOIL(			Client sample ID	IYF489 EB2012968035	IYFGG2 EB2012968038	IYF998 EB2012968060	IYM644 EB2012969008	IYM6G1 EB2012969009
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G)002	EB201865G)004	EB201865G)003	EB201865G)016	EB201865G)015
				Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr								
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%	))))	0'039	))))	))))	))))
Ei 0G0: Sgfrgr l wSOG2)								
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg	))))	<100	))))	))))	))))
ED004: Torl f Orcl atQCl ruoa HTOC(ta Sotf								
Torl f Orcl atQCl ruoa	----	0.02	%	0'06	0'0G	0'21	0'05	0'09
ED004TC: Torl f Cl ruoa HTC(ta Sotf								
Torl f Cl ruoa	TC	0.02	%	11'3	1'2G	12'6	8'44	10'3
ED004TIC: Torl f taorcl atQCl ruoa HTIC(ta Sotf								
Torl f laorcl atQCl ruoa	----	0.02	%	11'G	1'20	12'G	8'26	10'G

Analytical Results

Sub-Matrix: SOIL / Matrix: SOIL(				Client sample ID	IYU941 EB2012969024	IUR189 EB2012969044	IUM434 EB20129690G5	ZA7 239 EB2012969036	ZAJ446 EB2012969039
				Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB201865G021	EB201865G02G	EB201865G040	EB201865G04G	EB201865G043
					Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr									
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%	))))	0^008	))))	0^01G	))))	
Ei 0G0: Sgfrgr l wSOG2)									
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg	))))	160	))))	2400	))))	
ED004: Torl f Orcl atQCl ruoa HTOC(ta Sotf									
Torl f Orcl atQCl ruoa	----	0.02	%	0^08	0^08	0^0G	))))	1^43	
ED004TC: Torl f Cl ruoa HTC(ta Sotf									
Torl f Cl ruoa	TC	0.02	%	12^5	0^18	0^1G	))))	2^13	
ED004TIC: Torl f taorcl atQCl ruoa HTIC(ta Sotf									
Torl f laorcl atQCl ruoa	----	0.02	%	12^6	0^10	0^10	))))	0^80	

Analytical Results

Sub-Matrix: SOIL HMatrix: SOIL(			Client sample ID	ZAL098 EB201296906G	ZAL332 EB2012969065	ZAS514 EB2012950011	ZBA864 EB2012950016	ZB7 109 EB2012950020
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB201865G)046	EB201865G)049	EB201865G)0G2	EB201865G)0G5	EB201865G)0G9
				Result	Result	Result	Result	Result
EA026 : Csrop tgp RedgQtufe Sgfrgr								
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%	))))	0^118	0^008	<0.005	))))
Ei 0G0: Sgfrgr l wSOG2)								
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg	))))	<100	<100	<100	))))
ED004: Torl f Orcl atQCl ruoa HTOC(ta Sotf								
Torl f Orcl atQCl ruoa	----	0.02	%	0^05	0^10	))))	))))	0^09
ED004TC: Torl f Cl ruoa HTC(ta Sotf								
Torl f Cl ruoa	TC	0.02	%	0^G4	1^64	))))	))))	2^28
ED004TIC: Torl f taorcl atQCl ruoa HTIC(ta Sotf								
Torl f laorcl atQCl ruoa	----	0.02	%	0^46	1^34	))))	))))	2^19

Analytical Results

Sub-Matrix: SOIL / Matrix: SOIL(			Client sample ID	ZBJGG4 EB2012950021	ZBR002 EB2012950042	ZCI669 EB2012950045	h7 l ad EC oni l b l rer	))))
			Client sampling date / time	04-May-2020 00:00	04-May-2020 00:00	04-May-2020 00:00	23-Jul-2020 00:00	----
Compound	CAS Number	LOR	Unit	EB201865G)030	EB201865G)03G	EB201865G)033	EB201865G)062	))))))))
				Result	Result	Result	Result	----
EA002: h7 1:3 HSotfw(								
h7 Mi fge	----	0.1	pH Unit	))))	))))	))))	3'3	))))
EA010: CoadgQt. tn H:3(								
EfeQrrtQl f CoadgQt. tn - 23@	----	1	µS/cm	))))	))))	))))	<1	))))
EA026 : Csrop tgp RedgQtufe Sgfrngr								
Csrop tgp RedgQtufe Sgfhsgr	----	0.005	%	0'003	))))	))))	))))	))))
Ei 0G0: Sgfrngr l wSOG2)								
Sgfrhre l wSOG2)	14808-79-8	100	mg/kg	1990	))))	))))	))))	))))
ED004: Torl f Orcl atQCl ruoa HTOC(ta Sotf								
Torl f Orcl atQCl ruoa	----	0.02	%	))))	0'04	G'24	))))	))))
ED004TC: Torl f Cl ruoa HTC(ta Sotf								
Torl f Cl ruoa	TC	0.02	%	))))	0'03	G'48	))))	))))
ED004TIC: Torl f taorcl atQCl ruoa HTIC(ta Sotf								
Torl f laorcl atQCl ruoa	----	0.02	%	))))	0'02	0'13	))))	))))

ATTACHMENT D

Mineral Phase Distribution

9 Attachment D

9.1 XRD Mineral Analysis and Mineral Phase Distribution

9.1.1 Attachment D1: XRD Analysis for Rio Tinto Brockman Samples

9.1.2 Attachment D2: XRD Mineral Phase Distribution by Stratigraphy and Lithology

9.1.3 Attachment D3: XRD Patterns from Levay and Co.

XRD Analysis for Rio Tinto Brockman Samples

Drill Hole ID	IKN707	IKO939	IQS289	IQS300	IQS554	IRA619	IRI885
Sample Lithology	Shale	Banded Iron Formation	Lignite	Silcrete	Red Ochre Waste	Banded Iron Formation	Dolomite
Stratigraphy	Whaleback Shale	Marra Mamba	Detrital	Detrital	Detrital	Marra Mamba	Wittenoom Formation
Strand Formations	Whaleback Shale Upper	Newman Upper	Lignite	Silcrete	Red Ochre Detritals	Newman Lower Lower	Wittenoom Formation
Classification	Uncertain	Non-Acid Forming (Barren)	Potentially Acid Forming	Potentially Acid Forming	Non-Acid Forming (Barren)	Non-Acid Forming	Non-Acid Forming (Barren)
Actinolite	ND[2]	2.9	0.3	0.2	NA[3]	NA[3]	NA[3]
Alunite	0.2	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]
Calcite	ND[2]	0.4	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]
Dolomite/Ankerite	ND[2]	2.7	0.1	ND[2]	ND[2]	ND[2]	30.2
Goethite	51	4.7	0.4	0.3	16	ND[2]	0.1
Gypsum	0.4	ND[2]	ND[2]	ND[2]	0.1	ND[2]	ND[2]
Hematite	7	5.9	0.3	0.3	56.5	1	0.3
Kaolinite	40.4	0.3	5.2	8.5	20.1	4.3	57.3
Magnetite	ND[2]	29.4	ND[2]	ND[2]	ND[2]	7.3	ND[2]
Montmorillonite	0.9	ND[2]	ND[2]	ND[2]	0.7	ND[2]	ND[2]
Pyrite	0.1	ND[2]	1.8	0.8	0.3	1.1	ND[2]
Quartz	ND[2]	48.9	72.7	69.7	2.6	33.5	0.4
Siderite(VariablecompositionMg,Mn)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Stilpnomelane	ND[2]	0.8	ND[2]	ND[2]	ND[2]	9	0.1
Talc	ND[2]	1	ND[2]	ND[2]	NA[3]	NA[3]	NA[3]
Gibbsite	NA[3]	NA[3]	NA[3]	NA[3]	ND[2]	ND[2]	11.1
Illite(I-S)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Minnesotaite	NA[3]	NA[3]	NA[3]	NA[3]	ND[2]	5.6	ND[2]
Muscovite	NA[3]	NA[3]	NA[3]	NA[3]	3.6	2.5	0.4
Albite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Microcline	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Opal(?)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]

1. Semiquantitative detection limit ~ 0.4 wt. %
2. Non detectable (ND)
3. Not Analysed (NA)

XRD Analysis for Rio Tinto Brockman Samples

Drill Hole ID	IRL014	IRL163	ISI845	ISL365	ITL838	ITM815	ITN784
Sample Lithology	Dolerite	Shale	Low grade siliceous	Banded Iron Formation	Shale	Dolomite	Banded Iron Formation
Stratigraphy	Dolerite	Mount Sylvia	Joffre Member	Wittenoom Formation	Joffre Member	Wittenoom Formation	Marra Mamba
Strand Formations	Dolerite	Mount Sylvia Formation	Joffre 2	West Angela Member	Joffre 1	Wittenoom Formation	Newman Lower Lower
Classification	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)
Actinolite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Alunite	ND[2]	ND2	ND[2]	0.4	ND[2]	ND[2]	ND[2]
Calcite	ND[2]	ND[2]	ND[2]	0.7	ND[2]	ND[2]	ND[2]
Dolomite/Ankerite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	89.3	ND[2]
Goethite	14.9	3	43.7	16.9	46.7	4.5	16.4
Gypsum	0.4	ND2	ND[2]	0.5	0.1	ND[2]	ND[2]
Hematite	11.7	1.9	48.8	ND[2]	17.6	2.3	17.8
Kaolinite	60.3	34.7	1.6	27	13.3	1.7	1.3
Magnetite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	6.7
Montmorillonite	6.3	ND[2]	ND[2]	42.4	0.9	1.2	ND[2]
Pyrite	ND[2]	ND[2]	0.2	ND[2]	ND[2]	ND[2]	0.4
Quartz	3.6	55.4	5.4	5.3	21	0.7	52.7
Siderite(VariablecompositionMg,Mn)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Stilpnomelane	ND[2]	0.3	ND[2]	ND[2]	0.1	NA[3]	NA[3]
Talc	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Gibbsite	ND[2]	ND[2]	ND[2]	ND[2]	0.1	NA[3]	NA[3]
Illite(I-S)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Minnesotaite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	NA[3]	NA[3]
Muscovite	2.3	4.7	ND[2]	2.3	ND[2]	ND[2]	ND[2]
Albite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	0.1	ND[2]
Microcline	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	0.2	ND[2]
Opal(?)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]

1. Semiquantitative detection limit ~ 0.4 wt. %
2. Non detectable (ND)
3. Not Analysed (NA)

XRD Analysis for Rio Tinto Brockman Samples

Drill Hole ID	ITU378	ITV767	ITV838	IUI522	IUO168	IUO694	IUP204
Sample Lithology	Low Grade Limonite	Calcrete	Shale	Dolerite	Shale	Detrital Waste	Banded Iron Formation
Stratigraphy	Detrital	Detrital	Mount McRae Shale	Dolerite	Wittenoom Formation	Detrital	Dales Gorge Member
Strand Formations	Limonitic Detritals	Calcrete	Mount McRae Shale	Dolerite	Wittenoom Formation	Immature Detrital	Dales Gorge 2
Classification	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Potentially Acid Forming	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)
Actinolite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	ND2
Alunite	ND[2]	0.1	ND2	ND[2]	ND[2]	0.3	0.1
Calcite	ND[2]	15.3	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]
Dolomite/Ankerite	2.9	57.3	ND[2]	1.7	1.6	0.1	ND[2]
Goethite	92.8	3.4	1.1	19.6	65.8	75.8	44.1
Gypsum	ND[2]	ND[2]	ND[2]	0.8	ND[2]	ND[2]	0.5
Hematite	1.7	ND[2]	0.2	19.6	20.6	10.5	17.8
Kaolinite	1.7	ND[2]	50.1	56.1	3	6.7	16.7
Magnetite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]
Montmorillonite	ND[2]	0.8	ND[2]	1.9	4.9	0.6	0.7
Pyrite	ND[2]	ND[2]	1.9	ND[2]	ND[2]	ND[2]	ND[2]
Quartz	0.6	9.1	36.4	0.2	0.7	3.8	19
Siderite(VariablecompositionMg,Mn)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Stilpnomelane	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	ND[2]
Talc	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Gibbsite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	ND[2]
Illite(I-S)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Minnesotaite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Muscovite	0.2	ND[2]	10.4	0.1	ND[2]	ND[2]	ND[2]
Albite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	0.2	NA[3]
Microcline	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]
Opal(?)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]

1. Semiquantitative detection limit ~ 0.4 wt. %
2. Non detectable (ND)
3. Not Analysed (NA)

XRD Analysis for Rio Tinto Brockman Samples

Drill Hole ID	IVB619	IVM058	*IVM058*	IVN449	IVN891	IWS032	IWS038
Sample Lithology	Detrital Waste	Hydrated	Hydrated	Shale	Shale	Shale	Shale
Stratigraphy	Detrital	Dales Gorge Member	Dales Gorge Member	Mount Sylvia	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale
Strand Formations	Immature Detrital	Dales Gorge 1	Dales Gorge 1	Mount Sylvia Formation	Mount McRae Shale	Mount McRae Shale	Mount McRae Shale
Classification	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Potentially Acid Forming	Uncertain	Potentially Acid Forming - Low Capacity
Actinolite	ND[2]	ND[2]	ND2	ND[2]	0.1	ND[2]	ND[2]
Alunite	0.4	ND[2]	ND2	ND2	5.5	ND[2]	ND[2]
Calcite	ND[2]	ND[2]	ND2	1.1	ND[2]	ND[2]	ND[2]
Dolomite/Ankerite	ND[2]	ND[2]	ND2	1.8	0.1	ND[2]	ND[2]
Goethite	13.8	58.1	55.9	ND[2]	ND[2]	2.9	71.2
Gypsum	0.8	0.4	ND2	ND[2]	0.5	ND[2]	0.4
Hematite	26.2	26.1	25.1	1.8	0.2	0.7	0.3
Kaolinite	6.2	9.3	12.6	36.7	24.8	20.6	25.4
Magnetite	ND[2]	ND[2]	ND2	ND[2]	0.1	ND[2]	ND[2]
Montmorillonite	0.9	0.8	0.7	ND[2]	0.3	ND[2]	0.4
Pyrite	ND[2]	0.3	0.3	0.1	ND[2]	0.3	0.3
Quartz	48.9	5	5.2	49.8	32.1	57.1	2
Siderite(VariablecompositionMg,Mn)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Stilpnomelane	ND[2]	ND[2]	ND2	ND[2]	0.2	ND[2]	ND[2]
Talc	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Gibbsite	ND[2]	ND[2]	0.1	ND[2]	ND[2]	ND[2]	ND[2]
Illite(I-S)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Minnesotaite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Muscovite	ND[2]	ND[2]	ND2	8.6	36.1	18.5	ND[2]
Albite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Microcline	0.3	ND[2]	ND2	ND[2]	ND[2]	ND[2]	ND[2]
Opal(?)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]

1. Semiquantitative detection limit ~ 0.4 wt. %
2. Non detectable (ND)
3. Not Analysed (NA)

XRD Analysis for Rio Tinto Brockman Samples

Drill Hole ID	IXA258	IYF389	IYF998	IYV633	IYV641	IYZ407	IZR189
Sample Lithology	Shale	Manganiferous Shale	Dolomite	Calcrete	Calcrete	Detrital Waste	Low grade siliceous
Stratigraphy	Whaleback Shale	Wittenoom Formation	Wittenoom Formation	Detrital	Detrital	Detrital	Joffre Member
Strand Formations	Whaleback Shale Upper	Wittenoom Formation	Wittenoom Formation	Calcrete	Calcrete	Immature Detrital	Joffre 2
Classification	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)
Actinolite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Alunite	ND[2]	ND[2]	ND[2]	0.4	ND2	ND[2]	ND[2]
Calcite	ND[2]	ND[2]	ND[2]	46.5	90.8	ND[2]	ND[2]
Dolomite/Ankerite	ND[2]	85.6	94.2	23.2	0.9	ND[2]	ND[2]
Goethite	38.8	4.3	0.6	9.7	0.9	35	41.2
Gypsum	0.4	ND[2]	ND[2]	0.3	0.1	ND[2]	0.1
Hematite	18	1.3	1.1	0.3	ND[2]	32.8	51.8
Kaolinite	39.5	2.1	0.8	4.7	0.1	28.1	2.1
Magnetite	ND[2]	ND[2]	ND[2]	0.4	0.4	ND[2]	0.6
Montmorillonite	1	1.4	0.9	8.1	0.4	0.4	0.3
Pyrite	ND[2]	ND[2]	ND[2]	ND[2]	0.4	ND[2]	0.6
Quartz	2.3	2.2	0.8	2.5	3	0.1	3.1
Siderite(VariablecompositionMg,Mn)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Stilpnomelane	ND[2]	ND[2]	ND[2]	0.1	0.1	ND[2]	0.1
Talc	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Gibbsite	ND[2]	ND[2]	ND[2]	ND[2]	ND[2]	0.1	ND[2]
Illite(I-S)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Minnesotaite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Muscovite	ND[2]	ND[2]	ND[2]	ND[2]	0.8	2.9	0.1
Albite	ND2	0.2	0.6	ND[2]	0.2	ND[2]	ND[2]
Microcline	ND[2]	2.8	1.1	ND[2]	1.2	ND[2]	ND[2]
Opal(?)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]

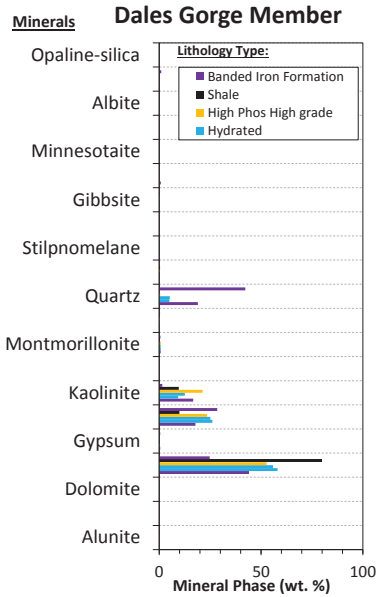
1. Semiquantitative detection limit ~ 0.4 wt. %
2. Non detectable (ND)
3. Not Analysed (NA)

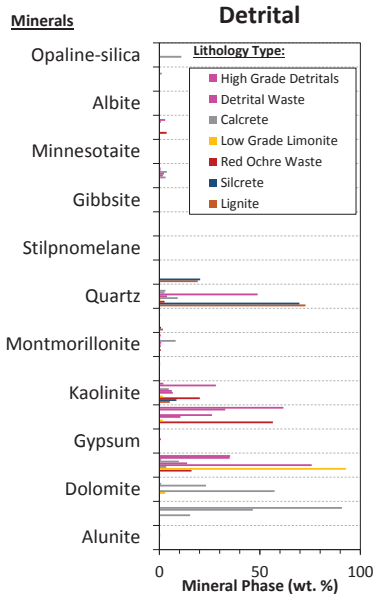
XRD Analysis for Rio Tinto Brockman Samples

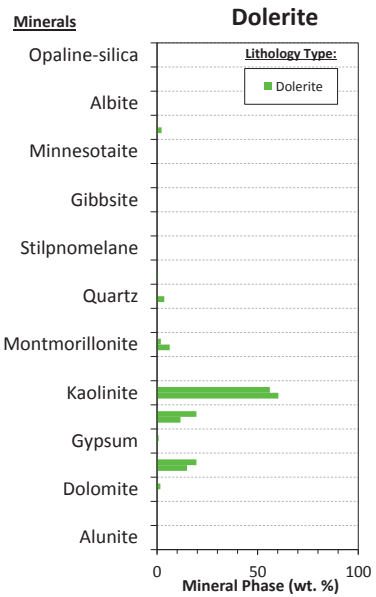
Drill Hole ID	KAH259	KAL552	KAS713	KAW711	KBJ443	KBR002
Sample Lithology	High Grade Detritals	Banded Iron Formation	High Phos High grade	Shale	Shale	Banded Iron Formation
Stratigraphy	Detrital	Marra Mamba	Dales Gorge Member	Dales Gorge Member	Whaleback Shale	Dales Gorge Member
Strand Formations	Mature Detritals	Nammuldi Member	Dales Gorge 2	Dales Gorge 2	Whaleback Shale Upper	Dales Gorge 3
Classification	Uncertain	Non-Acid Forming	Non-Acid Forming (Barren)	Non-Acid Forming (Barren)	Potentially Acid Forming - Low Capacity	Non-Acid Forming (Barren)
Actinolite	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Alunite	ND[2]	ND[2]	0.1	0.1	2.1	0.1
Calcite	ND[2]	0.1	ND[2]	ND[2]	ND[2]	ND[2]
Dolomite/Ankerite	ND[2]	6.9	ND[2]	ND[2]	ND[2]	ND[2]
Goethite	35.2	1.2	52.7	79.8	55.4	24.8
Gypsum	ND[2]	0.1	ND[2]	ND[2]	ND[2]	0.5
Hematite	61.7	1.9	23.5	9.9	18.7	28.5
Kaolinite	2	0.1	21.3	9.6	23.4	1.5
Magnetite	ND[2]	18.7	ND[2]	ND[2]	ND[2]	0.1
Montmorillonite	0.7	ND[2]	0.8	0.3	0.2	0.6
Pyrite	ND[2]	0.4	0.3	ND[2]	ND[2]	0.4
Quartz	ND[2]	51.6	0.5	ND[2]	ND[2]	42.3
Siderite(VariablecompositionMg,Mn)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Stilpnomelane	ND[2]	2.3	ND[2]	ND[2]	ND[2]	ND[2]
Talc	NA[3]	0.3	ND[2]	ND[2]	ND[2]	ND[2]
Gibbsite	0.2	1.3	0.2	ND[2]	0.1	0.1
Illite(I-S)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]
Minnesotaite	NA[3]	0.8	ND[2]	ND[2]	ND[2]	ND[2]
Muscovite	ND[2]	0.8	ND[2]	ND[2]	ND[2]	ND[2]
Albite	ND[2]	1.7	ND[2]	ND[2]	ND[2]	ND[2]
Microcline	ND[2]	0.2	ND[2]	ND[2]	ND[2]	1
Opal(?)	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]	NA[3]

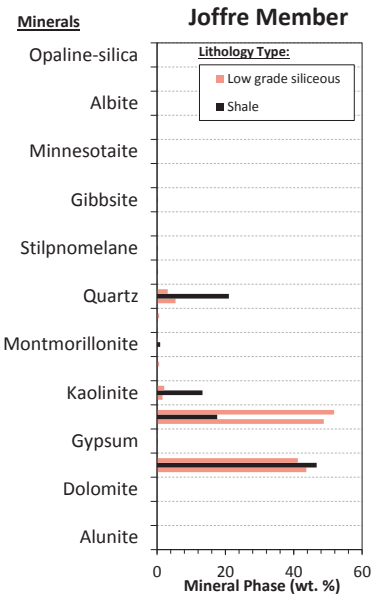
1. Semiquantitative detection limit ~ 0.4 wt. %
2. Non detectable (ND)
3. Not Analysed (NA)

XRD Mineral Phase Distribution by Stratigraphy and Lithology



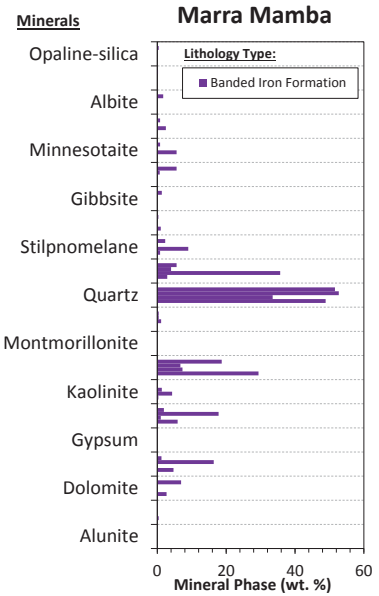


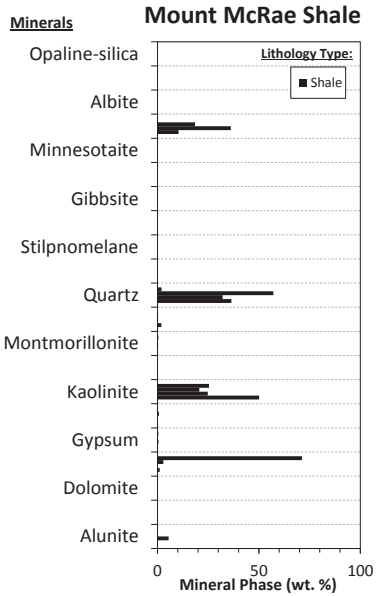


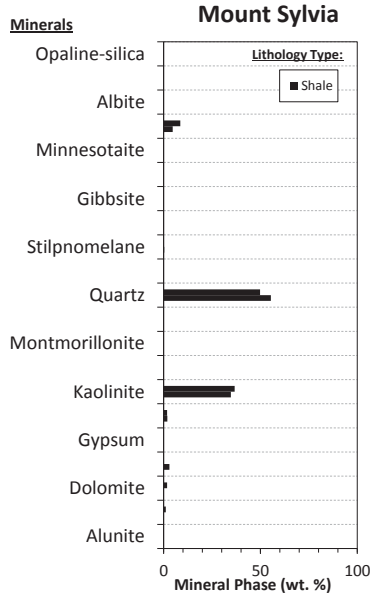


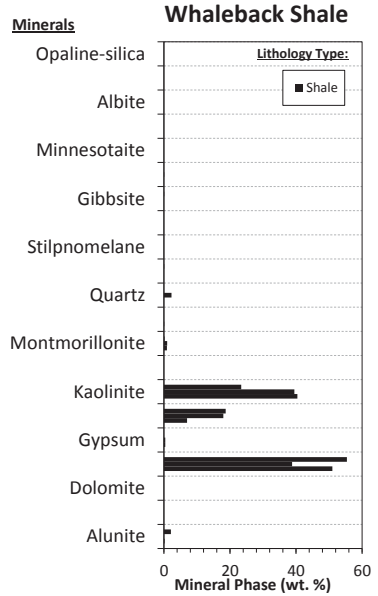
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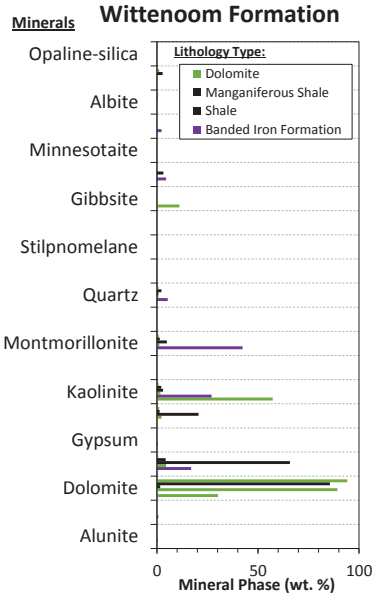
- Manganiferous Shale
- Shale
- Dolomite
- Banded Iron Formation
- Low grade siliceous
- Dolerite
- High Grade Detritals
- Detrital Waste
- Calcrete
- Low Grade Limonite
- Red Ochre Waste
- Silcrete
- Lignite
- High Phos High grade
- Hydrated

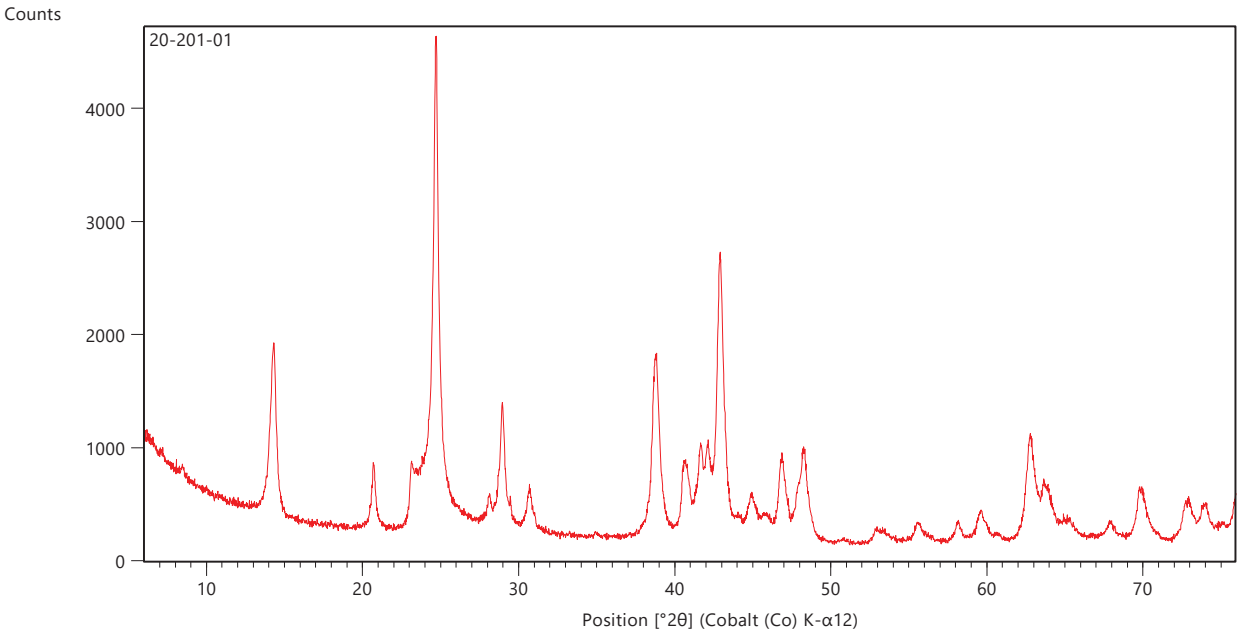




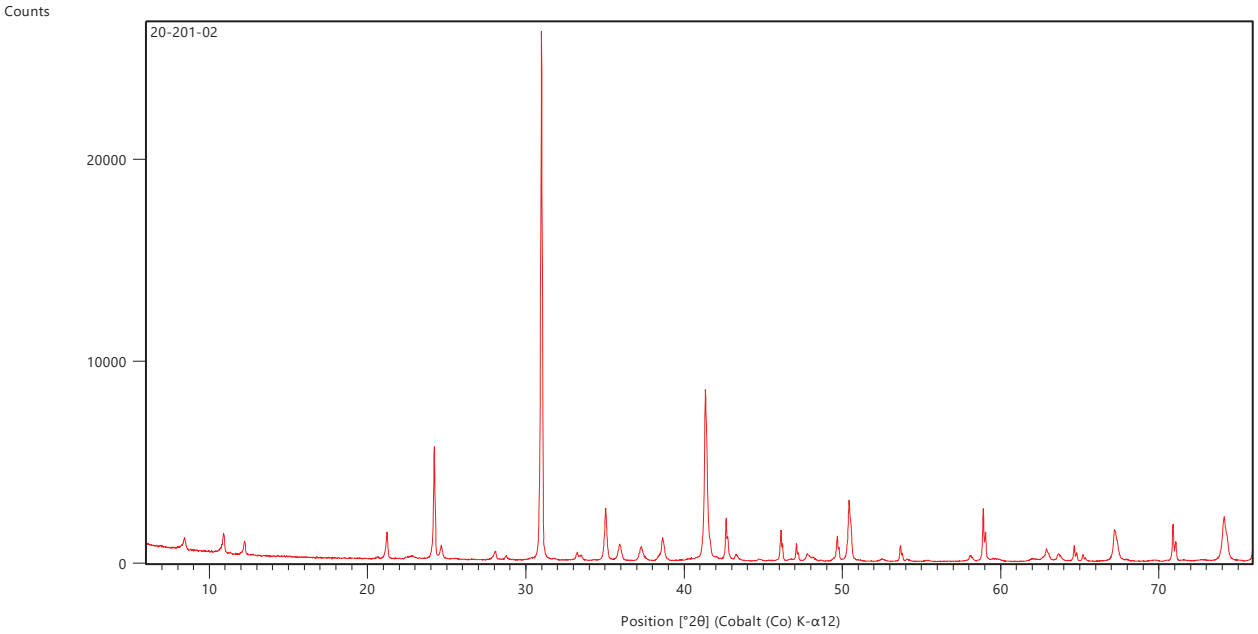




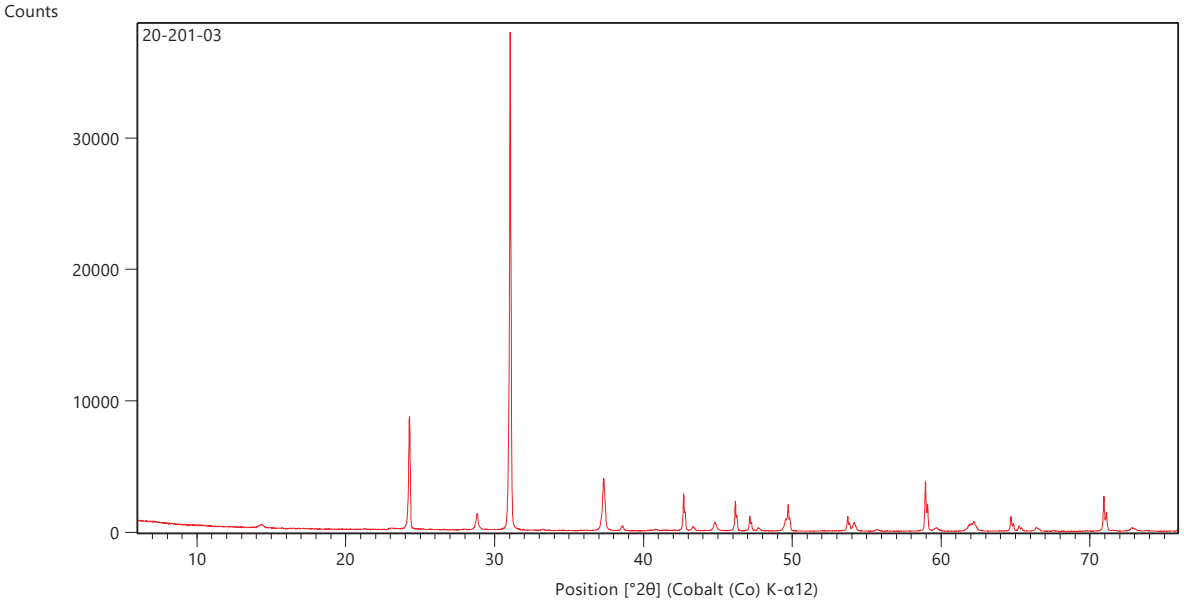




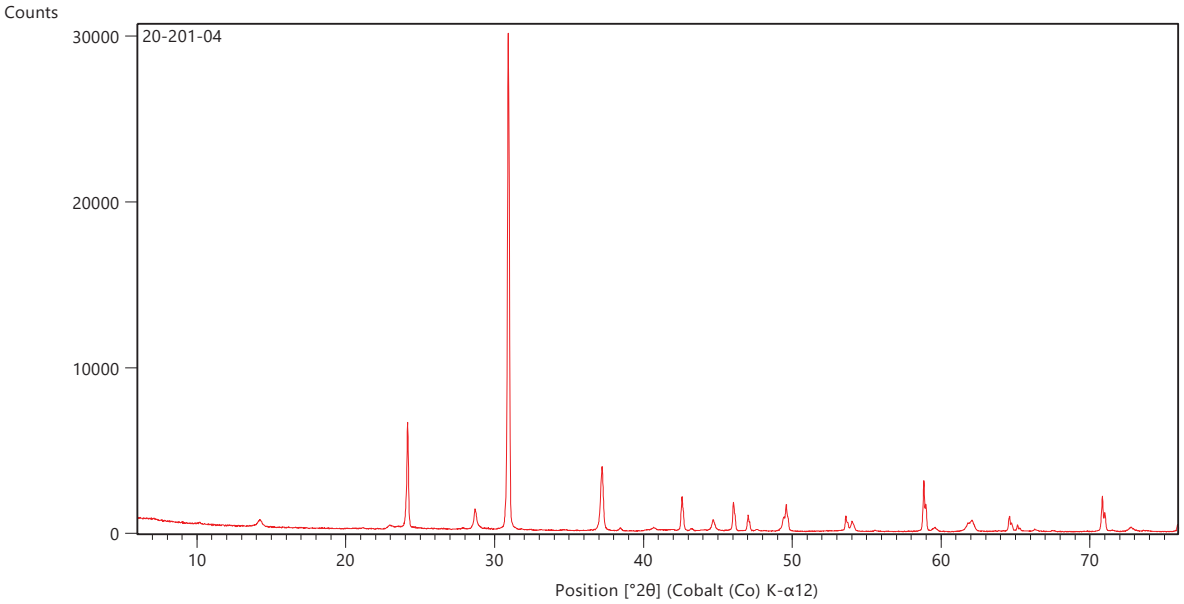
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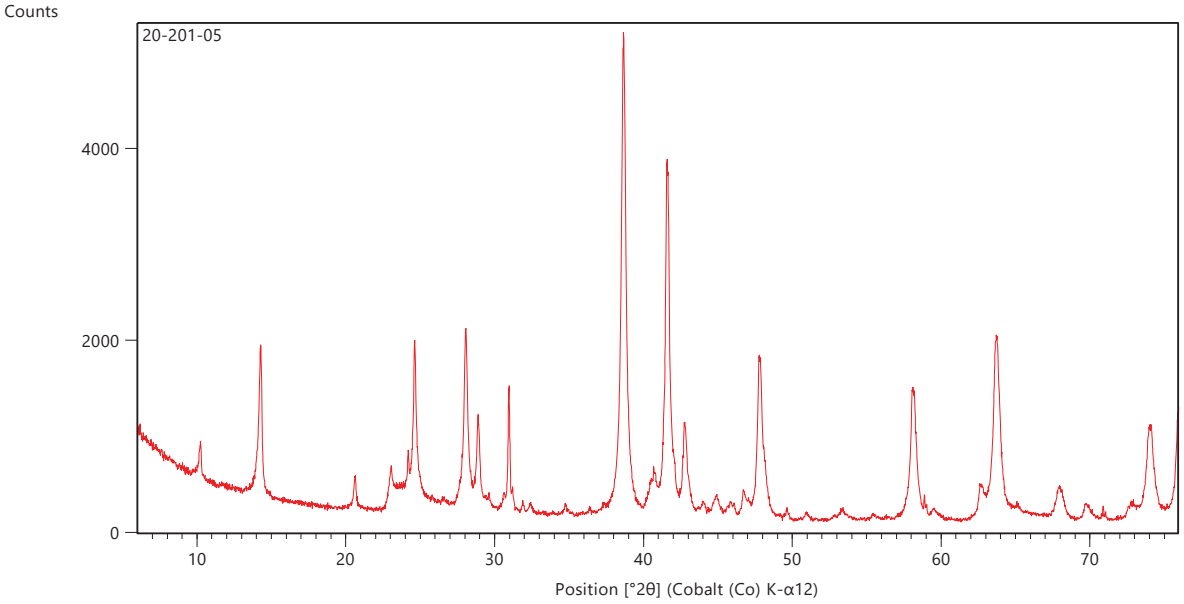
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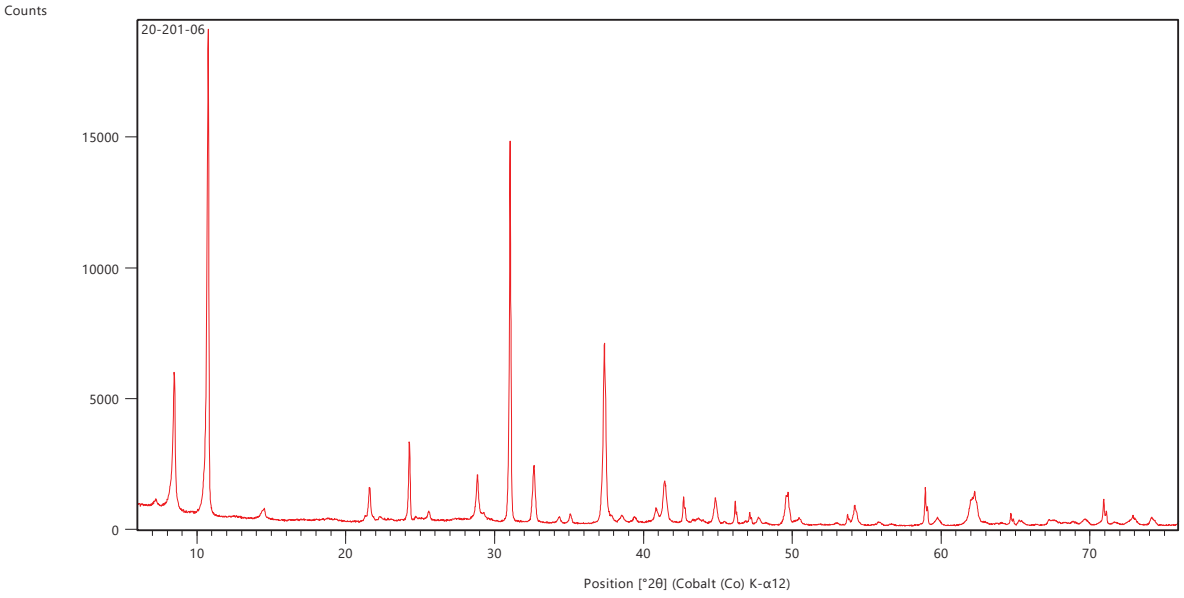
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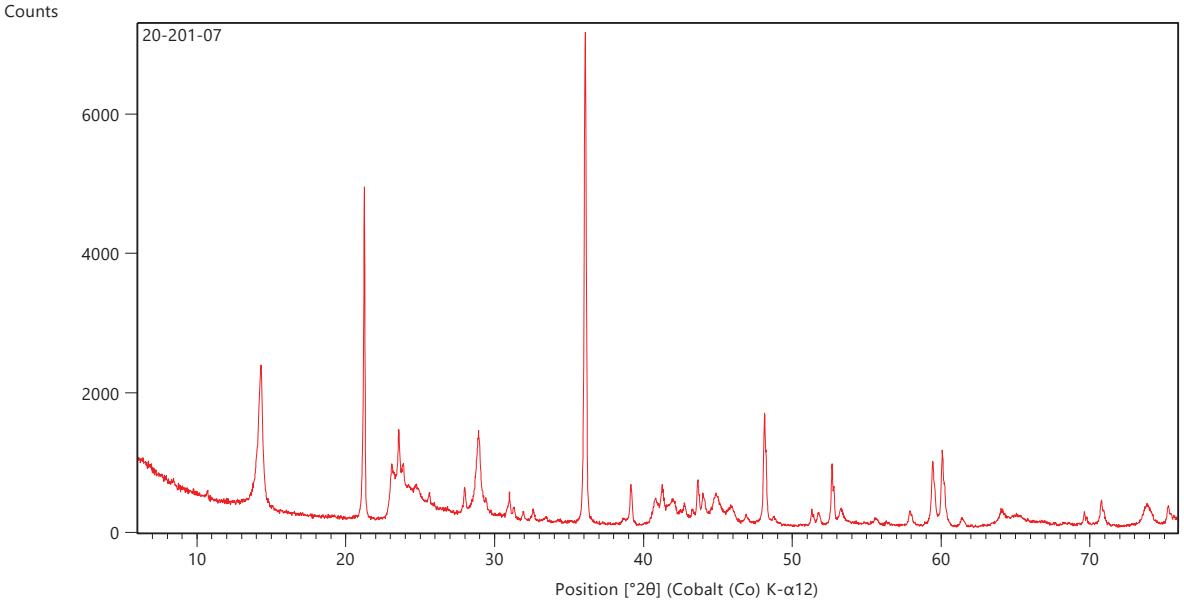
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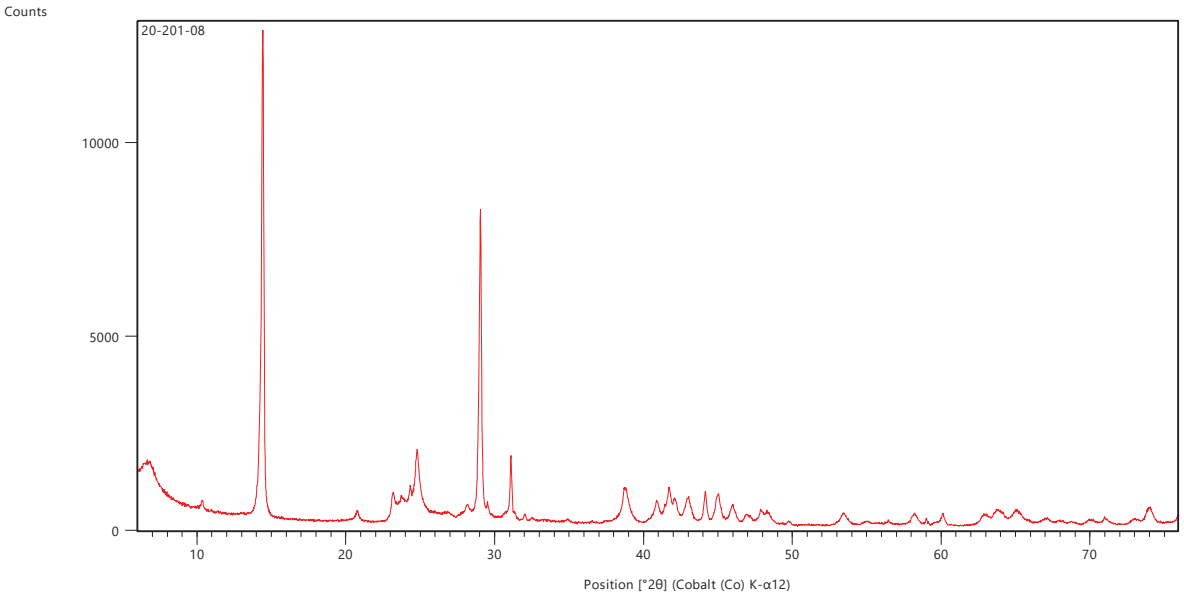
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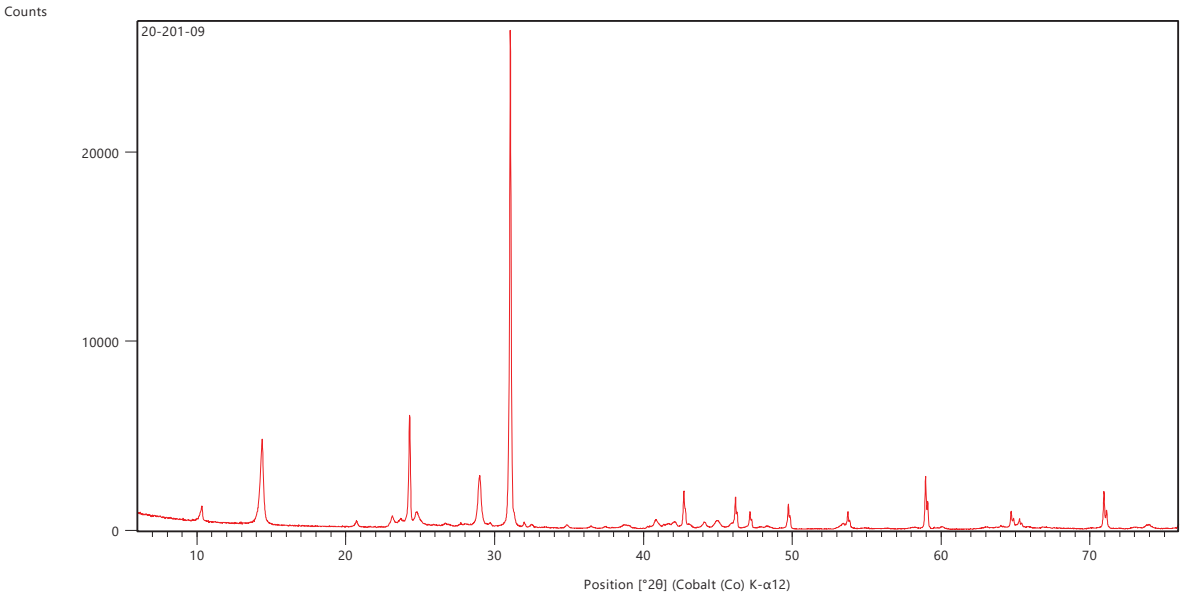
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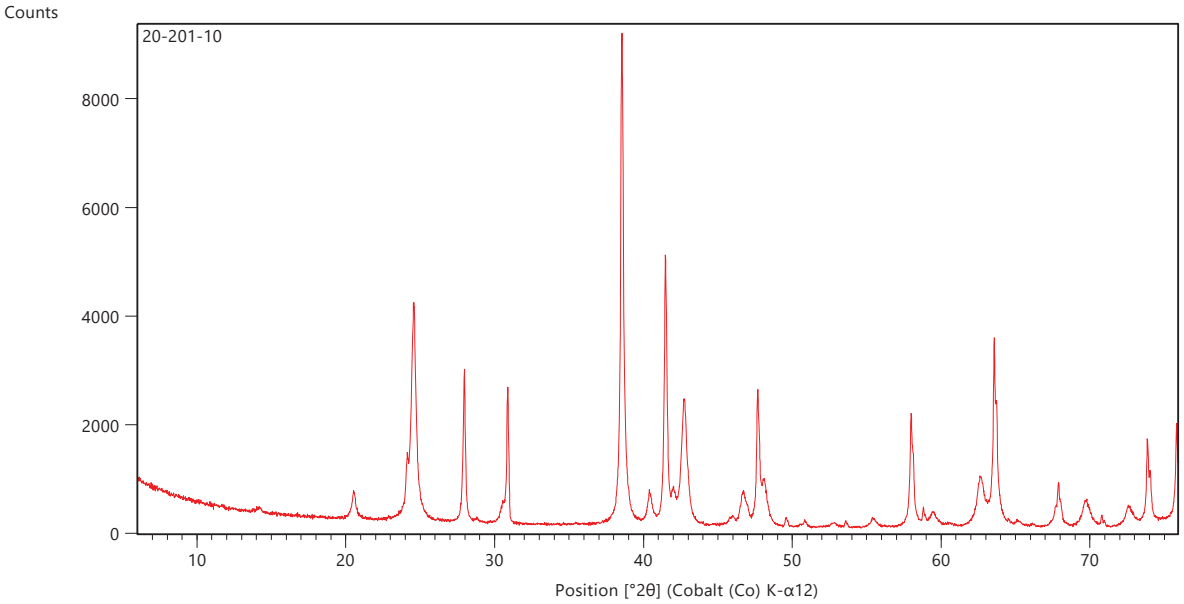
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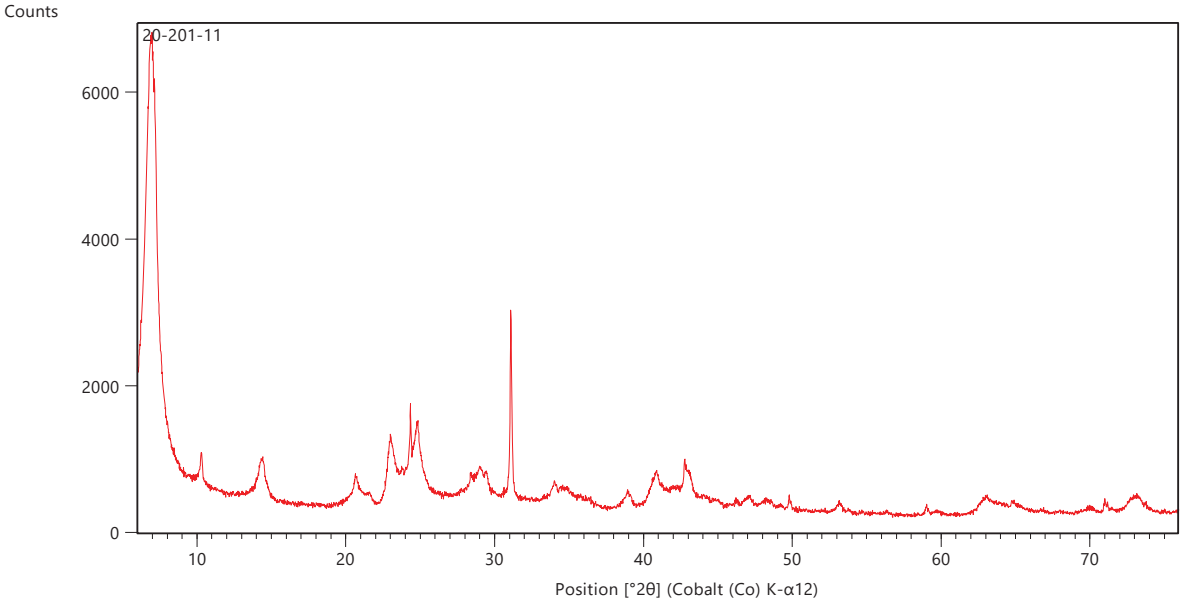
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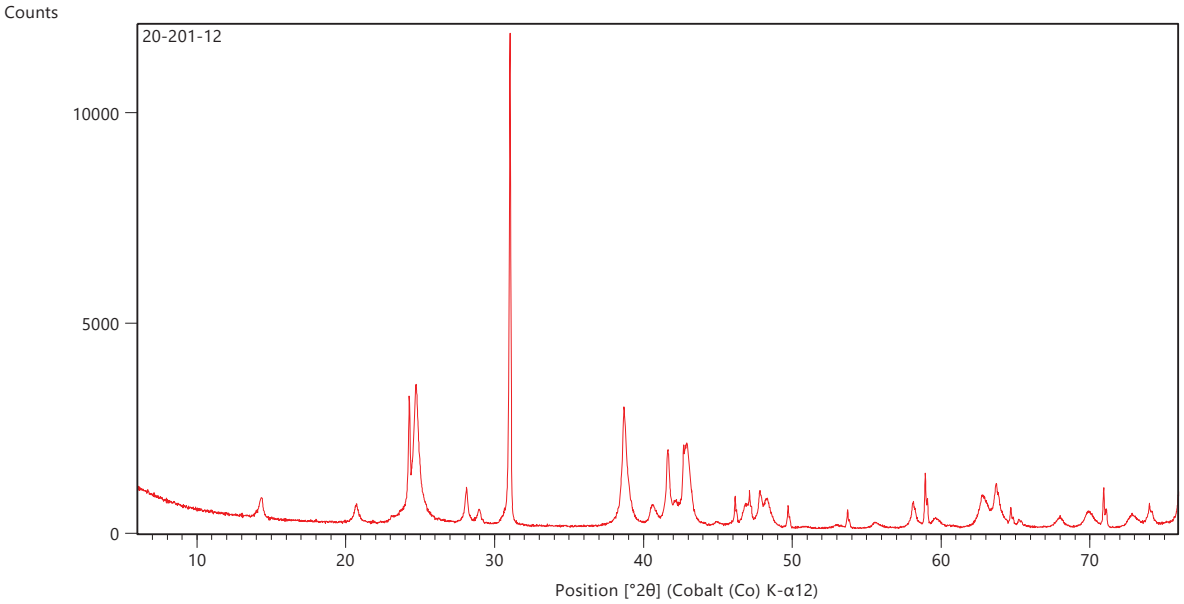
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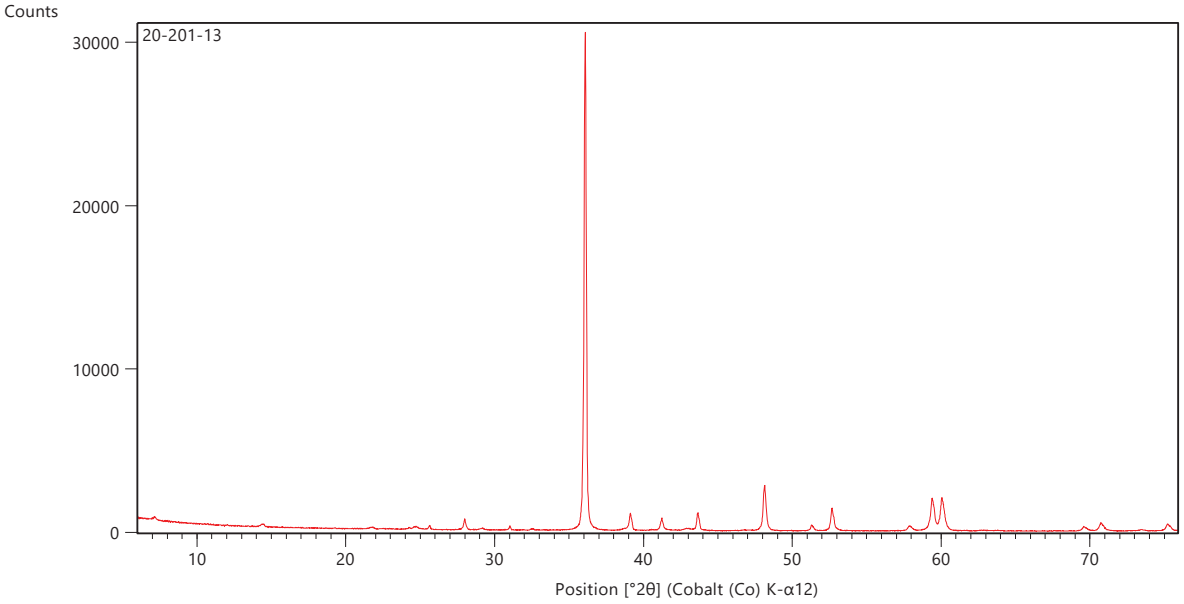
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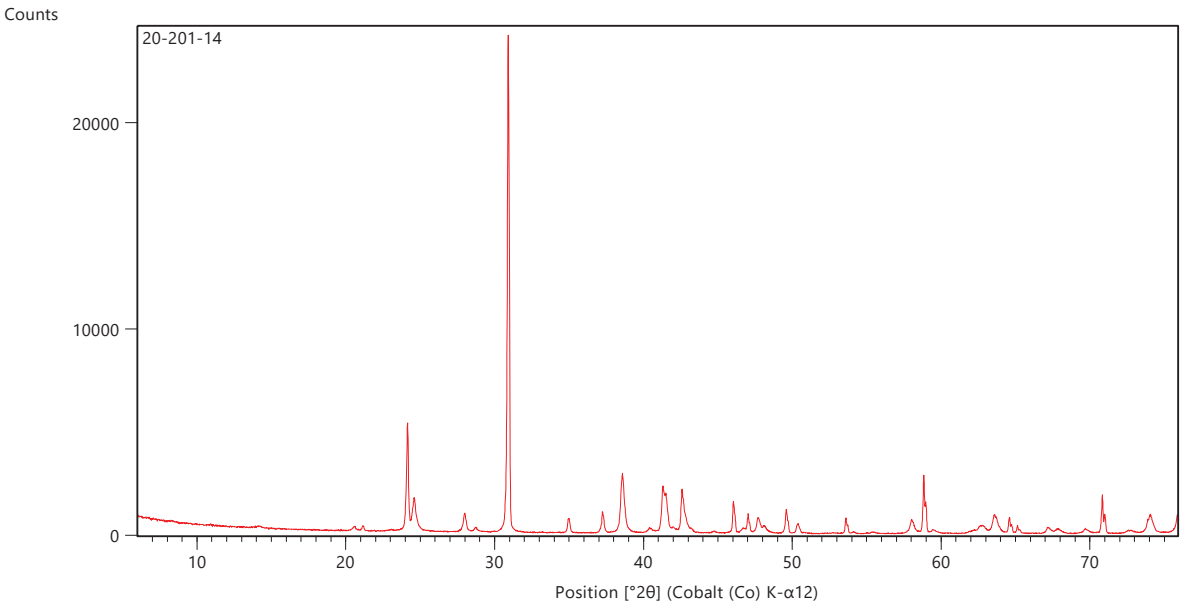
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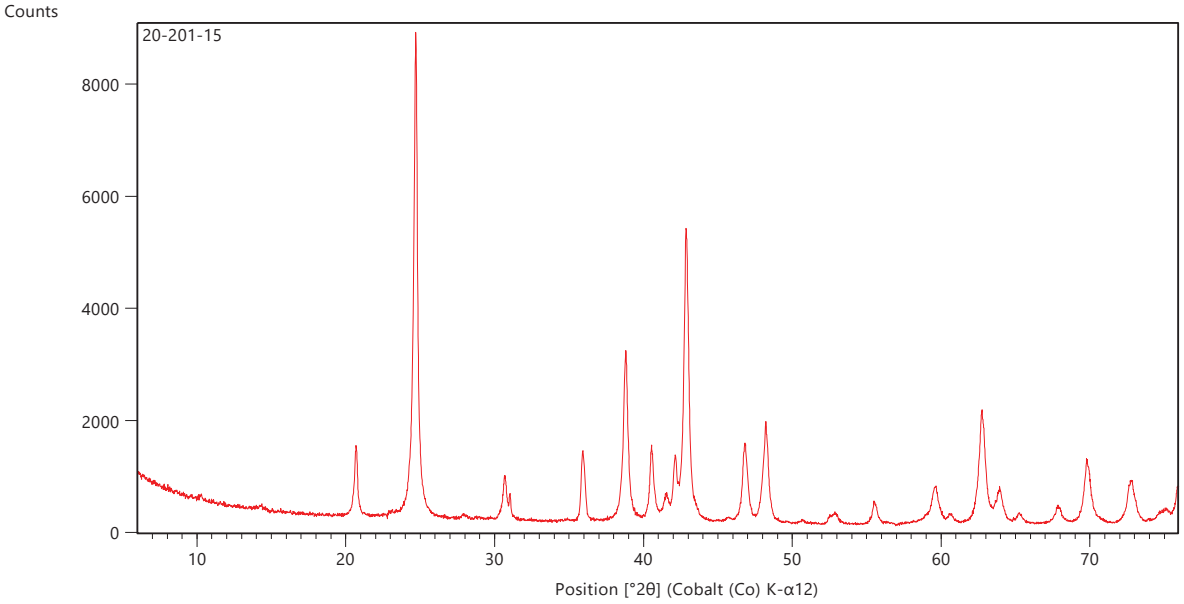
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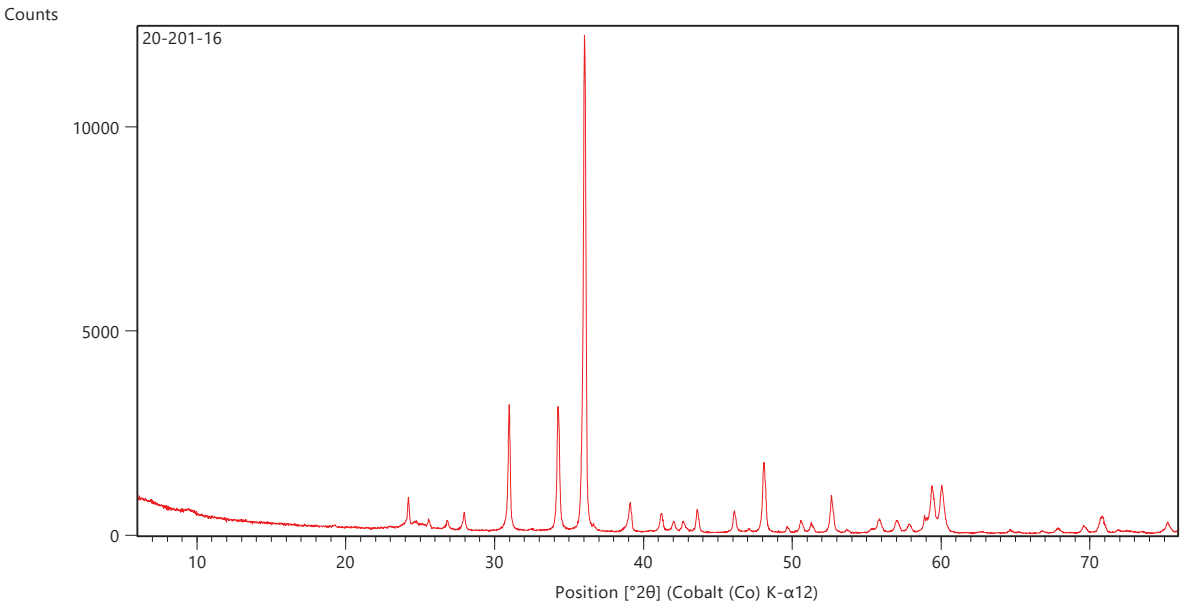
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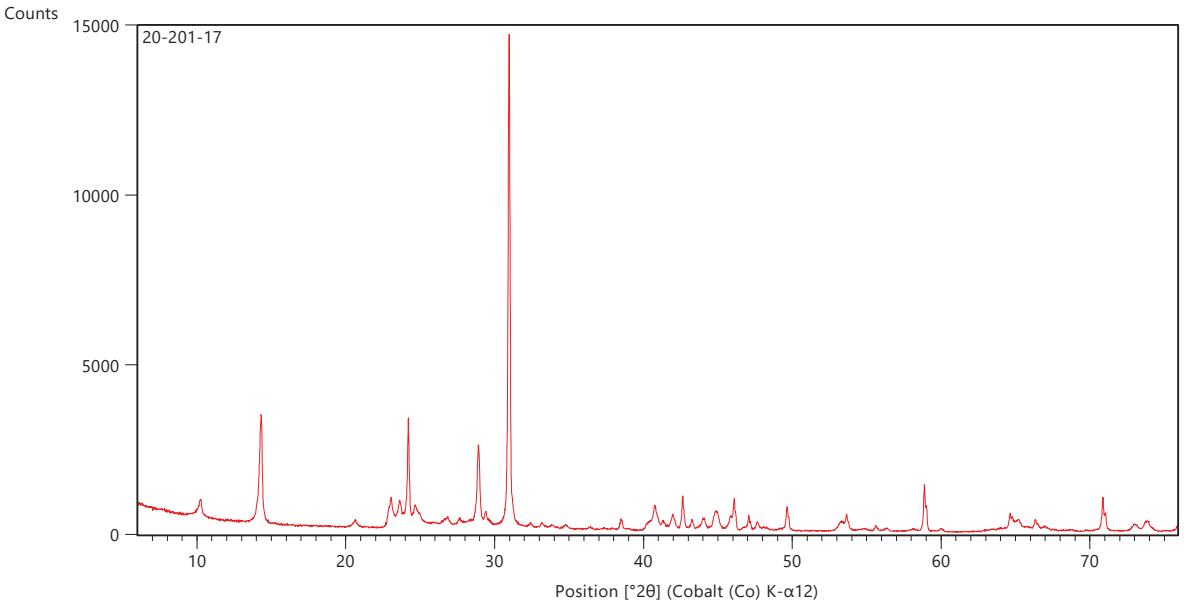
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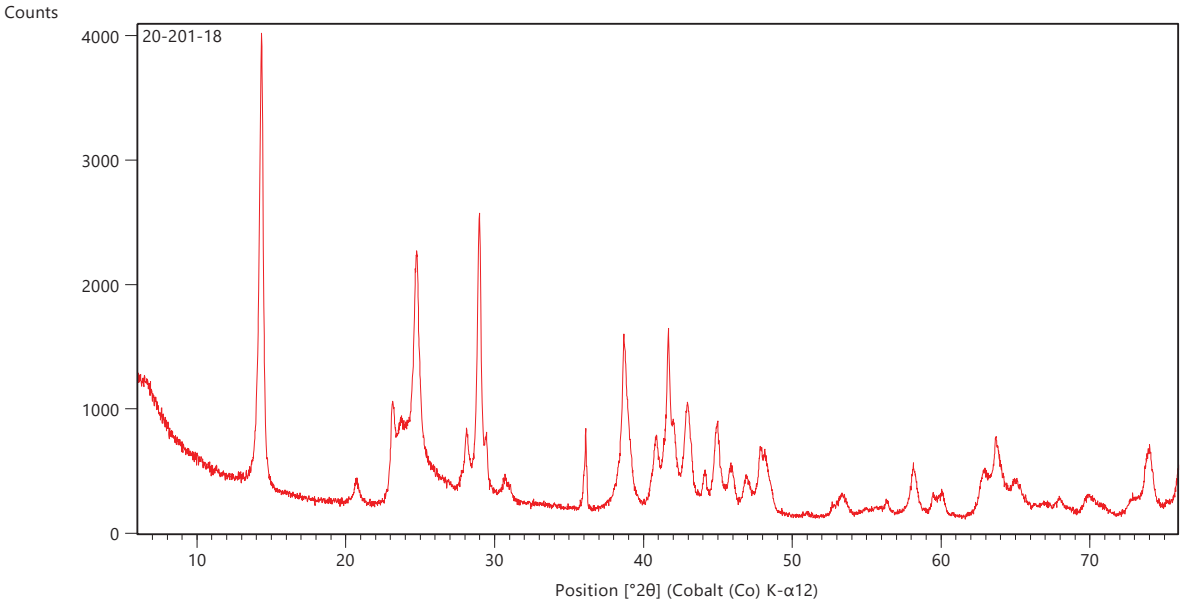
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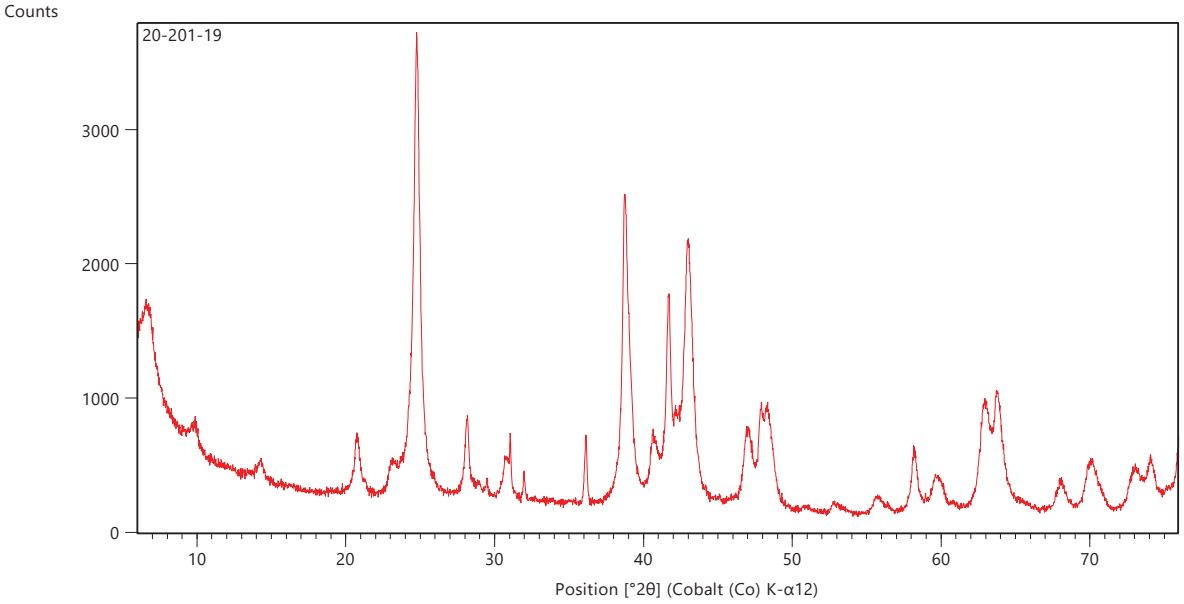
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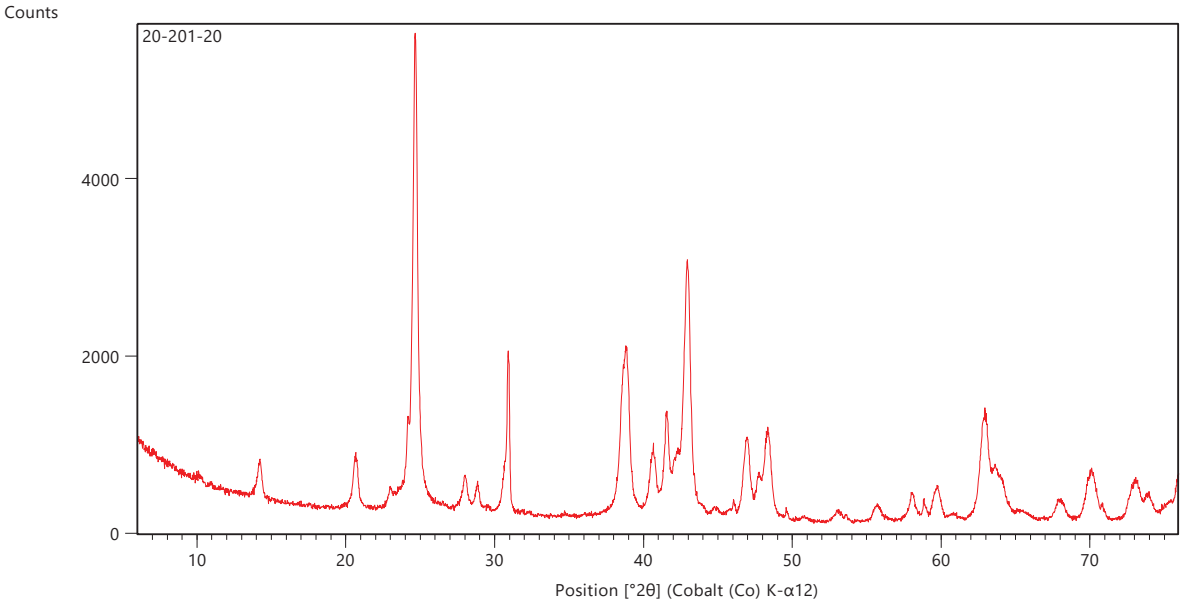
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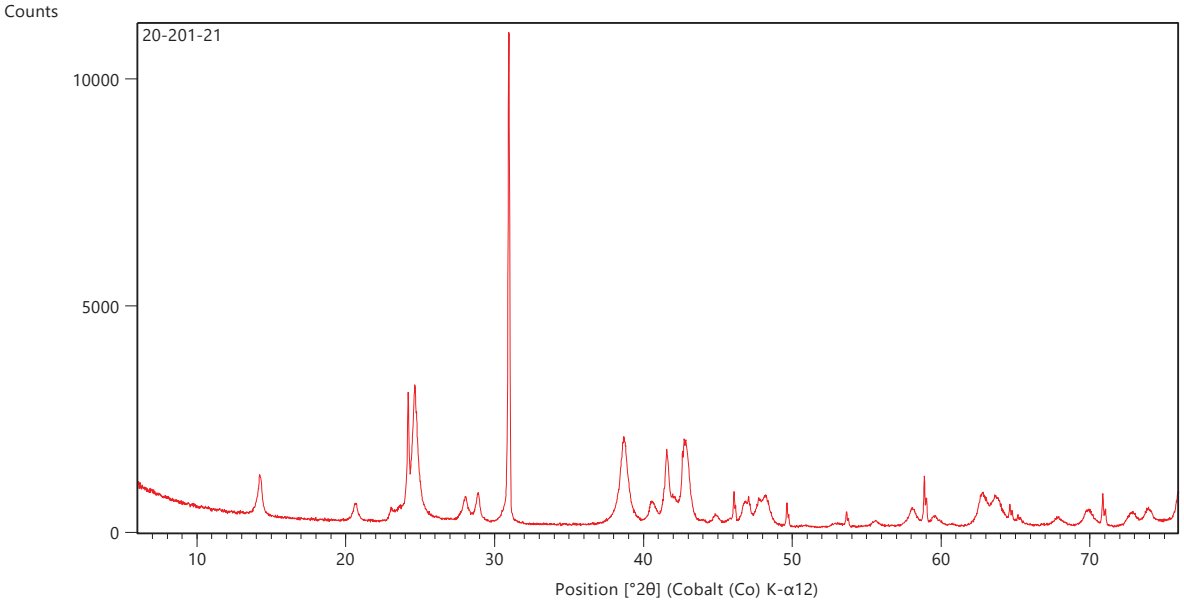
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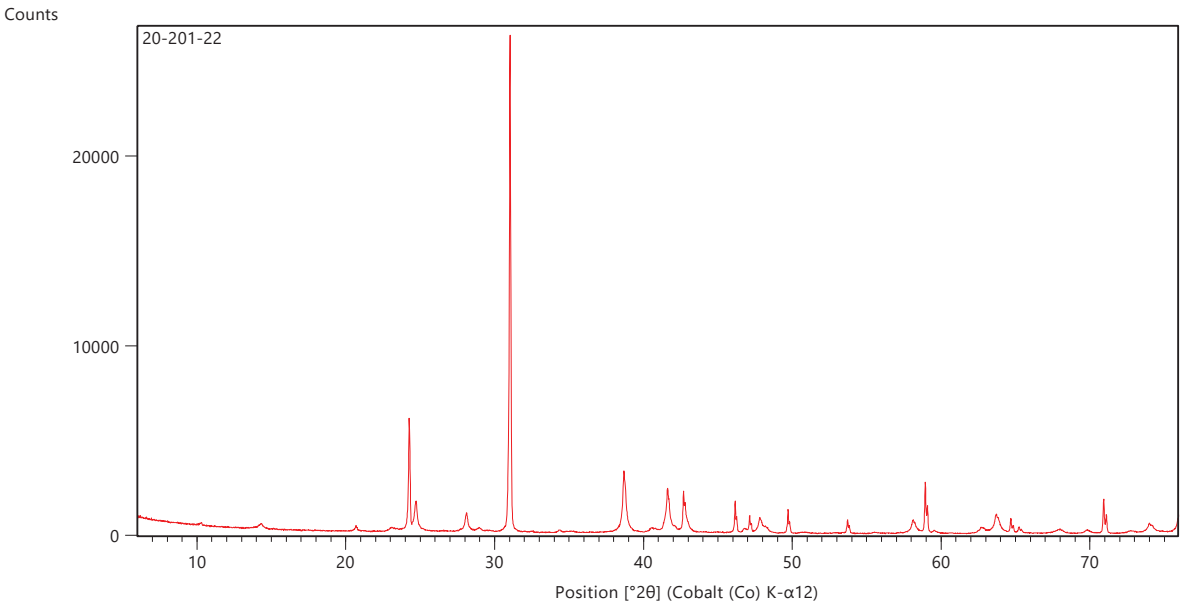
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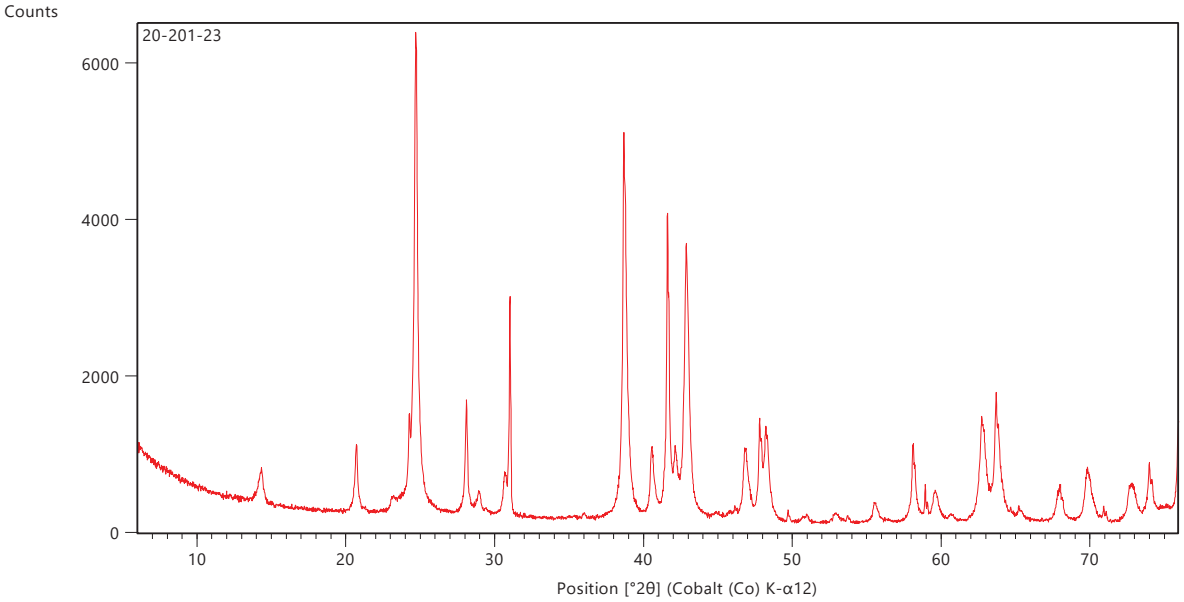
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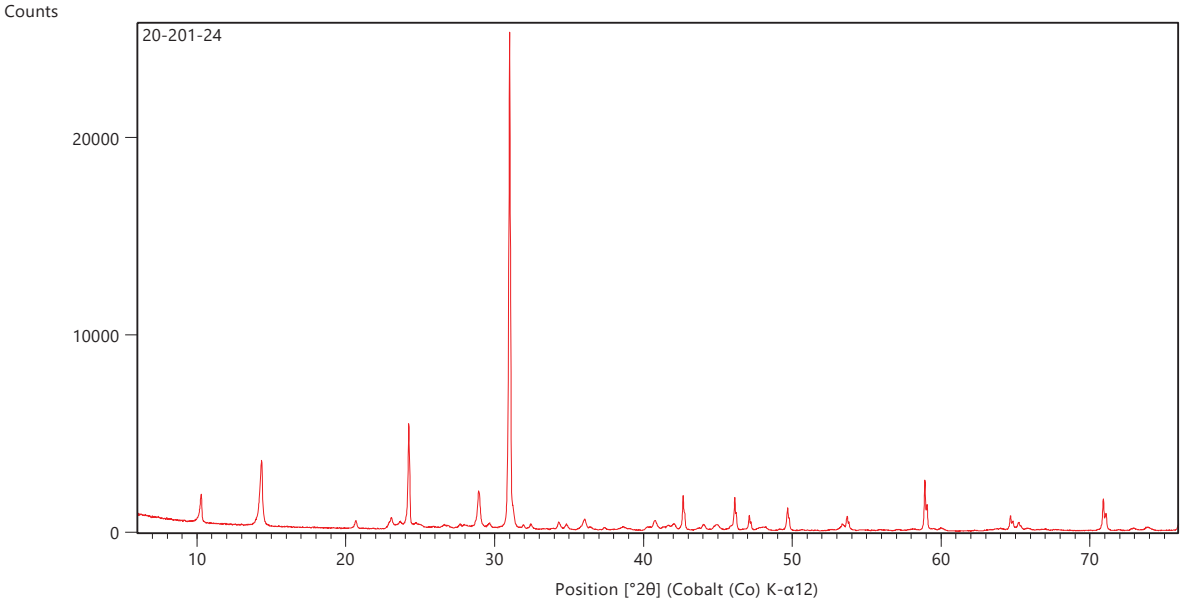
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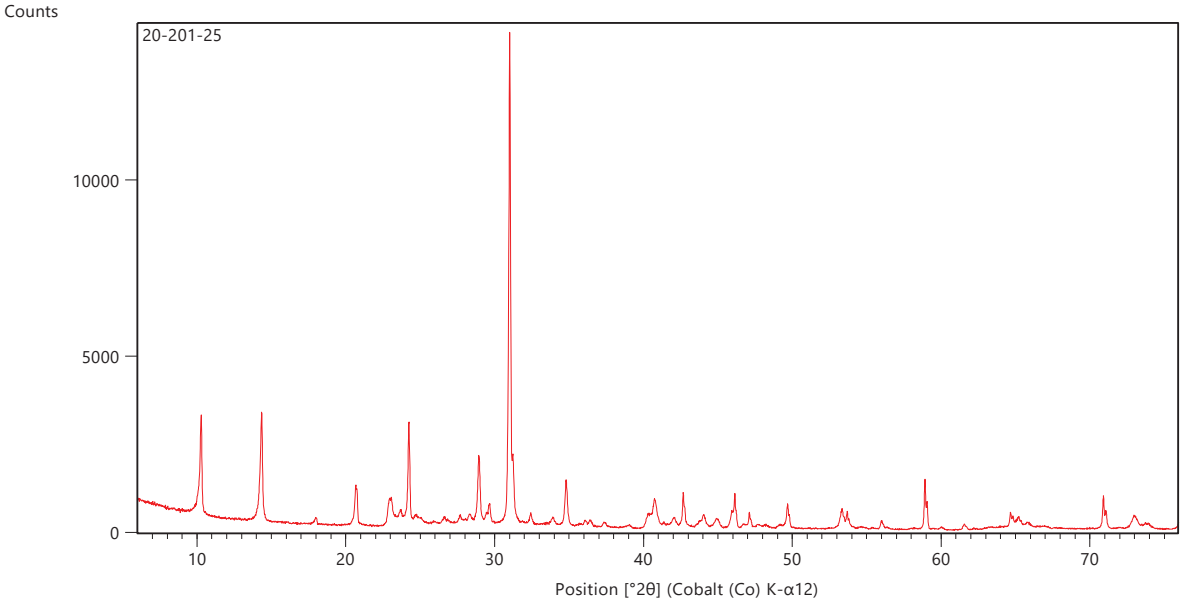
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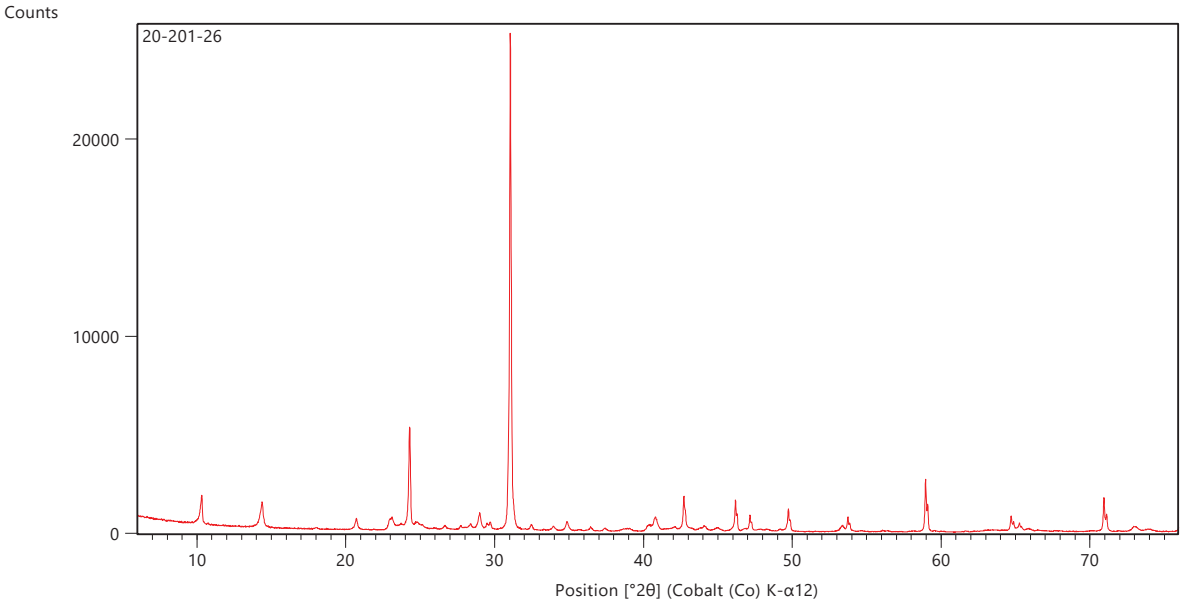
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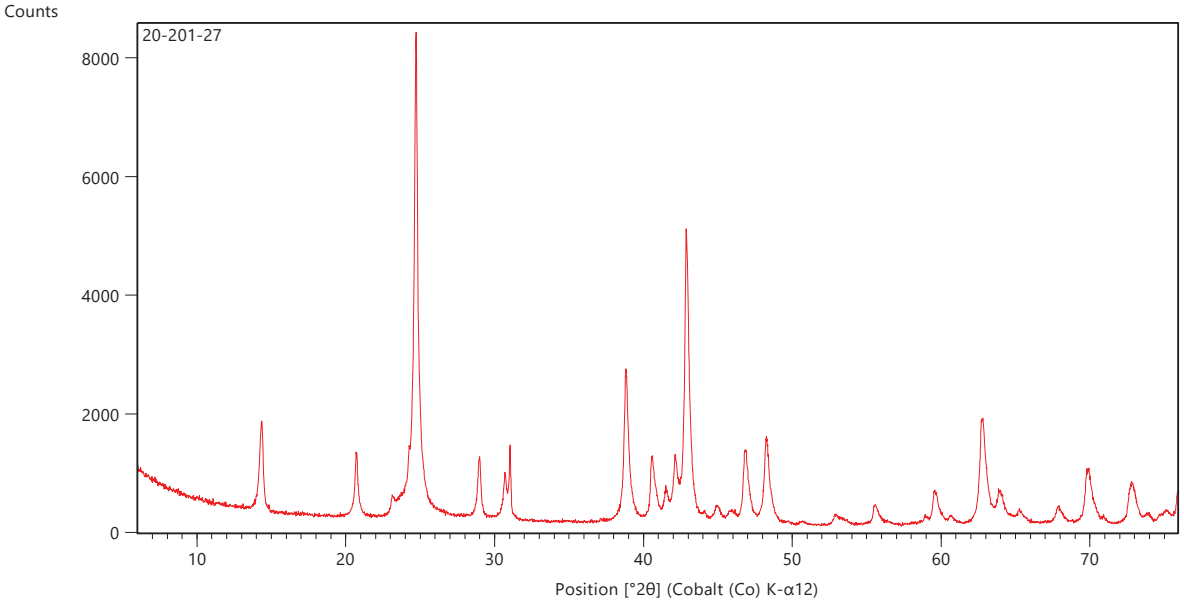
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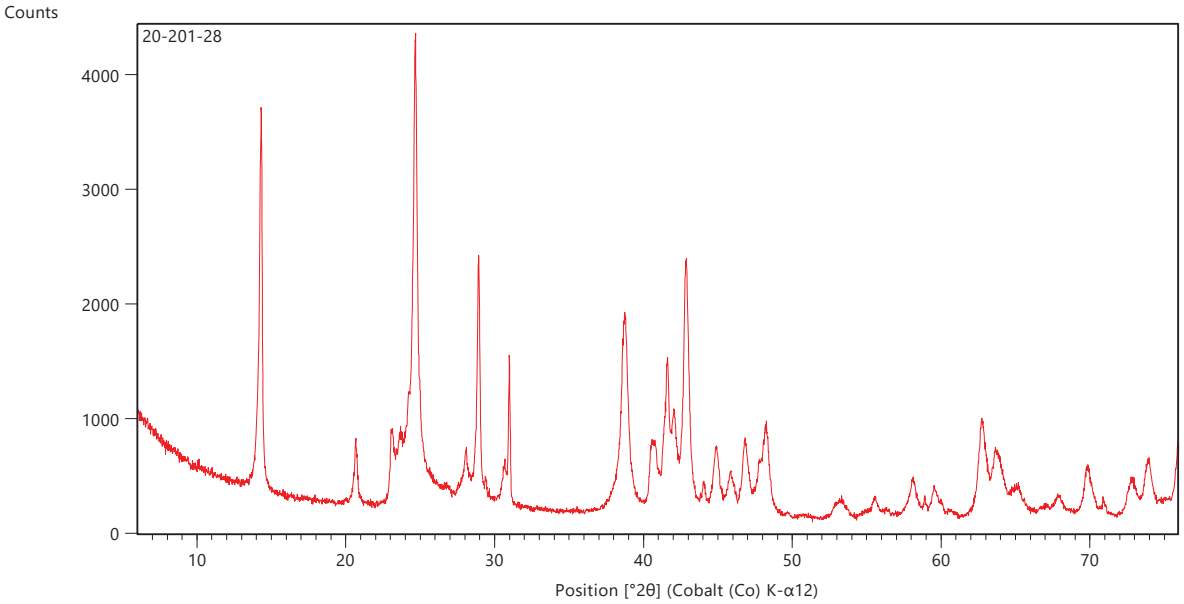
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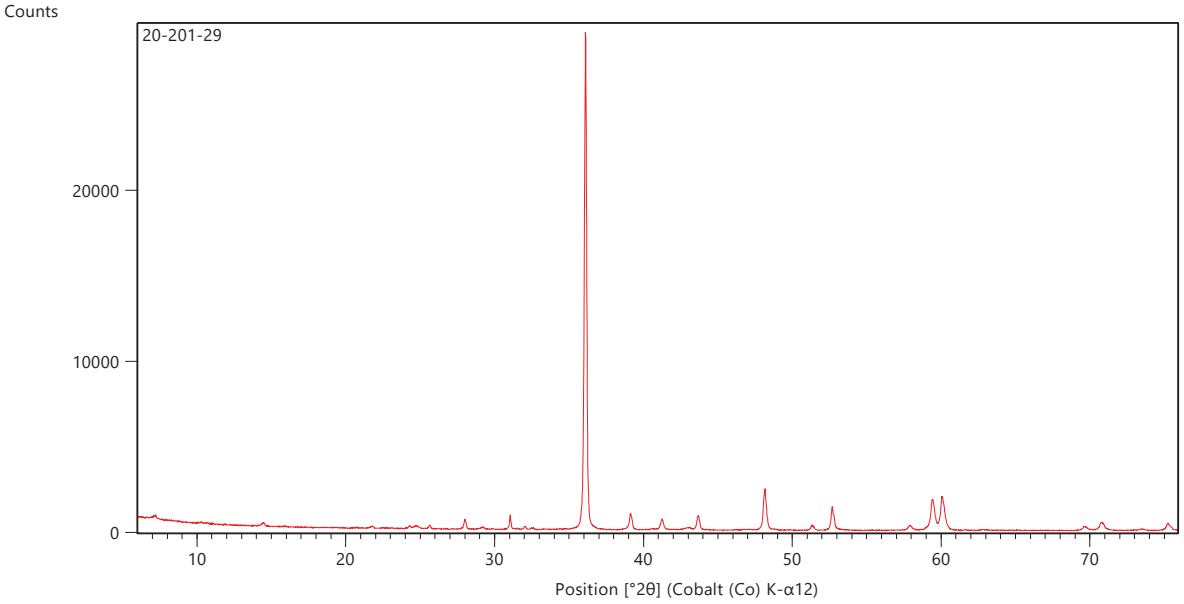
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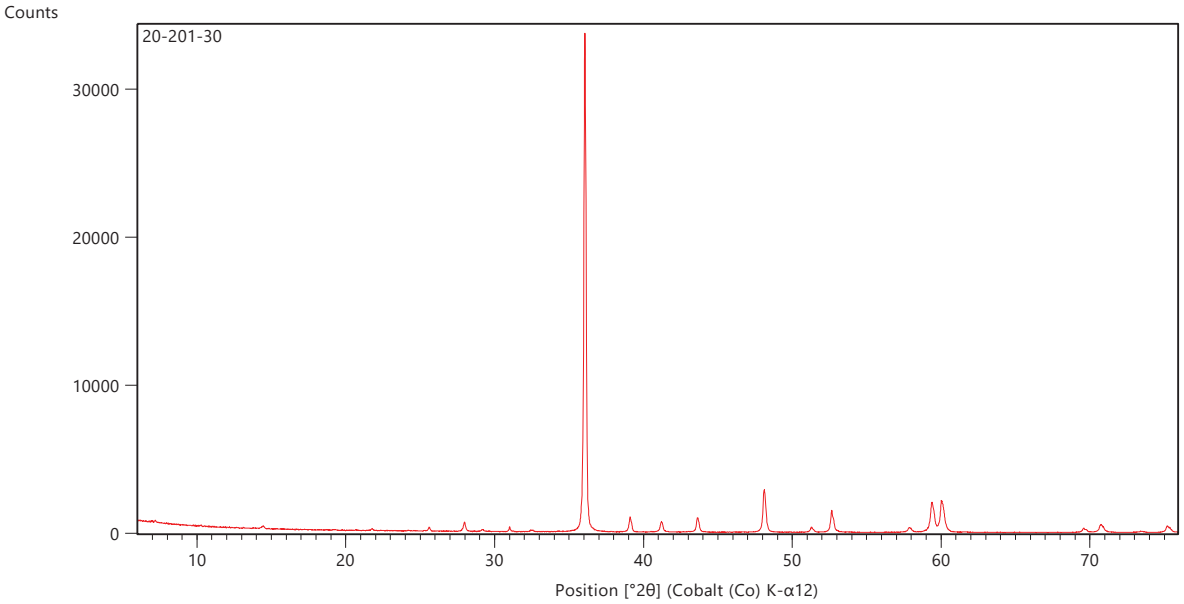
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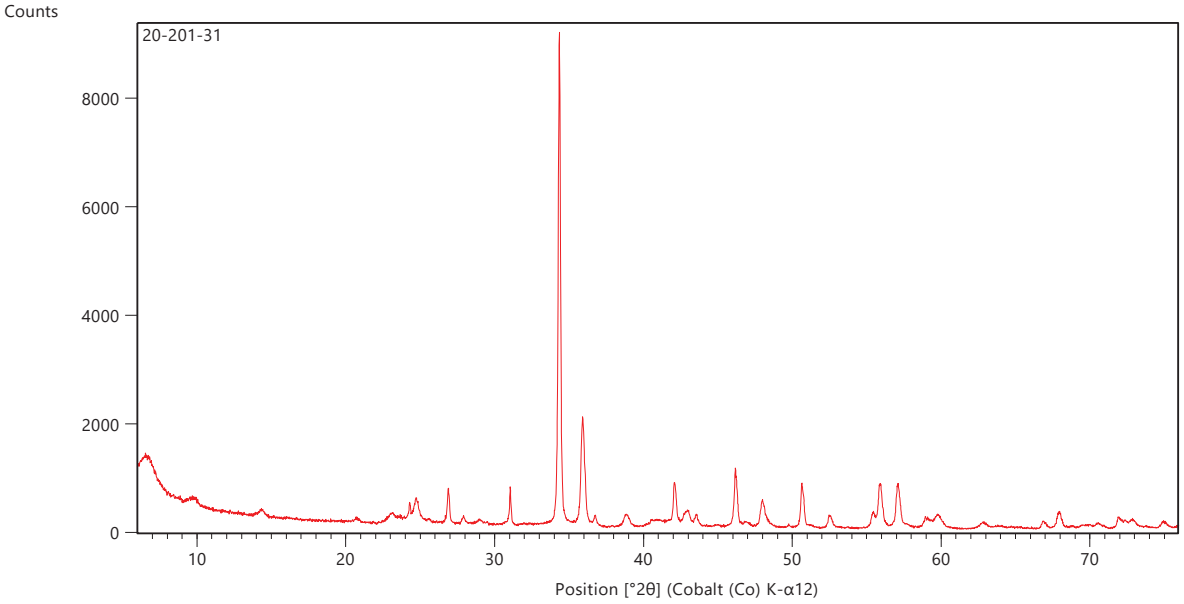
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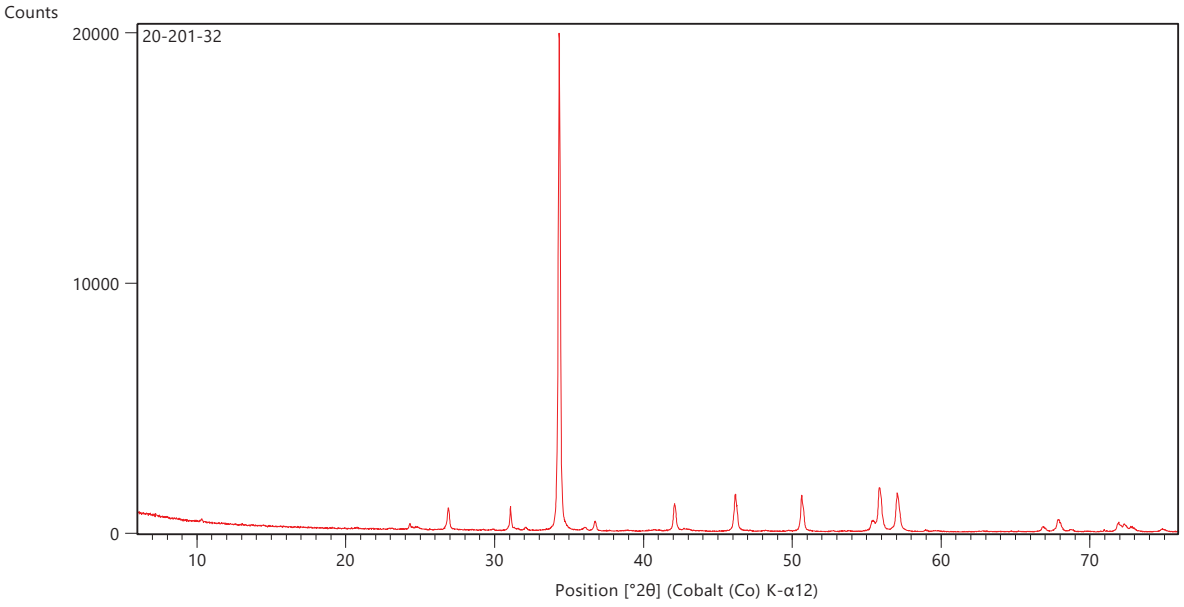
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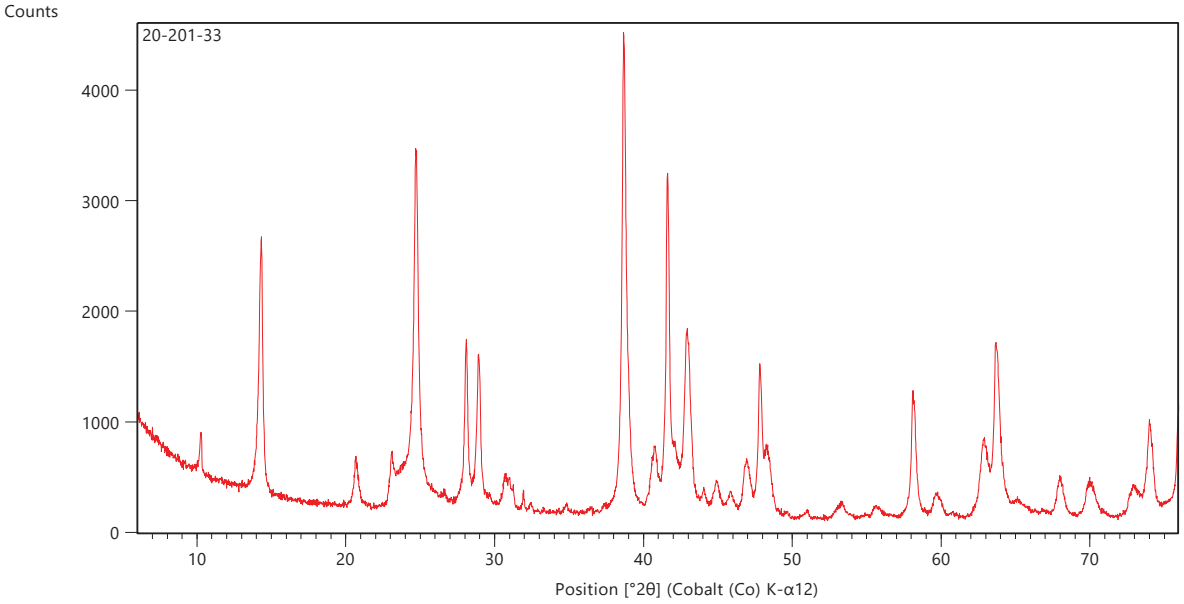
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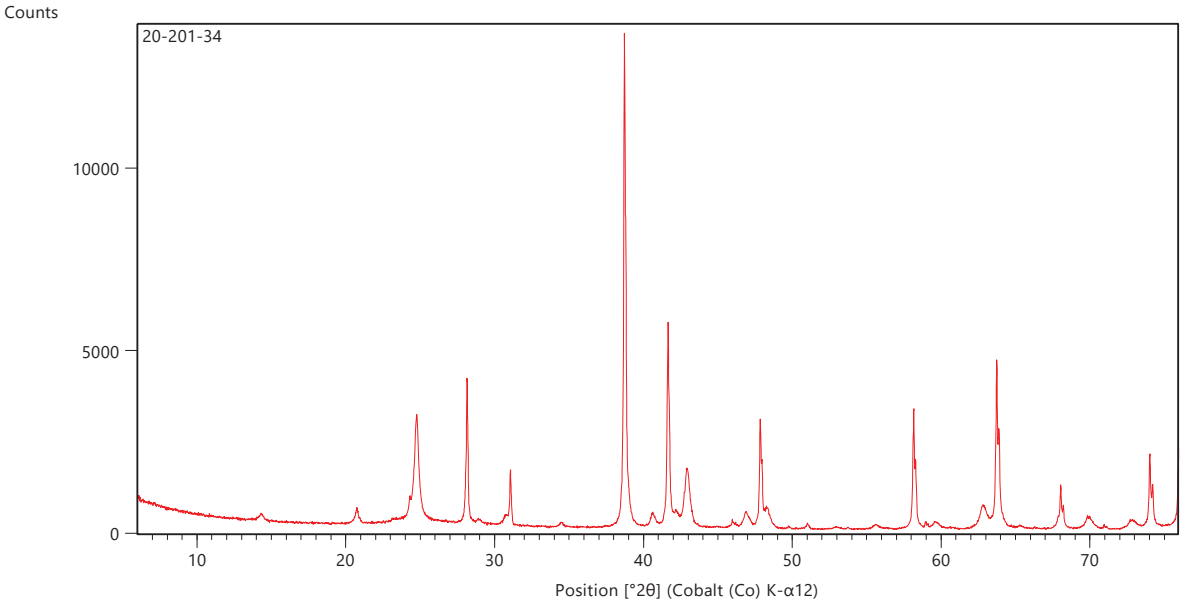
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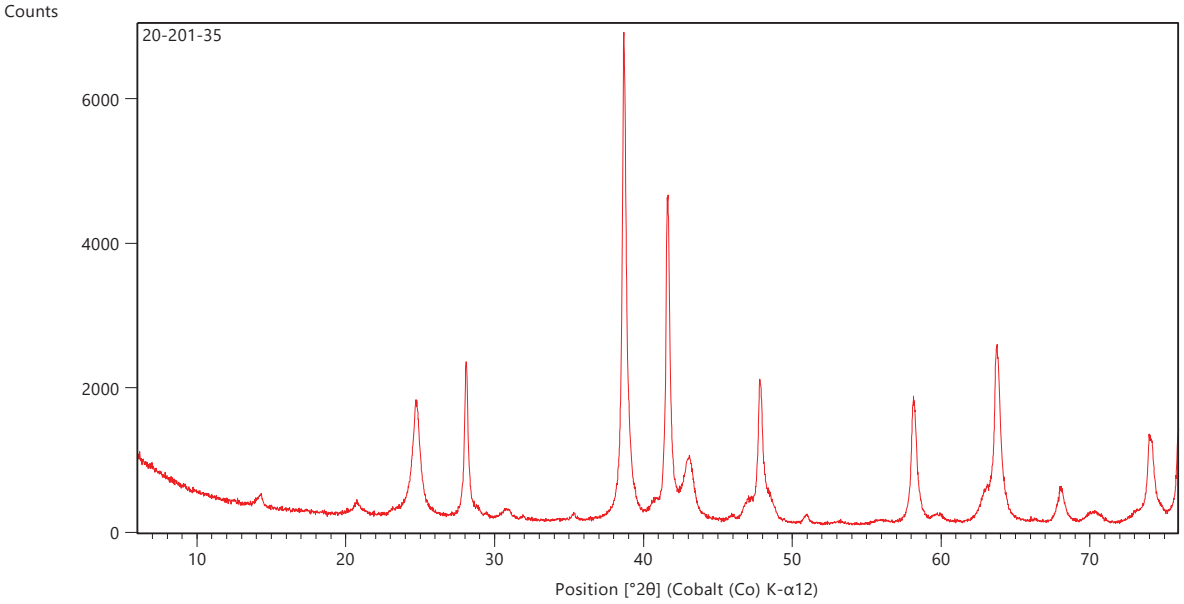
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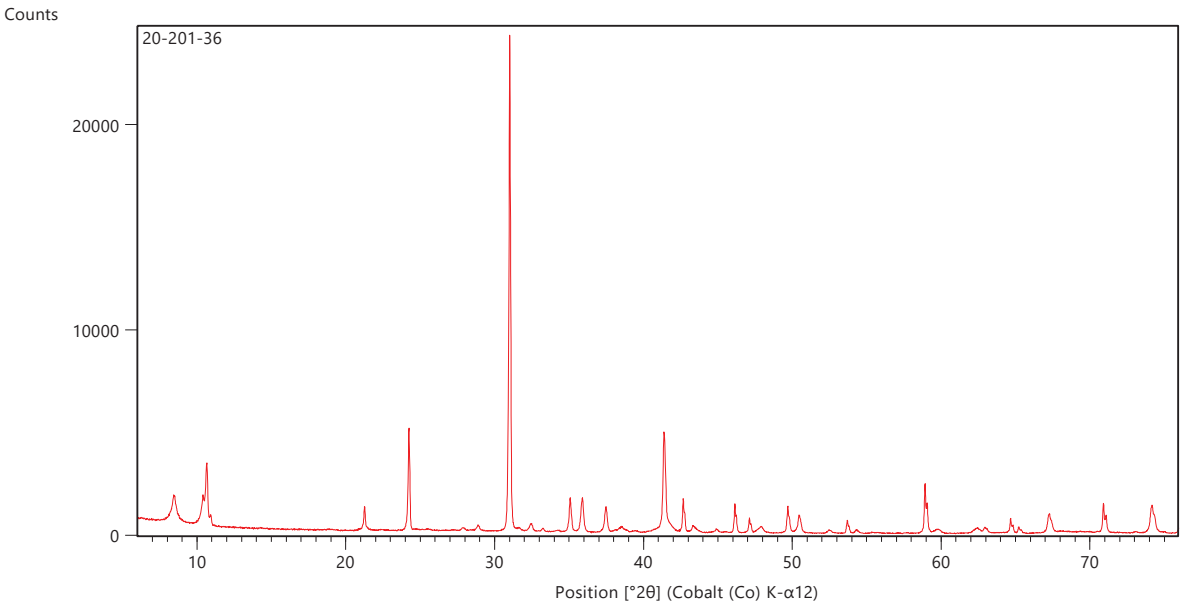
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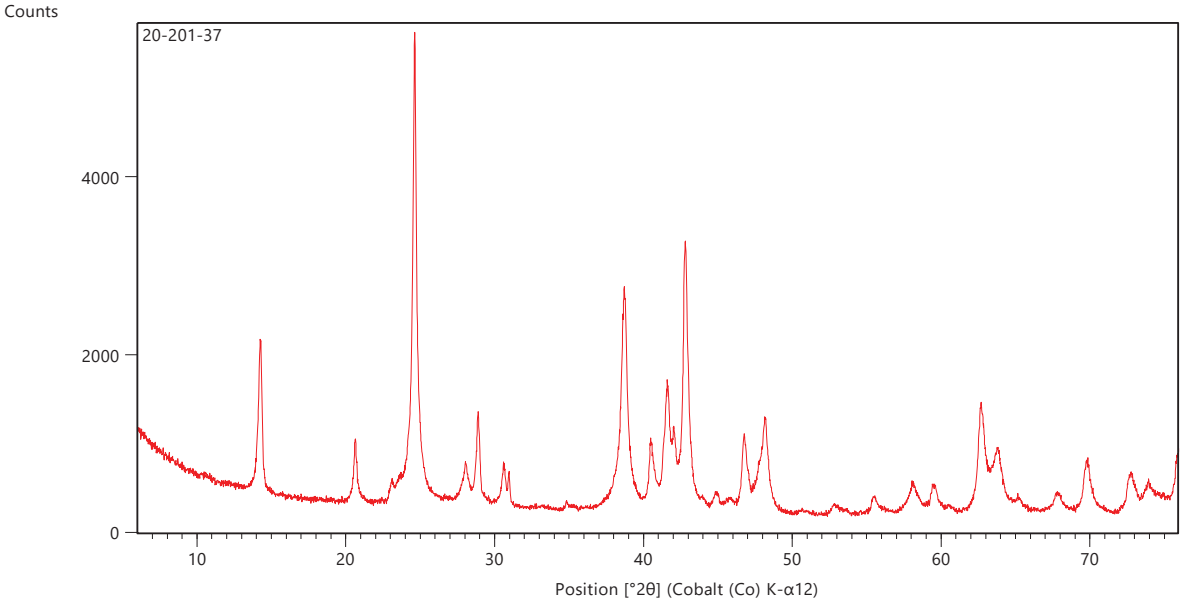
20-201-34



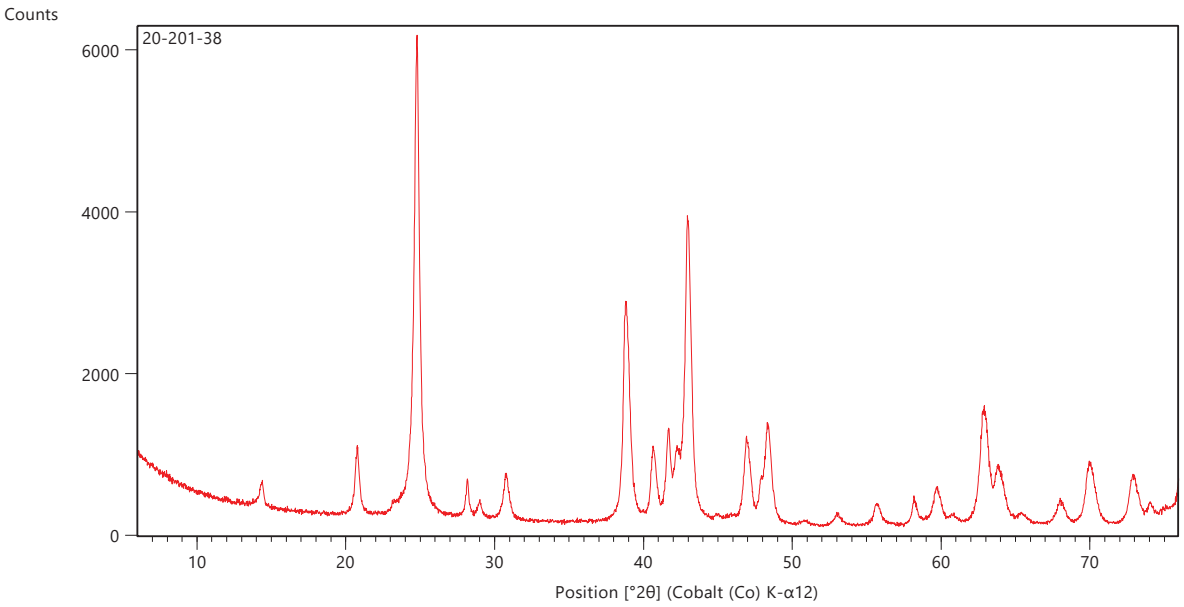
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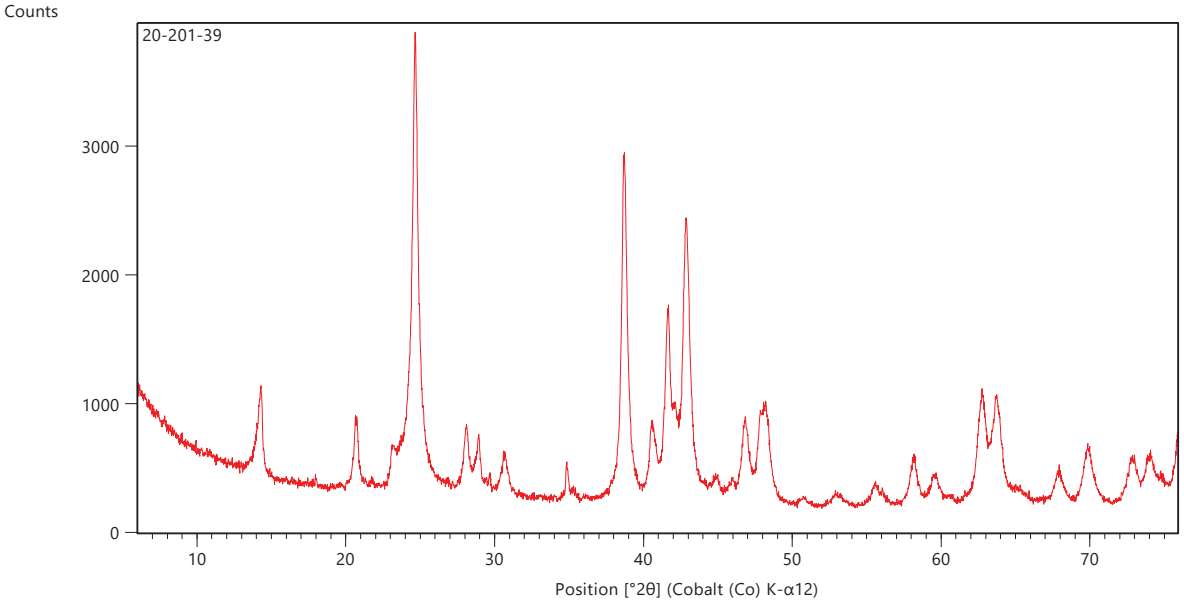
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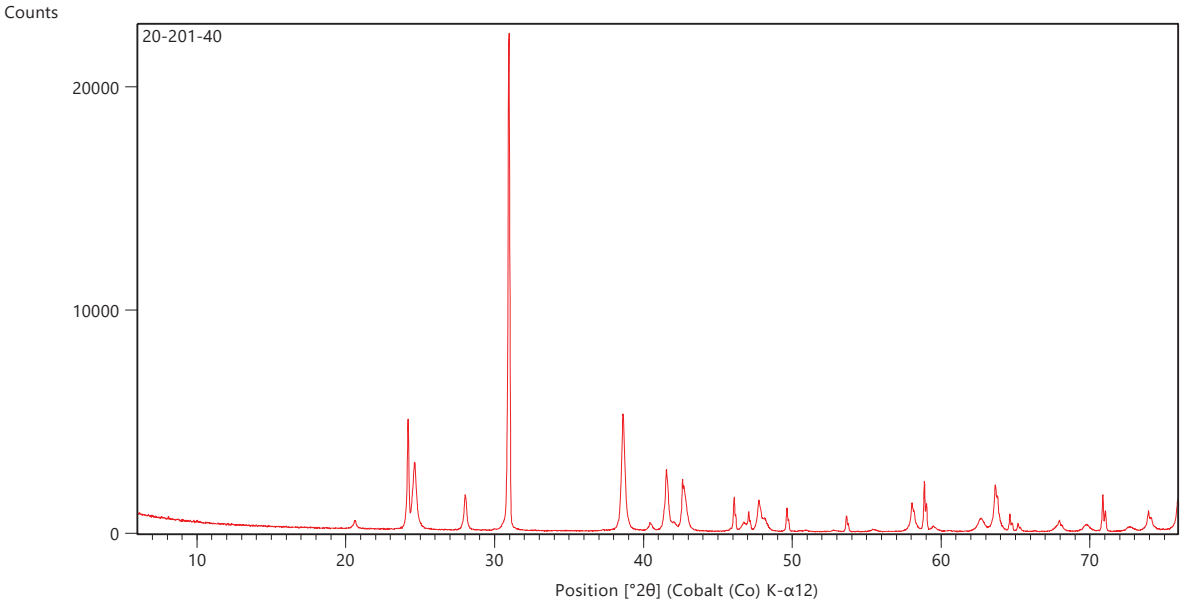
20-201-37



20-201-38



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MINE WASTE AND
WATER MANAGEMENT

Appendix 2 – Global Abundance Index Tables

Table A2.1 - GAI analysis BS1 project areas

Element/oxide	CLA					CAL					DET ORE					DET VASTE					DOR				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	150	28.27	31.64	53.39	0.58	2296	18.43	15.49	56.38	0.35	2742	55.01	56.00	68.42	28.64	3037	40.76	44.12	61.23	0.61	1401	21.24	19.27	58.17	1.59
AlZO3_pct	150	14.38	13.22	35.10	0.55	2296	5.68	4.07	33.77	0.10	2742	6.07	6.12	18.96	0.67	3037	9.14	8.50	35.59	0.28	1401	18.98	19.79	35.43	0.21
P_XRF_pct	150	0.04	0.03	0.31	0.00	2296	0.02	0.01	0.27	0.00	2742	0.06	0.06	0.63	0.01	3037	0.05	0.04	0.30	0.00	1401	0.07	0.06	0.28	0.01
TIO2_XRF_pct	150	0.90	0.75	10.50	0.03	2296	0.40	0.25	13.60	0.01	2738	0.60	0.60	2.22	0.02	3037	0.75	0.67	13.85	0.01	1401	1.77	1.84	10.40	0.01
CAO_XRF_pct	150	2.31	0.67	23.57	0.06	2296	15.15	13.77	50.94	0.03	2738	0.27	0.07	9.34	0.01	3037	1.58	0.27	44.71	0.01	1401	0.92	0.15	18.39	0.01
MN_XRF_pct	150	0.05	0.03	0.80	0.01	2296	0.03	0.01	3.29	0.01	2738	0.06	0.03	2.30	0.01	3037	0.06	0.03	6.61	0.01	1401	0.12	0.07	1.82	0.01
MGO_XRF_pct	150	1.88	0.75	18.90	0.11	2296	8.33	7.14	21.00	0.05	2738	0.13	0.10	3.08	0.01	3037	0.65	0.24	19.10	0.02	1401	0.99	0.26	10.80	0.01
S_XRF_pct	150	0.05	0.03	0.75	0.00	2295	0.03	0.02	2.11	0.00	2731	0.03	0.02	0.35	0.00	3017	0.04	0.02	2.90	0.00	1401	0.02	0.01	0.54	0.00
MNO_XRF_pct	38	0.12	0.04	1.03	0.01	23	0.26	0.01	1.81	0.01	74	0.08	0.05	0.55	0.01	158	0.08	0.04	0.83	0.01					
K2O_XRF_pct	112	0.02	0.00	1.00	0.00	2273	0.05	0.00	9.00	0.00						2879	0.02	0.00	6.00	0.00	1401	0.99	0.00	9.00	0.00
ARS_XRF_ppm	112	109.24	40.00	2670.00	5.00	2273	28.28	20.00	1120.00	5.00	2549	24.36	20.00	980.00	5.00	2726	30.80	20.00	820.00	5.00	1350	12.21	5.00	290.00	5.00
BA_XRF_ppm	112	81.92	5.00	2140.00	5.00	2273	68.52	20.00	3220.00	5.00	2549	45.68	30.00	2920.00	5.00	2726	89.13	50.00	6540.00	5.00	1350	143.95	60.00	2100.00	5.00
CL_XRF_ppm	112	369.02	325.00	1020.00	30.00	2273	398.80	260.00	5360.00	5.00	2549	177.21	130.00	3560.00	5.00	2726	235.08	140.00	3630.00	5.00	1350	332.10	260.00	3690.00	5.00
CO_XRF_ppm	112	24.82	10.00	250.00	5.00	2273	12.57	5.00	240.00	5.00	2549	10.18	10.00	110.00	5.00	2726	13.48	10.00	420.00	5.00	1350	30.67	20.00	330.00	5.00
CR_XRF_ppm	112	79.20	70.00	210.00	5.00	2273	39.43	20.00	1640.00	5.00	2549	50.31	50.00	340.00	5.00	2726	69.98	90.00	1400.00	5.00	1350	107.83	90.00	1140.00	5.00
CU_XRF_ppm	112	20.85	10.00	130.00	5.00	2273	17.44	10.00	300.00	5.00	2549	12.47	10.00	130.00	5.00	2726	24.65	20.00	220.00	5.00	1350	149.77	150.00	620.00	5.00
NA_PPM	110	731.36	700.00	2900.00	50.00	2271	509.25	400.00	6900.00	50.00	2664	284.19	200.00	1200.00	50.00	2877	519.82	400.00	4900.00	50.00	1392	2643.61	500.00	38000.00	50.00
NI_XRF_ppm	112	59.96	40.00	510.00	5.00	2273	23.74	20.00	250.00	5.00	2549	22.76	20.00	190.00	5.00	2726	35.95	30.00	580.00	5.00	1350	63.33	50.00	660.00	5.00
PB_XRF_ppm	112	15.18	5.00	130.00	5.00	2273	14.80	5.00	120.00	5.00	2549	12.18	5.00	120.00	5.00	2726	17.66	10.00	130.00	5.00	1350	17.96	10.00	90.00	5.00
SN_XRF_ppm	112	11.21	5.00	70.00	5.00	2273	17.92	5.00	140.00	5.00	2549	9.75	5.00	80.00	5.00	2726	8.63	5.00	90.00	5.00	1350	12.76	5.00	100.00	5.00
SR_XRF_ppm	112	79.11	60.00	450.00	5.00	2273	120.98	110.00	720.00	5.00	2549	41.70	40.00	280.00	5.00	2726	64.52	60.00	540.00	5.00	1350	79.70	80.00	380.00	5.00
V_XRF_ppm	112	139.60	130.00	680.00	5.00	2272	59.61	40.00	1240.00	5.00	2549	84.36	80.00	410.00	5.00	2726	130.44	120.00	960.00	5.00	1350	187.26	190.00	1080.00	5.00
ZN_XRF_ppm	112	106.83	60.00	920.00	5.00	2273	28.44	10.00	640.00	5.00	2549	16.94	10.00	500.00	5.00	2726	42.00	30.00	900.00	5.00	1350	99.44	80.00	800.00	5.00
ZR_XRF_ppm	112	157.37	130.00	960.00	5.00	2273	97.14	70.00	1730.00	5.00	2549	131.90	130.00	420.00	5.00	2726	164.84	160.00	1530.00	5.00	1350	145.03	140.00	1060.00	5.00

Element/oxide	YAN HYD					YAN VASTE					JOF HYD					JOF ORE					JOF VASTE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	6	50.76	52.11	52.73	45.52	23	25.95	26.73	41.25	11.67	3298	56.696	57.46	66.65	22.92	6235	60.3367	61.44	67.78	7.14	10433	38.961	39.30	63.72	0.75
AlZO3_pct	6	5.49	5.12	9.20	3.54	23	3.54	3.49	6.30	1.26	3298	2.82663	2.48	21.44	0.33	6235	2.36592	1.73	32.48	0.21	10433	1.91622	1.24	28.54	0.005
P_XRF_pct	6	0.17	0.15	0.39	0.08	23	0.06	0.04	0.20	0.02	3298	0.90338	0.097	1.26	0.014	6235	0.1084	0.103	2.111	0.025	10433	0.09047	0.087	0.617	0.003
TIO2_XRF_pct	6	0.19	0.18	0.29	0.11	23	0.20	0.15	0.83	0.09	3273	0.23777	0.13	7.01	0.005	6064	0.07528	0.05	2.09	0.005	10404	0.09178	0.04	27.01	0.005
CAO_XRF_pct	6	0.17	0.16	0.32	0.04	23	0.03	0.03	0.13	0.01	3275	0.1746	0.04	9.04	0.005	6078	0.06638	0.02	6.81	0.005	10400	0.08945	0.03	19.06	0.005
MN_XRF_pct	6	0.02	0.02	0.02	0.01	23	0.02	0.01	0.21	0.01	3275	0.02604	0.01	7.19	0.005	6078	0.03617	0.02	6.26	0.005	10404	0.05275	0.02	6.16	0.005
MGO_XRF_pct	6	0.85	0.13	0.24	0.09	23	0.09	0.06	0.57	0.02	3275	0.08565	0.04	3.45	0.005	6078	0.05834	0.04	4.29	0.005	10404	0.0981	0.05	6.93	0.005
S_XRF_pct	6	0.02	0.02	0.02	0.01	23	0.02	0.02	0.06	0.01	3270	0.04028	0.035	0.962	0.003	6061	0.02475	0.017	0.698	0.001	10389	0.01322	0.007	0.45	0.001
MNO_XRF_pct						5	0.136	0.13	0.21	0.06	17	0.05412	0.06	0.1	0.01	15	0.1978	0.04	0.74	0.03
K2O_XRF_pct																10389	0.00732	0	6	0					
ARS_XRF_ppm	6	20.00	20.00	30.00	10.00	23	18.26	10.00	70.00	5.00	3226	8.92672	10	100	5	6061	8.11665	5	240	5	10341	7.28121	5	110	5
BA_XRF_ppm	6	28.17	45.00	60.00	5.00	23	36.74	20.00	220.00	5.00	3226	55.6603	30	8230	5	6061	51.7019	40	8210	5	10341	55.8626	20	8200	5
CL_XRF_ppm	6	213.33	205.00	360.00	130.00	23	80.43	70.00	160.00	40.00	3226	159.09	150	8470	5	6061	169.328	130	2090	5	10341	126.118	100	2520	5
CO_XRF_ppm	6	13.33	10.00	20.00	10.00	23	8.70	5.00	30.00	5.00	3226	8.49729	5	330	5	6061	8.8525	10	130	5	10341	7.97457	5	690	5
CR_XRF_ppm	6	48.33	45.00	60.00	40.00	23	33.91	30.00	60.00	20.00	3226	17.2915	10	360	5	6061	11.9394	5	280	5	10341	11.7226	5	710	5
CU_XRF_ppm	6	26.67	20.00	50.00	20.00	23	15.43	10.00	30.00	5.00	3226	13.0766	10	230	5	6061	11.7844	10	160	5	10341	13.2666	10	370	5
NA_PPM	6	466.67	500.00	700.00	200.00	23	243.48	200.00	500.00	100.00	3270	215.215	200	1500	50	6061	174.08	200	1500	50	10382	176.876	100	8976	50
NI_XRF_ppm	6	18.33	15.00	30.00	10.00	23	22.61	20.00	50.00	10.00	3226	13.3772	10	330	5	6061	14.1553	10	230	5	10341	14.0307	10	400	5
PB_XRF_ppm	6	5.00	5.00	5.00	5.00	23	16.74	20.00	40.00	5.00	3226	8.02542	5	60	5	6061	8.92757	5	90	5	10341	15.1417	10	120	5
SN_XRF_ppm	6	5.00	5.00	5.00	5.00	23	5.00	5.00	5.00	5.00	3226	8.13701	5	70	5	6061	8.64874	5	60	5	10341	7.00126	5	120	5
SR_XRF_ppm	6	65.00	65.00	80.00	40.00	23	86.52	90.00	110.00	60.00	3226	35.7316	30	590	5	6061	32.3676	30	270	5	10341	66.1416	70	280	5
V_XRF_ppm	6	55.00	50.00	100.00	20.00	23	40.87	30.00	120.00	20.00	3226	39.2873	20	1110	5	6061	41.5603	10	550	5	10341	16.8664	5	1090	5
ZN_XRF_ppm	6	16.30	20.00	30.00	5.00	23	12.4324	10	490	5	6061	13.4425	10	140	5	10341	14.6412	10	470	5					
ZR_XRF_ppm	6	78.70	70.00	150.00	50.00	23	49.1445	40	380	5	6061	27.9195	20	430	5	10341	38.1506	30	3020	5					

Element/oxide	Crustal abundance	CLA				CAL				DET ORE				DET VASTE				DOR				YAN HYD			
Analysis_Units	mg/kg	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min
FE_XRF_pct	41000	2	2	3		2	1	3		3	3	3	2	3	3	3		2	2	3		3	3	3	1
AlZO3_pct	309886																								
P_XRF_pct	1000			1				1				2				1				1		0	0	1	
TIO2_XRF_pct	9343			3				3				1				3		0	0	3					
CAO_XRF_pct	57367			1		1	1	3				0				2				1					
MN_XRF_pct	950			2				5				4				6				4					
MGO_XRF_pct	37540			2		1	0	2								2				1					
S_XRF_pct	260	0		4				6				3				6				4					
MNO_XRF_pct	1227			2		1		3				2				2									
K2O_XRF_pct	50593							0												0					
ARS_XRF_ppm	2	6	4	10	1	4	3	9	1	3	3	9	1	4	3	9	1	2	1	7	1	3	3	4	2
BA_XRF_ppm	500			2				2				2				3				1					
CL_XRF_ppm	130	1	1	2		1	0	5				4		0		4		1	0	4		0	0	1	
CO_XRF_ppm	20			3				3				2				4		0		3					
CR_XRF_ppm	100			0				3				1				3				3					
CU_XRF_ppm	50			1				2				1				2		1	1	3					
NA_PPM	23000																			0					
NI_XRF_ppm	80			2				1				1				2				2					
PB_XRF_ppm	14			3				3				3				3				2					
SN_XRF_ppm	2	2	1	4	1	2	1	5	1	1	1	5	1	1	1	5	1	2	1	5	1	1	1	1	1
SR_XRF_ppm	370							0																	
V_XRF_ppm	160			2				2				1				2		1	1	2					
ZN_XRF_ppm	75			3				3				2				3				3					
ZR_XRF_ppm	190			2				3				1				2				2					

Element/oxide	YAN VASTE					JOF HYD					JOF ORE					JOF VASTE				
Analysis_Units	Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min	
FE_XRF_pct	2	2	3	1		3	3	3	0		3	3	3			3	3	3		
AlZO3_pct																				
P_XRF_pct			0					3					4					2		
TIO2_XRF_pct			0					2					1					4		
CAO_XRF_pct			1					0					0					1		
MN_XRF_pct			1					6					5					5		
MGO_XRF_pct			0					2					1					0		
S_XRF_pct			1			0		5					4					4		
MNO_XRF_pct			0					0					0			0		2		
K2O_XRF_pct																				
ARS_XRF_ppm	2	2	5	1		2	2	5	1		2	1	7	1		2	1	6	1	
BA_XRF_ppm			1					3					3					3		
CL_XRF_ppm			1					5					3					4		
CO_XRF_ppm			0					3					2					5		
CR_XRF_ppm			1					1					1					2		
CU_XRF_ppm			1					2					1					2		
NA_PPM																				
NI_XRF_ppm			1					1					1					2		
PB_XRF_ppm			2					2					1					2		
SN_XRF_ppm	1	1	4	1		1	1	4	1		1	1	4	1		1	1	4	1	
SR_XRF_ppm			0					0					0					0		
V_XRF_ppm			1					1					2					1		
ZN_XRF_ppm			1					1					2					1		
ZR_XRF_ppm			0					1					1					2		

Element/oxide	VS HYD					VS ORE				VS VASTE				DG HYD				DG ORE				DG VASTE			
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	1808	54.37	55.10	68.59	10.02	4337	57.28	57.86	65.81	6.44	9068	36.62	37.06	64.23	0.82	4381	56.15	56.74	66.34	4.21	16810	60.39	62.16	67.91	2.28	17352	39.03	38.74	66.40	0.52
AlZO3_pct	1808	4.12	3.59	28.94	0.52	4337	3.61	3.29	26.69	0.48	9068	5.60	3.50	39.67	0.06	4381	3.50	3.02	33.66	0.25	16810	2.33	1.50	32.97	0.15	17352	2.13	0.78	33.83	0.04
P_XRF_pct	1808	0.12	0.12	0.37	0.02	4337	0.17	0.17	0.51	0.02	9068	0.12	0.12	0.38	0.01	4381	0.10	0.10	0.41	0.01	16810	0.14	0.13	0.46	0.00	17352	0.10	0.09	0.61	0.00
TIO2_XRF_pct	1800	0.17	0.11	2.27	0.01	4330	0.10	0.09	3.56	0.01	9062	0.23	0.10	6.03	0.01	4346	0.20	0.13	8.30	0.01	16693	0.07	0.03	1.77	0.01	17324	0.08	0.02	8.54	0.01
CAO_XRF_pct	1800	0.21	0.05	17.95	0.01	4330	0.07	0.04	4.95	0.01	9062	0.14	0.04	13.60	0.01	4347	0.21	0.05	11.36	0.01	16700	0.10	0.03	28.56	0.01	17329	0.10	0.03	17.80	0.01
MN_XRF_pct	1800	0.20	0.05	7.90	0.01	4337	0.21	0.06	10.52	0.01	9063	0.27	0.05	17.72	0.01	4347	0.04	0.02	7.38	0.01	16700	0.06	0.03	14.54	0.01	17329	0.06	0.02	16.80	0.01
MGO_XRF_pct	1800	0.13	0.06	4.60	0.01	4337	0.08	0.06	2.90	0.01	9063	0.14	0.07	9.85	0.01	4347	0.14	0.07	4.09	0.01	16700	0.09	0.06	19.70	0.01	17329	0.09	0.06	9.60	0.01
S_XRF_pct	1795	0.05	0.04	1.66	0.00	4282	0.04	0.02	1.27	0.00	9027	0.02	0.01	1.99	0.00	4343	0.03	0.03	2.90	0.00	16650	0.02	0.01	1.13	0.00	17309	0.01	0.01	2.86	0.00
MNO_XRF_pct	5	0.06	0.06	0.07	0.03	55	0.23	0.10	1.87	0.04	26	0.41	0.06	3.20	0.02	11	0.04	0.03	0.06	0.02	50	0.05	0.05	0.13	0.02	44	0.05	0.06	0.09	0.02
K2O_XRF_pct						4282	0.00	0.00	1.00	0.00	9037	0.05	0.00	8.00	0.00											17285	0.01	0.00	10.00	0.00
ARS_XRF_ppm	1751	16.27	10.00	130.00	5.00	4280	16.53	10.00	2530.00	5.00	8879	21.94	10.00	550.00	5.00	4193	23.05	20.00	1130.00	5.00	16434	15.16	10.00	350.00	5.00	16800	13.59	10.00	730.00	5.00
BA_XRF_ppm	1751	156.52	40.00	6240.00	5.00	4280	105.19	20.00	5770.00	5.00	8879	179.51	20.00	18790.00	5.00	4193	50.20	20.00	10000.00	5.00	16434	58.07	30.00	10900.00	5.00	16800	51.46	5.00	25300.00	5.00
CL_XRF_ppm	1751	226.70	150.00	5160.00	5.00	4280	192.86	140.00	2470.00	5.00	8879	190.69	130.00	4120.00	5.00	4193	178.86	130.00	3350.00	5.00	16434	138.97	110.00	9550.00	5.00	16800	109.73	80.00	2240.00	5.00
CO_XRF_ppm	1751	9.96	10.00	150.00	5.00	4280	10.61	10.00	270.00	5.00	8879	10.75	5.00	430.00	5.00	4193	9.06	5.00	330.00	5.00	16434	9.70	10.00	200.00	5.00	16800	7.64	5.00	470.00	5.00
CR_XRF_ppm	1751	20.19	10.00	230.00	5.00	4280	15.92	10.00	470.00	5.00	8879	30.73	10.00	720.00	5.00	4193	19.24	10.00	210.00	5.00	16434	11.00	5.00	250.00	5.00	16800	12.10	5.00	690.00	5.00
CU_XRF_ppm	1751	12.46	10.00	80.00	5.00	4280	11.99	10.00	210.00	5.00	8879	21.36	10.00	330.00	5.00	4193	11.53	10.00	90.00	5.00	16434	12.32	10.00	130.00	5.00	16800	13.34	10.00	290.00	5.00
NA_PPM	1795	292.06	200.00	2900.00	22.00	4282	180.89	200.00	2400.00	50.00	9021	245.12	200.00	8514.00	50.00	4334	233.20	200.00	4000.00	50.00	16635	145.29	100.00	3900.00	50.00	17279	135.87	100.00	3800.00	30.00
NI_XRF_ppm	1751	15.81	10.00	150.00	5.00	4280	16.14	10.00	330.00	5.00	8879	21.54	20.00	370.00	5.00	4193	16.96	10.00	210.00	5.00	16434	16.25	10.00	320.00	5.00	16800	15.11	10.00	1550.00	5.00
PB_XRF_ppm	1751	10.15	5.00	100.00	5.00	4280	9.38	5.00	130.00	5.00	8879	18.78	10.00	370.00	5.00	4193	8.76	5.00	100.00	5.00	16434	9.90	5.00	120.00	5.00	16800	16.39	10.00	230.00	5.00
SN_XRF_ppm	1751	8.52	5.00	120.00	5.00	4280	8.15	5.00	60.00	5.00	8879	7.25	5.00	80.00	5.00	4193	8.13	5.00	70.00	5.00	16434	9.06	5.00	140.00	5.00	16800	6.93	5.00	100.00	5.00
SR_XRF_ppm	1751	43.10	30.00	610.00	5.00	4280	35.89	30.00	770.00	5.00	8879	61.42	60.00	990.00	5.00	4193	35.44	30.00	420.00	5.00	16434	35.33	30.00	1180.00	5.00	16800	61.63	60.00	1080.00	5.00
V_XRF_ppm	1751	29.26	20.00	350.00	5.00	4280	19.22	20.00	320.00	5.00	8879	42.60	20.00	760.00	5.00	4193	32.29	20.00	530.00	5.00	16434	13.86	5.00	350.00	5.00	16800	15.31	5.00	590.00	5.00
ZN_XRF_ppm	1751	21.75	20.00	220.00	5.00	4280	23.99	20.00	280.00	5.00	8879	36.79	20.00	580.00	5.00	4193	24.32	20.00	660.00	5.00	16434	26.01	20.00	550.00	5.00	16800	23.66	20.00	470.00	5.00
ZR_XRF_ppm	1751	56.48	50.00	330.00	5.00	4280	41.14	40.00	430.00	5.00	8879	76.97	60.00	700.00	5.00	4193	56.68	40.00	870.00	5.00	16434	30.96	20.00	990.00	5.00	16800	45.58	30.00	1190.00	5.00

Element/oxide	Crustal abundance	VS HYD				VS ORE				VS VASTE				DG HYD				DG ORE				DG VASTE			
Analysis_Units	mg/kg	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min
FE_XRF_pct	41000	3	3	3	1	3	3	3	0	3	3	3		3	3	3		3	3	3		3	3	3	1
AlZO3_pct	309886																								
P_XRF_pct	1000			1		0	0	2				1				1				2				2	
TIO2_XRF_pct	9343			1				1				2				3				0				3	
CAO_XRF_pct	57367			1				1				1				0				2				1	
MN_XRF_pct	950	0		6		1		6		1		7				5				7				7	
MGO_XRF_pct	37540											1								2				1	
S_XRF_pct	260	0		5				5				6				6				5				6	
MNO_XRF_pct	1227					0		3		1		4

Element/oxide	MTS ORE					MTS WASTE					VF ORE					VF WASTE					NEV HYD					NEV ORE					NEV WASTE					MAC WASTE					NAM WASTE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	11	49.08	46.25	62.69	35.60	845	28.31	27.68	64.67	0.88	11	53.10	53.67	59.05	41.79	1536	19.88	17.43	63.59	0.56	63	54.27	53.91	62.52	47.65	226	61.02	61.84	66.01	39.34	293	31.38	30.05	54.62	1.27	138	31.044	27.11	58.54	1.12	110	34.3261	32.05	56.1	13.22
Al2O3_pct	11	6.77	7.83	14.35	1.55	845	12.26	11.59	35.57	0.12	11	5.71	5.97	11.60	2.96	1536	14.28	14.48	39.73	0.14	63	4.27	4.22	8.28	0.79	226	1.67	1.23	10.04	0.37	293	1.28	0.62	16.65	0.15	138	4.37993	3.405	21.12	0.47	110	3.08984	2.18	13.17	0.46
P_XRF_pct	11	0.03	0.03	0.05	0.01	845	0.04	0.03	0.23	0.01	11	0.07	0.06	0.11	0.04	1536	0.05	0.05	0.18	0.00	63	0.06	0.06	0.12	0.02	226	0.08	0.07	0.17	0.03	293	0.05	0.04	0.14	0.00	138	0.03741	0.03	0.141	0.003	110	0.04278	0.0415	0.102	0.008
TiO2_XRF_pct	11	0.27	0.21	0.61	0.06	845	0.47	0.43	4.04	0.01	11	0.27	0.24	0.68	0.09	1536	0.66	0.62	6.49	0.01	63	0.25	0.22	0.70	0.03	226	0.06	0.04	0.69	0.01	293	0.07	0.02	2.09	0.01	138	0.24993	0.185	1.49	0.02	110	0.17073	0.1	0.63	0.02
CAO_XRF_pct	11	1.49	0.17	4.70	0.05	845	0.69	0.10	34.77	0.01	11	0.16	0.05	1.11	0.02	1536	2.12	0.16	47.58	0.01	63	0.32	0.09	1.59	0.01	226	0.04	0.03	0.89	0.01	293	0.22	0.02	12.36	0.01	138	0.2013	0.035	7.34	0.005	95	0.36565	0.06	3.65	0.005
MN_XRF_pct	11	0.07	0.03	0.46	0.01	845	0.05	0.02	3.46	0.01	11	0.31	0.20	1.05	0.08	1536	1.60	0.13	30.40	0.01	63	0.09	0.04	0.87	0.01	226	0.20	0.09	2.57	0.01	293	0.09	0.04	1.36	0.01	138	0.06612	0.03	2.09	0.005	110	0.026	0.01	0.3	0.005
MGO_XRF_pct	11	0.33	0.15	1.16	0.06	845	0.44	0.22	10.40	0.02	11	0.13	0.07	0.39	0.03	1536	1.29	0.54	20.50	0.01	63	0.26	0.14	1.11	0.04	226	0.10	0.09	0.45	0.03	293	0.15	0.06	3.75	0.02	138	0.32263	0.085	5.41	0.03	109	0.36266	0.1	3.57	0.02
S_XRF_pct	11	0.02	0.02	0.03	0.01	845	0.02	0.01	0.63	0.00	11	0.04	0.01	0.16	0.01	1534	0.03	0.01	2.41	0.00	63	0.02	0.02	0.06	0.01	226	0.01	0.01	0.07	0.00	293	0.01	0.01	0.14	0.00	138	0.02645	0.009	0.708	0.003	95	0.0404	0.016	0.333	0.001
MNO_XRF_pct						5	0.12	0.10	0.25	0.04						34	0.90	0.03	6.66	0.01																					48	0.03469	0.02	0.2	0.005
K2O_XRF_pct						840	0.25	0.00	4.00	0.00						1502	0.75	0.00	5.00	0.00																					62	0.02226	0	1	0
ARS_XRF_ppm	11	55.91	40.00	130.00	5.00	828	76.12	50.00	1280.00	5.00	11	33.64	40.00	50.00	10.00	1502	50.01	40.00	1110.00	5.00	63	22.54	20.00	120.00	5.00	226	15.53	10.00	160.00	5.00	293	10.34	5.00	110.00	5.00	138	14.4928	10	69	5	62	10.3226	10	30	5
BA_XRF_ppm	11	20.45	5.00	70.00	5.00	828	83.34	50.00	2540.00	5.00	11	194.55	80.00	900.00	5.00	1502	293.90	160.00	12900.00	5.00	63	63.10	5.00	1300.00	5.00	226	55.82	5.00	1100.00	5.00	293	43.46	5.00	1210.00	5.00	138	42.2826	5	1070	5	62	34.8387	5	530	5
CL_XRF_ppm	11	160.00	110.00	460.00	20.00	828	206.21	120.00	4130.00	5.00	11	301.82	130.00	700.00	80.00	1502	305.68	200.00	3150.00	5.00	63	265.24	200.00	1040.00	30.00	226	134.65	100.00	670.00	20.00	293	109.49	80.00	960.00	5.00	138	150.507	110	930	20	62	131.452	105	500	10
CO_XRF_ppm	11	5.45	5.00	10.00	5.00	828	14.57	10.00	190.00	5.00	11	38.18	30.00	100.00	5.00	1502	26.70	20.00	530.00	5.00	63	11.83	10.00	50.00	5.00	226	10.24	10.00	40.00	5.00	293	7.27	5.00	60.00	5.00	138	9.16667	7.5	50	5	62	17.0968	10	300	5
CR_XRF_ppm	11	64.55	40.00	160.00	5.00	828	92.48	80.00	1470.00	5.00	11	90.91	80.00	190.00	30.00	1502	152.22	100.00	3160.00	5.00	63	52.86	40.00	150.00	5.00	226	18.52	10.00	130.00	5.00	293	16.88	10.00	140.00	5.00	138	45.8696	30	290	5	62	36.2097	20	150	5
CU_XRF_ppm	11	21.82	20.00	40.00	10.00	828	35.95	30.00	360.00	5.00	11	58.64	50.00	130.00	5.00	1502	55.71	50.00	370.00	5.00	63	32.54	10.00	130.00	5.00	226	9.14	5.00	70.00	5.00	293	13.60	10.00	200.00	5.00	138	21.7029	10	120	5	62	37.0161	10	180	5
NA_PPM	11	259.09	300.00	400.00	50.00	831	387.84	300.00	2900.00	50.00	11	345.45	300.00	700.00	100.00	1497	493.82	400.00	2800.00	50.00	63	272.22	300.00	800.00	50.00	226	126.11	100.00	600.00	50.00	289	169.55	100.00	10300.00	50.00	138	270.29	200	2300	50	62	420.968	300	2000	50
NI_XRF_ppm	11	12.27	10.00	20.00	5.00	828	41.61	40.00	270.00	5.00	11	98.18	80.00	220.00	30.00	1502	116.05	70.00	2000.00	5.00	63	34.68	30.00	80.00	5.00	226	26.00	20.00	100.00	5.00	293	22.88	20.00	150.00	5.00	138	37.2826	30	110	5	62	40.9677	40	140	10
PB_XRF_ppm	11	12.27	5.00	30.00	5.00	828	37.13	30.00	180.00	5.00	11	55.91	5.00	240.00	5.00	1502	47.17	40.00	1460.00	5.00	63	7.06	5.00	30.00	5.00	226	9.89	5.00	260.00	5.00	293	23.67	10.00	350.00	5.00	138	14.3841	10	40	5	62	13.4677	10	50	5
SN_XRF_ppm	11	7.73	5.00	20.00	5.00	828	12.06	5.00	60.00	5.00	11	5.00	5.00	5.00	5.00	1502	14.31	5.00	130.00	5.00	63	5.40	5.00	20.00	5.00	226	7.46	5.00	40.00	5.00	293	6.45	5.00	40.00	5.00	138	6.01449	5	20	5	62	5.80645	5	20	5
SR_XRF_ppm	11	50.00	40.00	90.00	20.00	828	45.85	30.00	230.00	5.00	11	37.27	30.00	90.00	10.00	1502	97.68	80.00	720.00	5.00	63	32.86	30.00	90.00	5.00	226	31.66	30.00	110.00	5.00	293	31.19	30.00	180.00	5.00	138	73.4058	80	150	5	62	70.5645	80	120	5
V_XRF_ppm	11	95.91	70.00	200.00	5.00	828	97.88	70.00	450.00	5.00	11	194.55	90.00	270.00	40.00	1502	121.14	110.00	720.00	5.00	63	42.46	40.00	170.00	5.00	226	10.33	5.00	50.00	5.00	293	13.70	5.00	380.00	5.00	138	39.0435	30	290	5	62	34.8387	30	180	5
ZN_XRF_ppm	11	38.18	40.00	90.00	5.00	828	98.56	70.00	2100.00	5.00	11	250.91	170.00	1110.00	50.00	1502	161.57	110.00	5040.00	5.00	63	50.63	40.00	170.00	5.00	226	45.80	20.00	1070.00	5.00	293	46.21	20.00	2270.00	5.00	138	57.371	40	220	5	62	53.9516	20	320	5
ZR_XRF_ppm	11	57.27	70.00	130.00	10.00	828	110.48	100.00	460.00	5.00	11	72.73	70.00	130.00	20.00	1502	123.07	120.00	760.00	5.00	63	64.13	70.00	140.00	10.00	226	16.33	10.00	70.00	5.00	293	28.96	30.00	140.00	5.00	138	60.2536	50	200	5	62	49.5161	40	110	10

Element/oxide	Crustal abundance	MTS ORE					MTS WASTE					VF ORE					VF WASTE					NEV HYD					NEV ORE					NEV WASTE					MAC WASTE					NAM WASTE				
Analysis_Units	mg/kg	Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min	
FE_XRF_pct	41000	3	3	3	3		2	2	3			3	3	3	3		2	2	3			3	3	3	3		3	3	3	3		2	2	3			2	2	3			2	2	3		1
Al2O3_pct	309886																																													
P_XRF_pct	1000								1										0										0																
TiO2_XRF_pct	9343								2										2																										
CAO_XRF_pct	57367								2										2																										
MN_XRF_pct	950			2					5			1	0	3			3		8					3			0	4					3					4					1	
MGO_XRF_pct	37540								1										2																										
S_XRF_pct	260								4			0		2					6					1				1					2					4					0		3	
MNO_XRF_pct	1227								0								2		5																										
K2O_XRF_pct	50593																																												
ARS_XRF_ppm	2	5	4	6	1		5	4	9	1		4	4	4	2		4	4	9	1		3	3	6	1		3	2	6	1		2	1	6	1		3	2	5	1		2	2	4	1
BA_XRF_ppm	500								2					0					4					1				1							1				1					
CL_XRF_ppm	130			1			0		4			1		2			1	0	4			0	0	2				2							2				2				1	
CO_XRF_ppm	20								3			0	0	2					4					1				0							1				1				3	
CR_XRF_ppm	100			0					3					0			0		4					0											1				1				0	
CU_XRF_ppm	50								2					1					2					1											1				1				1	
NA_PPM	23000																																												
NI_XRF_ppm	80								1					1					4																	0								0	
PB_XRF_ppm	14			1			1	1	3			1		4			1	1	6					1				4			0		4					1				1	
SN_XRF_ppm	2	1	1	3	1		2	1	4	1		1	1	1	1		2	1	5	1		1	1	3	1		1	1	4	1		1	1	4	1		1	1	3	1		1	1	3	1
SR_XRF_ppm	370																		0																										
V_XRF_ppm	160								1					0					2																	1									
ZN_XRF_ppm	75								4			1	1	3			1		5					1				3							4				1				2	
ZR_XRF_ppm	190								1										1																										

Table A2.2 - GAI analysis BS2 project areas

Element/oxide	CLA					CAL					DET ORE					DET WASTE					DOR					JOF HYD					JOF WASTE					VS HYD					VS ORE					VS VASTE					DG HYD				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	1723	36.30	40.55	58.33	0.51	2037	24.03	22.98	57.56	0.40	24989	57.36	57.47	68.70	2.08	23989	42.28	43.61	62.10	0.76	351	26.37	24.47	64.14	2.61	13	57.37	57.40	63.04	50.81	11	43.52	41.22	53.73	31.58	1047	56.351	57	64.8	20.45	456	59.4332	60.35	64.75	31.87	1768	39.3256	39.845	62.84	2.18	9374	58.40	58.99	66.82	17.24
Al2O3_pct_BEST	1723	12.31	10.65	49.14	0.88	2037	4.28	3.30	28.19	0.15	24989	4.48	4.46	27.26	0.32	23989	5.66	5.12	36.69	0.32	351	20.71	21.91	35.83	0.70	13	2.94	2.57	5.39	1.60	11	2.08	1.41	6.75	0.85	1047	3.7797	3.15	25.45	0.5	456	3.02510	2.51	19.4	0.7	1768	6.84924	4.685	36.9	0.1	9374	2.69	2.25	24.55	0.07
P_XRF_pct	1723	0.06	0.04	0.45	0.00	2037	0.02	0.01	0.18	0.00	24989	0.06	0.06	0.63	0.01	23989	0.07	0.07	0.27	0.00	351	0.12	0.12	0.31	0.00	13	0.10	0.10	0.14	0.07	11	0.07	0.07	0.17	0.03	1047	0.1514	0.14	3.71	0.04	456	0.16369	0.164	0.38	0.061	1768	0.11872	0.111	0.378	0.008	9374	0.11	0.10	1.75	0.02
TiO2_XRF_pct	1723	0.76	0.65	6.05	0.01	2031	0.31	0.24	4.74	0.01	24984	0.36	0.34	3.63	0.01	23962	0.37	0.34	11.90	0.01	351	1.46	1.56	2.62	0.01	13	0.12	0.11	0.20	0.06	11	0.10	0.06	0.28	0.03	1047	0.13046	0.09	1.48	0.005	456	0.07833	0.06	0.96	0.005	1767	0.26938	0.13	2.15	0.005	9352	0.13	0.09	3.76	0.01
CaO_XRF_pct	1722	0.47	0.10	19.97	0.01	2037	10.67	8.36	41.19	0.06	24406	0.11	0.07	29.82	0.01	23948	0.32	0.10	29.06	0.01	351	0.12	0.04	3.32	0.01	13	0.02	0.01	0.04	0.01	11	0.04	0.05	0.07	0.01	1047	0.10718	0.02	3.48	0.005	456	0.01171	0.01	0.11	0.005	1762	0.90668	0.02	9.47	0.005	9334	0.06	0.04	5.90	0.01
MN_COMBINED_D	1723	0.06	0.02	6.64	0.00	2035	0.07	0.03	5.37	0.00	24972	0.04	0.02	13.90	0.00	23965	0.06	0.04	3.64	0.00	351	0.06	0.05	1.56	0.00	13	0.02	0.02	0.06	0.00	11	0.02	0.02	0.06	0.01	1047	0.03713	0.04	9.29	0.001	456	0.12329	0.05	5.57	0.01	1756	0.96626	0.039	11.85	0.001	9374	0.09	0.02	10.10	0.00
MGO_XRF_pct	1698	0.60	0.27	14.90	0.01	2033	7.38	5.77	28.55	0.03	24185	0.14	0.10	19.40	0.01	22367	0.23	0.15	20.10	0.01	351	0.14	0.09	2.69	0.01	13	0.03	0.02	0.05	0.01	11	0.05	0.05	0.06	0.02	1047	0.05467	0.03	1.27	0.005	456	0.02343	0.02	0.12	0.005	1768	0.06741	0.04	1.49	0.005	9315	0.07	0.05	4.44	0.01
S_XRF_pct	1692	0.02	0.01	0.97	0.00	1982	0.01	0.01	0.11	0.00	24640	0.03	0.02	0.37	0.00	23256	0.02	0.02	1.25	0.00	351	0.06	0.03	2.51	0.00	13	0.05	0.04	0.10	0.03	11	0.06	0.04	0.16	0.02	1047	0.09115	0.057	2.28	0.008	456	0.05793	0.049	0.567	0.002	1768	0.06858	0.039	3.35	0.002	9364	0.04	0.03	1.35	0.00
MNO_XRF_pct	180	0.06	0.03	0.49	0.01	200	0.07	0.04	0.58	0.01	7682	0.06	0.04	3.00	0.01	7264	0.07	0.05	2.43	0.01																												51	0.1212	0.039	1.459	0.005	352	0.07	0.03	3.80	0.01
K2O_XRF_pct	1613	0.09	0.00	5.00	0.00	1735	0.01	0.00	3.00	0.00	17298	0.00	0.00	2.00	0.00	16631	0.00	0.00	3.00	0.00	351	0.05	0.00	2.00	0.00																						1768	0.0017	0	2	0	9042	0.00	0.00	0.00	0.00
ARS_XRF_ppm	1613	132.30	60.00	3590.00	5.00	1731	32.24	20.00	1010.00	5.00	17290	41.20	20.00	2340.00	5.00	16592	35.76	20.00	1460.00	5.00	351	119.39	20.00	3940.00	5.00	13	8.08	5.00	20.00	5.00	11	15.00	5.00	50.00	5.00	1047	22.8928	20	270	5	456	26.8867	20	110	5	1705	29.8387	20	220	5	9022	27.94	20.00	670.00	5.00
BA_XRF_ppm	1613	63.79	10.00	2810.00	5.00	1731	82.94	5.00	6830.00	5.00	17290	41.25	30.00	6250.00	5.00	16602	84.24	60.00	2430.00	5.00	351	78.22	20.00	2730.00	5.00	13	30.00	30.00	70.00	5.00	11	79.55	90.00	150.00	5.00	1047	141.28	40	5690	5	456	53.8268	5	2230	5	1760	155.622	30	8290	5	9041	103.52	30.00	18300.00	5.00
CL_XRF_ppm	1613	80.12	40.00	1220.00	5.00	1731	64.19	40.00	2010.00	5.00	17290	134.38	90.00	1630.00	5.00	16592	206.91	150.00	4650.00	5.00	351	181.05	130.00	1360.00	5.00	13	37.69	20.00	90.00	5.00	11	52.27	50.00	140.00	5.00	1047	235.535	150	1580	5	456	140.362	100	780	5	1705	224.49	120	3450	5	9022	147.98	90.00	3080.00	5.00
CO_XRF_ppm	1613	12.04	5.00	160.00	5.00	1731	13.37	10.00	170.00	5.00	17290	12.92	10.00	400.00	5.00	16593	10.63	10.00	490.00	5.00	351	12.28	5.00	70.00	5.00	13	22.31	20.00	50.00	5.00	11	10.45	5.00	30.00	5.00	1047	12.1394	10	100	5	456	13.8268	10	60	5	1723	9.34707	5	100	2	9022	11.16	10.00	190.00	5.00
CR_XRF_ppm	1613	98.39	80.00	2210.00	2.00	1731	35.24	18.00	2360.00	2.00	17286	46.32	41.00	2440.00	2.00	16602	69.81	68.00	2540.00	2.00	351	150.13	145.00	2320.00	2.00	13	22.00	21.00	55.00	5.00	11	19.18	5.00	75.00	5.00	1047	24.5473	17	653	2	456	24.2632	14	694	2	1734	42.2082	28	1020	2	9041	18.40	10.00	1595.00	2.00
CU_XRF_ppm	1613	19.08	10.00	230.00	5.00	1731	9.67	5.00	130.00	5.00	17290	11.38	5.00	380.00	5.00	16601	19.16	20.00	300.00	5.00	351	113.63	110.00	960.00	5.00	13	11.54	10.00	20.00	5.00	11	17.27	5.00	80.00	5.00	1047	15.468	10	900	5	456	15.4057	10	340	5	1714	20.8606	10	560	2	9042	10.90	5.00	3370.00	5.00
NA_PPM_COMBINED	1613	281.19	200.00	1580.00	20.00	1735	210.12	200.00	1900.00	20.00	17296	214.19	200.00	2630.00	4.00	16631	402.80	400.00	7590.00	4.00	320	281.47	210.00	1700.00	20.00	13	179.23	200.00	240.00	100.00	11	200.00	200.00	600.00	20.00	989	260.779	200	5400	20	439	199.446	90	560	20	1723	262.454	200	3000	20	9022	190.90	170.00	1900.00	4.00
NI_XRF_ppm	1613	36.80	30.00	650.00	5.00	1731	23.62	20.00	590.00	5.00	17292	21.54	20.00	5070.00	5.00	16592	27.34	20.00	1560.00	5.00	351	63.43	50.00	350.00	5.00	13	17.31	20.00	40.00	5.00	11	23.64	20.00	30.00	10.00	1047	19.4986	20	620	5	456	26.9538	20	1260	5	1707	27.3257	20	1060	5	9033	17.09	10.00	2720.00	5.00
PB_XRF_ppm	1613	28.27	10.00	360.00	5.00	1731	11.38	5.00	160.00	5.00	17290	16.82	5.00	200.00	5.00	16592	18.24	10.00	360.00	5.00	351	20.90	5.00	1400.00	5.00	13	5.38	5.00	10.00	5.00	11	15.00	5.00	60.00	5.00	1047	19.6084	5	200	5	456	21.4145	10	100	5	1705	19.0411	5	150	5	9022	12.10	5.00	170.00	5.00
SN_XRF_ppm	1613	11.06	5.00	90.00	5.00	1731	16.54	5.00	280.00	5.00	17290	13.53	10.00	110.00	5.00	16592	10.41	5.00	130.00	5.00	351	9.26	5.00	50.00	5.00	13	5.38	5.00	10.00	5.00	11	13.64	5.00	50.00	5.00	1047	9.68004	5	60	5	456	11.4693	5	60	5	1705	9.12903	5	80	5	9022	12.45	5.00	230.00	5.00
SR_XRF_ppm	1613	43.47	30.00	240.00	5.00	1731	74.23	60.00	310.00	5.00	17290	26.72	20.00	430.00	5.00	16592	55.60	50.00	250.00	5.00	351	65.27	60.00	640.00	5.00	13	14.62	5.00	40.00	5.00	11	75.45	80.00	120.00	30.00	1047	36.595	30	380	5	456	28.8579	20	230	5	1705	50.9672	40	500	5	9022	25.71	20.00	500.00	5.00
Y_XRF_ppm	1613	115.57	100.00	680.00	5.00	1731	32.57	20.00	530.00	5.00	17297	59.13	60.00	440.00	5.00	16601	75.89	70.00	670.00	5.00	351	362.89	390.00	910.00	5.00	13	27.69	30.00	50.00	20.00	11	21.82	10.00	70.00	10.00	1047	27.469	20	260	5	456	19.2895	10	110	5	1729	55.6536	30	1040	5	9034	22.68	20.00	370.00	5.00
ZN_XRF_ppm	1613	44.93	20.00	780.00	5.00	1731	43.04	10.00	1560.00	5.00	17296	21.17	10.00	990.00	5.00	16602	35.47	30.00	1900.00	5.00	351	68.56	60.00	370.00	5.00	13	15.00	10.00	70.00	5.00	11	20.00	20.00	50.00	10.00	1047	25.6543	20	220	5	456	25.625	20	120	5	1759	44.9645	30	590	5	9041	24.94	20.00	760.00	5.00
ZR_XRF_ppm	1613	162.54	150.00	770.00	5.00	1731	61.24	50.00	450.00	5.00	17290	84.03	90.00	620.00	5.00	16592	111.43	110.00	1430.00	5.00	351	112.11	100.00	760.00	5.00	13	56.15	60.00	90.00	30.00	11	61.82	40.00	160.00	20.00	1047	80.8369	40	320	5	456	38.2566	30	240	5	1705	85.7067	60	380	5	9022	37.79	30.00	620.00	5.00

Element/oxide	Crustal abundance	CLA					CAL					DET ORE					DET WASTE					DOR					JOF HYD					JOF WASTE					VS HYD					VS ORE					VS VASTE					Crusta l	DG HYD				
Analysis_Units	mg/Kg	Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min	mg/Kg	Mean	Median	Max	Min
FE_XRF_pct	41000	3	3	3			2	2	3			3	3	3			3	3	3			2	2	3			3	3	3	3		3	3	3	2		3	3	3	2		3	3	3	2		3	3	3		41000	3	3	3	1
Al2O3_pct_BEST	309886			0																																															309886				
P_XRF_pct	1000			2					0					2					1					1					0					0		5			0	0	1								1000			4	
TiO2_XRF_pct	9343			2					2					1					3		0	0	1												0														9343			1	
CaO_XRF_pct	57367			1			0		2					2					2																														57367			0	
MN_COMBINED_D	950			5					5					7					5				3													6			5			0		6				950			6	
MGO_XRF_pct	37540			1			0	0	2					2					2																														37540				
S_XRF_pct	260			5					1					3					5		1		6			0	0	1			1	2			1	1	6			1	0	4			1	0	6		260	0		5	
MNO_XRF_pct	1227			1					2					4					4																														1227			4	
K2O_XRF_pct	50593																																																50593				
NA2O_XRF_pct	62007																																																62007				
ARS_XRF_ppm	2	6	5	11	1		4	3	9	1		4	3	10	1		4	3	9	1		6	3	11	1		2	1	3	1		3	1	4	1		3	3	7	1		4	3	6	1		4	3	7	1	2	4	3	8	1
BA_XRF_ppm	500			2					3					3					2				2													3							2							3		500			5	
CL_XRF_ppm	130			3					3					3			0		5				3											0		3					2							4		130			4	
CO_XRF_ppm	20			2					3					4				1	4				0	4											2							1							2		20			3	
CR_XRF_ppm	100			4					4					4					4		0		4												2							2							3		100			3	
CU_XRF_ppm	50			2					1					2					2		1	1	4												4						0	2						3		50			5	
NI_XRF_ppm	80			2					2					5					4				2												3							3							3		80			5	
PB_XRF_ppm	14	0		4					3					3					4				6												3					0		2							3		14			3	
SN_XRF_ppm	2	2	1	5	1		2	1	6	1		2	2	5	1		2	1	5	1		1	1	4	1		1	1	2	1		2	1	4	1		2	1	4	1		1	1	4	1		1	1	5	1	2	2	1	6	1
SR_XRF_ppm	370																																																370				
Y_XRF_ppm	160			2					1					1					1		1	1	2												0														2	160			1	
ZN_XRF_ppm	75			3					4					3					4				2												1						0									75			3	
ZR_XRF_ppm	190			1					1					1					2				1												0														1	190			1	

Element/oxide	DG ORE					DG VASTE					FVZ ORE					FVZ VASTE					MCS VASTE					MTS ORE					MTS VASTE					VF ORE					VF VASTE					NEW VASTE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	13311	61.38	62.58	67.62	14.38	16301	42.07	41.77	64.85	1.24	2330	56.67	56.91	66.85	31.54	3431	39.82	39.61	63.23	1.94	8260	19.89	15.37	60.17	0.16	7	53.02	50.55	61.14	46.28	2612	32.1118	32.985	65.18	0.98	10	53.965	53.435	58.31	49.36	6016	23.4319	20.795	64.7	0.74	4	29.35	29.245	33.78	25.13
Al2O3_pct_BEST	13311	1.99	1.37	30.40	0.17	16301	1.85	0.92	33.21	0.03	2330	3.96	3.60	19.66	0.22	3431	4.19	3.32	27.97	0.15	8260	15.30	14.85	44.19	0.29	7	7.29	9.65	10.52	2.76	2612	10.6932	9.76	35.61	0.25	10	5.817	5.96	9.12	2.98	6016	13.2464	12.63	52.19	0.06	4	0.2025	0.21	0.24	0.15
BA_XRF_ppm	13311	0.15	0.14	0.49	0.03	16301	0.11	0.10	2.43	0.01	2330	0.16	0.15	0.50	0.02	3431	0.12	0.11	1.36	0.01	8260	0.04	0.03	0.60	0.00	7	0.06	0.07	0.13	0.02	2612	0.04147	0.023	0.306	0.002	10	0.072	0.0705	0.099	0.039	6016	0.02685	0.029	0.218	0.001	4	0.0135	0.014	0.016	0.012
TiO2_XRF_pct	13279	0.06	0.04	1.65	0.01	16289	0.06	0.02	1.53	0.01	2330	0.15	0.13	0.83	0.01	3431	0.15	0.11	1.46	0.01	8260	0.56	0.53	6.00	0.01	7	0.30	0.36	0.45	0.06	2612	0.41443	0.36	6.78	0.005	10	0.205	0.205	0.3	0.09	6011	0.60259	0.55	18.3	0.005	4	0.02	0.02	0.02	0.02
CaO_XRF_pct	13307	0.03	0.02	6.68	0.01	16287	0.04	0.02	6.11	0.01	2330	0.04	0.03	0.68	0.01	3422	0.05	0.04	4.41	0.01	8209	0.20	0.05	30.82	0.01	7	0.05	0.05	0.07	0.04	2584	0.10364	0.05	14.25	0.005	10	0.078	0.07	0.13	0.05	5972	3.24635	0.09	36.71	0.005	4	0.115	0.125	0.15	0.06
MN_COMBINED_D	13311	0.09	0.03	14.50	0.00	16281	0.11	0.02	23.30	0.00	2330	0.10	0.04	6.58	0.00	3427	0.26	0.03	14.72	0.00	8235	0.06	0.02	12.70	0.00	7	0.01	0.01	0.03	0.01	2578	0.05952	0.02	4.09	0.001	10	0.652	0.18	4.95	0.1	5982	0.25932	0.024	10.1	0.001	4	0.175	0.18	0.25	0.09
MGO_XRF_pct	13254	0.05	0.04	1.15	0.00	16282	0.05	0.04	3.88	0.01	2327	0.08	0.07	0.74	0.01	3430	0.08	0.06	1.70	0.01	8239	0.70	0.57	13.85	0.01	7	0.16	0.16	0.23	0.10	2593	0.25161	0.17	10.8	0.005	10	0.221	0.23	0.33	0.12	5913	2.55349	0.57	23.7	0.005	4	0.5325	0.525	0.82	0.26
S_XRF_pct	13233	0.02	0.02	1.74	0.00	16278	0.02	0.01	2.37	0.00	2327	0.03	0.01	0.34	0.00	3426	0.02	0.01	2.15	0.00	8241	0.14	0.01	17.10	0.00	7	0.02	0.02	0.03	0.02	2595	0.02195	0.014	1.57	0.001	10	0.0135	0.014	0.017	0.008	5874	0.03203	0.0125	1.92	0.001	4	0.10075	0.0775	0.206	0.042
MNO_XRF_pct	315	0.05	0.04	0.37	0.01	401	0.12	0.03	18.00	0.01	85	0.06	0.05	0.41	0.01	71	1.05	0.03	19.00	0.01	709	0.04	0.03	0.65	0.01						312	0.05763	0.03	1.033	0.005						1742	0.06375	0.03	6.77	0.005					
K2O_XRF_pct	13024	0.00	0.00	1.00	0.00	16158	0.00	0.00	9.00	0.00						3367	0.01	0.00	3.00	0.00	7573	1.18	1.00	8.00	0.00	7	0.00	0.00	0.00	0.00	2283	0.16689	0	4	0						4240	0.91745	0	7	0					
ARS_XRF_ppm	12996	19.58	20.00	170.00	5.00	15880	17.17	10.00	670.00	5.00	2245	52.26	40.00	2020.00	5.00	3356	62.92	40.00	2120.00	5.00	7526	277.75	170.00	7740.00	5.00	7	67.14	60.00	100.00	40.00	2266	149.764	70	7720	5	10	50	50	120	30	4233	63.5424	50	1080	5	4	5	5	5	5
BA_XRF_ppm	13024	83.92	30.00	14700.00	5.00	16095	96.99	5.00	222000.00	5.00	2245	78.30	5.00	8600.00	5.00	3358	240.07	5.00	17600.00	5.00	7552	162.47	120.00	15300.00	5.00	7	5.00	5.00	5.00	5.00	2276	68.4653	30	3350	5	10	29.5	5	250	5	4233	122.219	80	3410	5	4	5	5	5	5
CL_XRF_ppm	12996	121.76	70.00	2140.00	5.00	15880	83.53	50.00	2050.00	5.00	2245	149.84	70.00	3550.00	5.00	3356	195.79	50.00	2470.00	5.00	7526	180.29	90.00	2930.00	5.00	7	32.86	40.00	50.00	10.00	2266	96.0939	60	1030	5	10	82	80	130	20	4233	96.8285	80	1210	5	4	47.5	55	60	20
CO_XRF_ppm	12997	12.90	10.00	430.00	5.00	16069	10.34	5.00	450.00	2.00	2245	13.62	10.00	170.00	5.00	3358	14.02	10.00	400.00	5.00	7530	15.18	10.00	280.00	5.00	7	7.14	5.00	10.00	5.00	2266	10.9396	5	310	5	10	17.5	20	30	5	4233	15.0591	5	410	5	4	5	5	5	5
CR_XRF_ppm	13020	13.22	5.00	721.00	2.00	15929	12.99	5.00	622.00	2.00	2245	23.16	20.00	359.00	2.00	3359	24.92	20.00	420.00	2.00	7552	110.97	100.00	2000.00	2.00	7	29.29	30.00	50.00	5.00	2272	88.754	70	2030	3	10	95	85	160	50	4233	189.678	140	3940	3	4	5	5	5	5
CU_XRF_ppm	13025	19.74	5.00	550.00	5.00	15998	11.59	5.00	580.00	5.00	2245	13.89	10.00	100.00	5.00	3358	16.49	10.00	130.00	5.00	7530	51.79	40.00	4160.00	5.00	7	40.00	40.00	70.00	20.00	2270	35.2895	30	680	5	10	18.5	20	30	5	4233	44.3444	30	1020	5	4	5	5	5	5
NA_PPM_COMBINED	12996	131.25	100.

Table A2.3 - GAI analysis BS3 and BS4 project areas

Element/oxide	CLA					CAL					DET ORE					DET WASTE					DOR					YAN WASTE					YAN HYD					YAN ORE					JOF HYD					JOF ORE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	82	27.22	25.95	59.20	1.97	278	18.13	15.83	52.04	0.66	4977	55.93	55.85	66.65	39.54	12856	41.67	43.32	62.65	0.98	6447	19.15	17.21	62.08	1.24	2346	35.32	37.16	62.25	1.01	1954	56.24	56.38	65.67	28.40	141	58.04241	58.5	64.7	45.67	9319	58.38043	59.01	67.43	9.23	11705	61.8767	62.68	68.54	31.97
AlO3_pct	82	16.31	15.22	32.33	1.81	278	9.86	8.96	32.08	1.20	4977	5.28	5.10	16.90	0.56	12856	9.94	9.14	38.45	0.30	6447	18.13	17.05	36.06	0.45	2346	6.05	5.18	29.60	0.52	1954	3.96	3.73	18.31	0.68	141	4.237305	4.03	10.3	1.53	9319	2.983418	2.57	30.32	0.26	11705	2.294543	1.9	20.4	0.2
P_XRF_pct	82	0.03	0.03	0.12	0.01	278	0.02	0.02	0.08	0.00	4977	0.06	0.05	0.29	0.01	12856	0.04	0.04	0.31	0.00	6447	0.06	0.05	0.51	0.00	2346	0.06	0.04	0.49	0.00	1954	0.11	0.10	0.50	0.02	141	0.155944	0.153	0.328	0.057	9319	0.113532	0.107	6.03	0.011	11705	0.154515	0.152	1.04	0.009
TiO2_XRF_pct	82	1.01	0.88	2.61	0.08	278	0.61	0.55	2.27	0.06	4977	0.56	0.48	7.33	0.01	12856	0.89	0.76	11.00	0.02	6447	1.74	1.65	5.30	0.04	2346	0.49	0.36	5.09	0.02	1954	0.28	0.23	1.58	0.02	141	0.174326	0.16	0.5	0.04	9319	0.16486	0.09	5.65	0.005	11701	0.05973	0.04	2.5	0.005
CAO_XRF_pct	82	0.30	0.16	1.79	0.01	278	11.29	9.32	44.80	0.06	4963	0.09	0.05	7.50	0.01	12855	0.33	0.12	43.00	0.01	6447	1.01	0.24	11.36	0.01	2346	0.20	0.09	10.75	0.01	1954	0.08	0.05	1.45	0.01	141	0.07125	0.05	0.37	0.02	9319	0.09668	0.04	6.2	0.005	11704	0.041241	0.02	3.01	0.001
MN_XRF_pct	82	0.06	0.03	0.36	0.01	278	0.28	0.07	6.73	0.01	4977	0.07	0.03	3.56	0.00	12856	0.07	0.03	23.16	0.00	6447	0.14	0.08	13.70	0.00	2346	0.02	0.01	0.61	0.00	1954	0.02	0.01	0.30	0.00	141	0.019329	0.02	0.07	0.001	9319	0.028136	0.02	6.19	0.001	11706	0.045296	0.02	5.74	0.001
MGO_XRF_pct	81	0.72	0.65	2.71	0.09	278	6.25	5.25	31.00	0.22	4901	0.10	0.08	4.69	0.01	12799	0.31	0.16	24.00	0.01	6445	1.42	0.56	16.42	0.01	2331	0.53	0.22	12.00	0.01	1947	0.13	0.09	1.04	0.01	141	0.180426	0.11	0.25	0.03	9265	0.077508	0.06	1.74	0.005	11630	0.053392	0.05	1.3	0.005
S_XRF_pct	64	0.04	0.02	0.65	0.00	269	0.02	0.02	0.15	0.00	4847	0.04	0.03	0.92	0.00	12253	0.02	0.02	0.58	0.00	6303	0.03	0.01	2.76	0.00	2277	0.01	0.01	0.14	0.00	1907	0.03	0.02	0.19	0.00	141	0.009193	0.007	0.057	0.002	8975	0.038344	0.029	3.42	0.001	11053	0.018412	0.007	0.779	0.001
MNO_XRF_pct	45	0.05	0.03	0.32	0.01	33	0.80	0.09	5.50	0.01	1187	0.11	0.04	4.60	0.01	2213	0.08	0.04	5.91	0.01	2223	0.17	0.09	15.97	0.01	390	0.04	0.03	0.41	0.01	324	0.03	0.03	0.17	0.01	30	0.030467	0.026	0.09	0.005	2901	0.03247	0.026	3.705	0.005	3451	0.045469	0.026	5.203	0.001
K2O_XRF_pct	37	0.19	0.00	2.00	0.00	245	0.19	0.00	3.00	0.00						11549	0.01	0.00	3.00	0.00	6095	1.38	0.00	9.00	0.00	2253	0.03	0.00	6.00	0.00	1000					141					8972					11051				
APS_XRF_ppm	37	17.84	10.00	60.00	5.00	245	21.86	10.00	120.00	5.00	4220	32.13	20.00	620.00	5.00	11549	25.26	10.00	1740.00	5.00	6095	7.45	5.00	280.00	5.00	2253	18.38	20.00	250.00	5.00	1000	17.20	10.00	500.00	5.00	141	18.5461	10	120	5	8972	8.966228	5	150	5	11050	7.771946	5	220	5
BA_XRF_ppm	37	64.05	40.00	240.00	5.00	245	168.10	120.00	1640.00	5.00	3821	42.33	20.00	2160.00	5.00	10730	95.57	60.00	6820.00	5.00	4786	212.82	140.00	14900.00	5.00	2048	53.12	10.00	4010.00	5.00	734	34.95	20.00	390.00	5.00	111	25.36036	5	140	5	6800	75.94706	50	5000	5	9472	69.44523	50	5130	5
CL_XRF_ppm	37	384.32	160.00	2080.00	60.00	245	261.37	180.00	1920.00	5.00	4220	141.95	100.00	2230.00	5.00	11549	174.34	110.00	4300.00	5.00	6095	437.18	240.00	4700.00	5.00	2253	89.69	60.00	670.00	5.00	1000	105.22	60.00	500.00	5.00	141	40.49645	30	590	5	8972	171.1753	110	3650	5	11049	109.9538	60	2150	5
CO_XRF_ppm	37	27.84	10.00	320.00	5.00	245	14.51	10.00	100.00	5.00	4220	11.25	10.00	150.00	2.00	11549	12.16	10.00	550.00	2.00	6095	37.80	20.00	1100.00	2.00	2253	11.45	5.00	210.00	2.00	1000	10.38	5.00	140.00	2.00	141	8.078014	5	30	2	8972	10.29614	5	430	2	11050	11.36724	5	820	2
CR_XRF_ppm	37	210.51	90.00	2320.00	10.00	245	94.59	50.00	2230.00	5.00	4206	42.29	40.00	400.00	3.00	11536	94.13	80.00	2570.00	3.00	6095	91.24	55.00	1620.00	3.00	2253	36.86	30.00	470.00	3.00	1000	31.33	21.00	370.00	3.00	141	50.39716	33	880	3	8914	20.63043	10	1400	3	10949	15.91351	5	610	3
CU_XRF_ppm	37	76.22	60.00	180.00	5.00	245	38.92	20.00	370.00	5.00	4220	13.14	10.00	120.00	5.00	11549	26.96	20.00	400.00	5.00	6095	185.20	160.00	630.00	5.00	2253	15.36	10.00	180.00	5.00	1000	15.08	10.00	100.00	5.00	141	16.34752	20	50	5	8972	16.62902	10	320	5	11051	14.71803	10	320	5
NA_PPM	37	67162	300.00	24000.00	50.00	245	457.47	400.00	1900.00	50.00	3824	217.89	200.00	3410.00	20.00	10618	501.41	400.00	17265.00	20.00	5259	6363.95	1076.00	33500.00	20.00	2043	303.42	230.00	11400.00	20.00	744	185.01	190.00	2300.00	20.00	114	125.0088	100	1669	20	7197	303.9835	200	8531	20	9799	164.4704	100	3658	20
NI_XRF_ppm	37	76.62	50.00	530.00	5.00	245	43.94	40.00	220.00	5.00	4220	24.04	20.00	680.00	5.00	11549	36.82	30.00	900.00	5.00	6095	61.63	50.00	6300.00	5.00	2253	24.15	20.00	980.00	5.00	1000	21.92	16.00	780.00	5.00	141	53.90071	20	2100	5	8972	20.87327	10	4460	5	11051	20.49453	10	1610	5
PB_XRF_ppm	37	10.00	5.00	60.00	5.00	245	10.76	5.00	120.00	5.00	4220	18.02	5.00	140.00	1.00	11549	18.55	5.00	210.00	1.00	6095	27.95	10.00	260.00	1.00	2253	23.79	10.00	120.00	1.00	1000	29.67	10.00	140.00	1.00	141	41.52369	40	140	1	8972	26.58948	5	240	1	11050	26.76226	5	200	1
SN_XRF_ppm	37	13.78	10.00	40.00	5.00	245	27.22	5.00	150.00	5.00	4220	9.67	5.00	110.00	5.00	11549	9.10	5.00	130.00	5.00	6095	18.70	5.00	230.00	5.00	2253	9.23	5.00	100.00	5.00	1000	9.04	5.00	100.00	5.00	141	8.120567	5	50	5	8972	10.8677	5	160	5	11050	11.34615	5	140	5
SR_XRF_ppm	37	65.68	70.00	110.00	5.00	245	105.86	100.00	300.00	5.00	3790	31.90	30.00	220.00	5.00	10640	59.83	60.00	790.00	5.00	4224	85.72	80.00	400.00	5.00	2036	39.74	30.00	160.00	5.00	730	18.50	16.00	100.00	5.00	111	15.85586	10	70	5	6418	31.3914	30	640	5	8256	29.67611	20	420	5
V_XRF_ppm	37	172.97	140.00	410.00	30.00	245	94.16	80.00	460.00	5.00	4220	88.70	70.00	1060.00	5.00	11549	183.04	150.00	2200.00	5.00	6095	409.19	280.00	1650.00	5.00	2253	80.79	70.00	530.00	5.00	1000	53.58	40.00	320.00	5.00	141	36.47598	30	200	5	8972	38.25067	20	810	5	11051	19.16252	10	680	5
ZN_XRF_ppm	37	92.16	70.00	740.00	20.00	245	41.24	30.00	270.00	5.00	4220	21.08	10.00	1080.00	5.00	11549	28.67	20.00	480.00	5.00	6095	190.71	100.00	860.00	5.00	2253	24.66	20.00	480.00	5.00	1000	18.72	10.00	230.00	5.00	141	19.32624	20	100	5	8972	18.95787	10	750	5	11050	20.47014	20	1240	5
ZR_XRF_ppm	37	121.62	120.00	340.00	20.00	245	102.55	90.00	370.00	5.00	3790	95.33	90.00	440.00	5.00	10640	163.22	150.00	1110.00	5.00	4224	145.46	140.00	500.00	5.00	2036	86.77	70.00	680.00	5.00	730	52.55	40.00	220.00	5.00	111	59.32432	50	200	5	6418	39.67903	30	390	5	8256	21.99491	20	330	5

Element/oxide	Crustal abundance	CLA				CAL				DET ORE				DET WASTE				DOR				YAN WASTE				YAN HYD				YAN ORE				JOF HYD				JOF ORE			
Analysis_Units	mg/kg	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min
FE_XRF_pct	41000	2	2	3		2	1	3		3	3	3	3	3	3	3		2	1	3		3	3	3		3	3	3	2	3	3	3	1	3	3	3	2				
AlO3_pct	308686																																								
P_XRF_pct	1000											1				1				2				2				2		0	0	1				5		0	0	3	
TiO2_XRF_pct	9043			1				1				2				3		0	0	2				3				0							2				1	
CAO_XRF_pct	57367					0	0	2								2				0				0				2												
MN_XRF_pct	950			1		1		6				5				7		0		7				2				1							5				5	
MGO_XRF_pct	37540					0		2								2				2				1																
S_XRF_pct	260	0		4				2		0		5				4				6				2				2		1					6				4	
MNO_XRF_pct	1227			1		2		5				5				5				6				1											4				5	
K2O_XRF_pct	50593																			0																					
APS_XRF_ppm	2	3	2	5	1	3	2	6	1	4	3	8	1	3	2	10	1	2	1	7	1	3	3	7	1	3	2	8	1	3	2	6	1	2	1	6	1	2	1	7	1
BA_XRF_ppm	500							1				2				3				4				2											3				3	
CL_XRF_ppm	130	1		3		0		3				4				4		1	0	5				2				2				1			4				3	
CO_XRF_ppm	20			3				2				2				4		0		5				3				2				0			4				5	
CR_XRF_ppm	100	1		4				4				1				4				3				2				1				3			3				2	
CU_XRF_ppm	50	0		1				2				1				2		1	1	3				1				0							2				2	
NA_PPM	23000																																								
NI_XRF_ppm	80			2				1				3				3				6				3				3				4			5				4	
PB_XRF_ppm	14			2				3				3				3		0		4		0		3		0		3		1	1	3		0	4		0		3	
SN_XRF_ppm	2	2	2	4	1	3	1	6	1	2	1	5	1	1	1	5	1	3	1	6	1	1	1	5	1	1	1	5	1	1	1	4	1	2	1	6	1	2	1	5	1
SR_XRF_ppm	370															1																				0					
V_XRF_ppm	160			1				1				2				3		1	1	3				1				0				2			2				2	
ZN_XRF_ppm	75			3				1				3				2				3				2				1							3				3	
ZR_XRF_ppm	190			0				0				1				2				1				1											0				0	

Element/oxide	JOF VASTE					VS HYD					VS ORE					VS VASTE					DG HYD					DG ORE					DG VASTE					FVZ ORE					FVZ VASTE					MCS VASTE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	21228	39.13	38.98	64.40	0.41	2010.00	55.77	55.84	65.29	14.14	3036	57.40	57.83	66.26	29.30	10375	36.84	36.91	66.23	1.66	8194	57.66	58.29	66.95	17.29	12756	61.40	62.95	67.78	9.16	14091	40.72	40.18	66.59	1.11	1254	57.31	57.49	66.12	38.58	2401	36.80	35.75	64.53	1.72	4383	18.25	14.71	62.77	0.42
AlZO3_pct_BEST	21228	2.07	1.28	35.59	0.06	2010.00	4.35	4.06	29.90	0.61	3036	4.01	3.66	20.80	0.39	10375	5.76	3.75	35.21	0.14	8194	3.22	2.66	27.89	0.21	12756	2.26	1.48	33.19	0.05	14091	2.20	0.91	33.74	0.04	1254	3.77	3.42	13.92	0.54	2401	3.40	2.23	29.58	0.09	4383	14.79	14.50	40.97	0.33
P_XRF_pct	21228	0.09	0.09	5.07	0.00	2010.00	0.14	0.14	0.42	0.02	3036	0.19	0.18	0.45	0.04	10375	0.12	0.12	0.94	0.01	8194	0.11	0.10	0.42	0.02	12756	0.15	0.14	0.45	0.02	14091	0.10	0.09	0.60	0.00	1254	0.17	0.17	0.40	0.03	2401	0.11	0.11	0.68	0.01	4383	0.04	0.03	0.43	0.00
TIO2_XRF_pct	21188	0.10	0.04	5.33	0.01	2010.00	0.16	0.12	1.97	0.01	3035	0.11	0.10	2.10	0.01	10351	0.22	0.11	2.81	0.01	8180	0.15	0.10	3.48	0.01	12619	0.06	0.03	1.56	0.01	13523	0.08	0.03	2.69	0.01	1254	0.11	0.10	0.63	0.01	2397	0.12	0.08	2.18	0.01	4383	0.53	0.51	4.37	0.01
CAO_XRF_pct	21228	0.07	0.03	19.40	0.00	2010.00	0.11	0.05	7.64	0.01	3036	0.04	0.03	1.70	0.01	10375	0.07	0.04	5.62	0.00	8192	0.08	0.04	6.36	0.00	12751	0.04	0.02	4.50	0.01	14091	0.05	0.02	8.85	0.00	1250	0.05	0.03	1.50	0.00	2395	0.05	0.02	4.45	0.00	4383	0.15	0.04	13.90	0.00
MN_XRF_pct	21228	0.04	0.02	10.80	0.00	2010.00	0.19	0.05	11.50	0.01	3036	0.17	0.07	9.14	0.01	10375	0.30	0.06	17.16	0.00	8194	0.07	0.03	18.60	0.00	12756	0.10	0.04	12.70	0.00	14091	0.07	0.02	15.30	0.00	1254	0.17	0.03	10.30	0.00	2401	0.21	0.02	17.30	0.00	4383	0.07	0.01	12.80	0.00
MGO_XRF_pct	20924	0.07	0.04	17.00	0.01	1971.00	0.10	0.08	1.35	0.01	2937	0.06	0.05	0.34	0.01	10225	0.09	0.06	2.22	0.01	8052	0.08	0.06	1.26	0.01	12384	0.06	0.05	0.76	0.01	13506	0.06	0.05	1.95	0.01	1235	0.07	0.06	0.62	0.01	2312	0.08	0.05	1.58	0.01	4380	0.45	0.33	8.94	0.01
S_XRF_pct	19819	0.01	0.01	0.83	0.00	1902.00	0.05	0.03	4.51	0.00	2850	0.04	0.01	0.82	0.00	9980	0.03	0.01	2.21	0.00	7943	0.04	0.03	0.94	0.00	12277	0.02	0.01	0.74	0.00	13023	0.01	0.01	1.80	0.00	1232	0.02	0.01	0.21	0.00	2265	0.02	0.01	1.79	0.00	4342	0.07	0.01	11.80	0.00
MNO_XRF_pct	9226	0.04	0.01	12.76	0.01	546.00	0.32	0.08	4.80	0.01	666	0.26	0.10	5.84	0.01	4129	0.49	0.08	22.15	0.01	3169	0.08	0.04	10.13	0.01	4679	0.15	0.05	10.32	0.01	4681	0.10	0.04	14.90	0.01	412	0.27	0.05	12.65	0.01	731	0.31	0.04	19.40	0.01	1238	0.08	0.01	9.81	0.01
K2O_XRF_pct	19814	0.01	0.00	8.00	0.00	1896.00					2850			6.00	0.00	9973	0.01	0.00	6.00	0.00	7904	0.00	0.00	1.00	0.00	13014	0.00	0.00	5.00	0.00	1228					2254	0.02	0.00	3.00	0.00	4301	0.59	0.00	4.00	0.00					
ARS_XRF_ppm	19814	7.23	5.00	168.00	5.00	1896.00	16.65	10.00	160.00	5.00	2850	18.27	20.00	140.00	5.00	9973	19.75	10.00	230.00	5.00	7904	18.81	10.00	220.00	5.00	12259	12.48	10.00	260.00	5.00	13014	12.80	5.00	220.00	5.00	1228	37.40	20.00	360.00	5.00	2254	37.46	20.00	990.00	5.00	4301	112.98	70.00	1950.00	5.00
BA_XRF_ppm	13030	69.04	30.00	15550.00	5.00	1604.00	129.76	30.00	10500.00	5.00	2472	100.98	20.00	6200.00	5.00	7305	238.53	40.00	13700.00	5.00	5578	100.40	30.00	3080.00	5.00	9789	98.30	40.00	16200.00	5.00	9987	74.54	5.00	12200.00	5.00	918	205.61	5.00	17600.00	5.00	1766	264.71	5.00	20200.00	5.00	3374	147.32	70.00	10700.00	5.00
CL_XRF_ppm	19814	101.28	50.00	3500.00	5.00	1896.00	286.61	160.00	3500.00	5.00	2850	156.80	100.00	1650.00	5.00	9973	194.72	100.00	4450.00	5.00	7904	169.35	100.00	3300.00	5.00	12259	114.62	70.00	1750.00	5.00	13014	92.48	60.00	2420.00	5.00	1228	135.14	90.00	1430.00	5.00	2254	114.13	70.00	2030.00	5.00	4301	235.01	150.00	2120.00	5.00
CO_XRF_ppm	19814	9.23	5.00	1020.00	2.00	1896.00	8.82	5.00	150.00	2.00	2850	9.42	5.00	100.00	2.00	9973	8.72	5.00	450.00	2.00	7904	9.73	5.00	930.00	2.00	12259	9.40	5.00	250.00	2.00	13014	6.31	5.00	300.00	2.00	1228	9.89	5.00	140.00	2.00	2254	11.76	5.00	910.00	2.00	4301	11.77	5.00	570.00	2.00
CR_XRF_ppm	19739	32.40	20.00	3110.00	3.00	1891.00	22.25	14.00	310.00	3.00	2846	17.52	10.00	730.00	3.00	9929	46.67	30.00	2830.00	3.00	7845	22.10	10.00	1330.00	3.00	12183	13.67	5.00	1320.00	3.00	12900	23.94	7.00	2760.00	3.00	1228	23.09	10.00	770.00	3.00	2254	33.59	20.00	1390.00	3.00	4283	122.54	100.00	2620.00	3.00
CU_XRF_ppm	19814	16.60	10.00	1050.00	5.00	1896.00	11.42	5.00	120.00	5.00	2850	11.16	5.00	100.00	5.00	9974	18.24	10.00	720.00	5.00	7904	11.75	5.00	1030.00	5.00	12259	12.33	5.00	5080.00	5.00	13014	11.45	5.00	880.00	5.00	1228	14.21	10.00	70.00	5.00	2254	15.93	10.00	320.00	5.00	4301	41.90	30.00	820.00	5.00
NA_PPM	13722	249.33	130.00	7864.00	20.00	1640.00	279.81	200.00	1847.00	20.00	2483	160.78	100.00	2033.00	20.00	7056	279.12	200.00	12988.00	20.00	6056	330.16	200.00	8620.00	20.00	9411	226.71	100.00	8457.00	20.00	10155	183.24	100.00	6802.00	20.00	972	265.79	200.00	4444.00	20.00	1766	221.94	100.00	2634.00	20.00	3173	457.94	400.00	19659.00	20.00
NI_XRF_ppm	19814	20.14	10.00	5550.00	5.00	1896.00	21.30	20.00	640.00	5.00	2850	20.83	20.00	1470.00	5.00	9974	24.21	10.00	6560.00	5.00	7904	24.94	20.00	2520.00	5.00	12259	22.15	20.00	3330.00	5.00	13014	19.50	10.00	6310.00	5.00	1228	30.04	20.00	1750.00	5.00	2254	24.66	10.00	2910.00	5.00	4301	55.17	40.00	4750.00	5.00
PB_XRF_ppm	19814	37.14	20.00	220.00	1.00	1896.00	22.91	5.00	140.00	1.00	2850	19.51	5.00	140.00	1.00	9973	24.10	10.00	170.00	1.00	7904	27.86	5.00	180.00	1.00	12259	25.15	5.00	210.00	1.00	13014	25.96	5.00	210.00	1.00	1228	21.07	5.00	140.00	1.00	2254	26.53	5.00	170.00	1.00	4301	63.89	60.00	300.00	1.00
SN_XRF_ppm	19814	12.71	5.00	200.00	5.00	1896.00	9.18	5.00	120.00	5.00	2850	9.46	5.00	140.00	5.00	9973	10.05	5.00	190.00	5.00	7904	12.18	5.00	150.00	5.00	12253	11.48	5.00	160.00	5.00	13014	10.88	5.00	200.00	5.00	1228	11.03	5.00	150.00	5.00	2254	10.32	5.00	180.00	5.00	4301	15.01	5.00	170.00	5.00
SR_XRF_ppm	12002	48.84	40.00	330.00	5.00	1464.00	35.83	30.00	1040.00	5.00	2370	29.13	20.00	300.00	5.00	6198	54.58	50.00	570.00	5.00	4995	29.90	30.00	380.00	5.00	9076	31.07	30.00	650.00	5.00	9384	57.79	60.00	330.00	5.00	840	33.35	30.00	330.00	5.00	1682	62.86	60.00	190.00	5.00	3121	70.05	70.00	360.00	5.00
V_XRF_ppm	19814	23.21	5.00	1200.00	5.00	1896.00	25.73	20.00	400.00	5.00	2850	17.34	10.00	250.00	5.00	9973	38.54	10.00	530.00	5.00	7904	21.72	10.00	450.00	5.00	12259	11.36	5.00	210.00	5.00	13014	13.90	5.00	630.00	5.00	1228	17.39	10.00	150.00	5.00	2254	19.67	5.00	350.00	5.00	4301	94.34	100.00	590.00	5.00
ZN_XRF_ppm	19814	17.57	10.00	340.00	5.00	1896.00	23.39	20.00	470.00	5.00	2850	28.44	30.00	240.00	5.00	9973	31.59	20.00	3020.00	5.00	7904	20.32	10.00	510.00	5.00	12253	23.43	20.00	2590.00	5.00	13014	21.16	10.00	390.00	5.00	1228	40.50	30.00	470.00	5.00	2254	40.42	30.00	500.00	5.00	4301	116.62	60.00	1940.00	5.00
ZR_XRF_ppm	12002	37.11	30.00	440.00	5.00	1464.00	54.47	50.00	340.00	5.00	2370	45.62	40.00	240.00	5.00	6198	83.57	60.00	450.00	5.00	4995	47.01	40.00	740.00	5.00	9076	27.61	20.00	1100.00	5.00	9384	45.60	30.00	1010.00	5.00	840	36.85	30.00	280.00	5.00	1682	47.45	40.00	340.00	5.00	3121	156.52	150.00	920.00	5.00

Element/oxide	Crustal abundance	JOF VASTE				VS HYD				VS ORE				VS VASTE				DG HYD				DG ORE				DG VASTE				FVZ ORE				FVZ VASTE				MCS VASTE			
Analysis_Units	mg/kg	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min
FE_XRF_pct	41000	3	3	3		3	3	3	1	3	3	3	2	3	3	3		3	3	3	1	3	3	3		3	3	3		3	3	3	3	3	3	3		2	1	3	
AlZO3_pct_BEST	309886																																								
P_XRF_pct	1000			5				1		0	0	2				3				1		0		2				2		0	0	1				2			2		
TIO2_XRF_pct	9343			2				0				1				1				1				0				1								1			2		
CAO_XRF_pct	57367			1																																			1		
MN_XRF_pct	950			6		0		6		0		6		1		7				7				6				7		0		6		1		7			6		
MGO_XRF_pct	37540			2																																			1		
S_XRF_pct	260			4		0		7				4				6				5				4				6				2				6		1	8		
MNO_XRF_pct	1227			6		1		5		0		5		1		7				6				6				6		1		6		1		7			6		
K2O_XRF_pct	56593			0																																					
ARS_XRF_ppm	2	2	1	6	1	3	2	6	1	3	3	6	1	3	2	7	1	3	2	7	1	3	2	7	1	3	1	7	1	4	3	7	1	4	3	9	1	6	5	10	1
BA_XRF_ppm	500			4				4				3				4				5				4				4				5				5			4		
CL_XRF_ppm	130			4		1		4				3				5				4				3				4				3				3		0	3		
CO_XRF_ppm	20			5				2				2				4				5				3				5				2				5			4		
CR_XRF_ppm	100			4				1				2				4				3				3				4				2				3			4		
CU_XRF_ppm	50			4				1				1				4				3				4				6				1				2			3		
NA_PPM	23000																																								
NI_XRF_ppm	80			6				2				4				6				4				5				6				4				5			5		
PB_XRF_ppm	14	1		3		0		3				3		1		3		0		3		0		3		0		3		0		3		0		3		2	2	4	
SN_XRF_ppm	2	2	1	6	1	1	1	5	1	2	1	5	1	2	1	6	1	2	1	6	1	2	1	6	1	2	1	6	1	2	1	6	1	2	1	6	1	2	1	6	1
SR_XRF_ppm	370							1								0								0																	
V_XRF_ppm	160			2				1				0				1				1				1				1								1			1		
ZN_XRF_ppm	75			2				2				1				5				2				5				1				2				2		0	4		
ZR_XRF_ppm	190			1				0								1				1				2				2								0			2		

Element/oxide	MTS ORE					MTS VASTE					VF ORE					VF VASTE					NEV HYD					NEV ORE					NEV VASTE					MAC VASTE					NAM VASTE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	9	53.98	54.94	63.45	33.20	1045	32.00	30.14	66.01	1.79	118	47.69	53.28	65.44	12.70	5794	25.61	23.15	63.42	0.83	393	56.15	56.81	65.79	36.05	991	61.83	63.20	66.75	25.08	1136	34.30	32.51	61.76	0.61	332	30.81	28.77	59.99	7.88	81	28.65	26.58	49.57	14.19					
AlZO3_pct_BEST	9	4.76	3.67	11.62	0.40	1045	11.24	10.09	33.27	0.18	118	5.49	4.62	19.24	0.89	5794	12.79	12.70	32.10	0.12	393	3.31	2.82	12.13	0.44	991	1.63	1.22	22.30	0.29	1136	1.37	0.74	16.80	0.10	332	3.77	2.18	28.51	0.26	81	1.01	0.68	7.24	0.19					
P_XRF_pct	9	0.12	0.13	0.24	0.03	1045	0.04	0.03	0.16	0.00	118	0.07	0.07	0.11	0.02	5794	0.05	0.05	0.45	0.00	393	0.05	0.04	0.09	0.02	991	0.06	0.06	0.16	0.02	1136	0.04	0.04	0.14	0.01	332	0.04	0.03	0.12	0.01	81	0.06	0.05	0.12	0.01					
TIO2_XRF_pct	9	0.32	0.31	0.63	0.01	1045	0.42	0.38	1.67	0.01	118	0.24	0.19	0.88	0.02	5794	0.62	0.59	15.10	0.01	393	0.18	0.11	1.60	0.02	991	0.06	0.04	1.10	0.01	1136	0.07	0.03	2.14	0.01	332	0.19	0.09	1.56	0.01	81	0.06	0.03	0.47	0.01					
CAO_XRF_pct	9	0.07	0.08	0.17	0.02	1045	0.14	0.04	14.60	0.01	118	0.29	0.10	7.12	0.01	5791	1.59	0.93	49.29	0.01	392	0.13	0.04	3.85	0.01	987	0.06	0.02	5.33	0.01	1136	0.11	0.02	7.68	0.01	332	0.23	0.04	6.85	0.01	81	0.49	0.03	4.97	0.02					
MN_XRF_pct	9	0.34	0.02	1.30	0.01	1045	0.09	0.02	6.79	0.00	118	2.68	0.33	30.50	0.02	5794	1.50	0.34	45.10	0.00	393	0.08	0.06	1.38	0.01	991	0.16	0.11	2.27	0.01	1136	0.20	0.05	10.40	0.01	332	0.19	0.05	4.25	0.01	81	0.02	0.02	0.14	0.01					
MGO_XRF_pct	9	0.16	0.16	0.28	0.06	1040	0.25	0.12	11.30	0.01	118	0.38	0.24	2.81	0.07	5792	1.27	0.53	19.40	0.01	393	0.12	0.08	2.93	0.01	991	0.10	0.09	0.29	0.01	1136	0.09	0.06	2.13	0.01	332	0.24	0.08	5.09	0.01	81	0.68	0.08	4.31	0.03					
S_XRF_pct	0	0.02	0.02	0.03	0.01	1030	0.02	0.02	0.45	0.00	109	0.01	0.01	0.12	0.00	5427	0.02	0.01	3.56	0.00	373	0.03	0.03	0.14	0.00	779	0.01	0.01	0.09	0.00	944	0.01	0.00	0.12	0.00	328	0.02	0.01	1.33	0.00	81	0.10	0.01	1.34	0.00					
MNO_XRF_pct	0	0.00	0.00	0.00	0.00	164	0.28	0.03	9.77	0.01	10	1.36	0.44	3.80	0.16	582	1.46	0.26	32.20	0.01	25	0.13	0.09	0.96	0.01	220	0.24	0.16	2.80	0.02	214	0.25	0.06	8.80	0.01	4	0.03	0.03	0.06	0.01										
K2O_XRF_pct	0	0.00	0.00	0.00	0.00	947	0.19	0.00	3.00	0.00	109	0.05	0.00	2.00	0.00	5212	0.66	0.00	7.00	0.00																					4	0.00	0.00	3.00	0.00	81	0.04	0.00	1.00	0.00					
ARS_XRF_ppm	9	58.89	40.00	120.00	30.00	947	67.24	50.00	930.00	5.00	109	48.66	40.00	250.00	5.00	5212	53.04	40.00	810.00	5.00	368	22.99	20.00	80.00	5.00	771	16.67	10.00	70.00	5.00	943	12.30	10.00	160.00	5.00	328	15.40	10.00	100.00	5.00	81	9.63	10.00	30.00	5.00					
BA_XRF_ppm	9	613.33	40.00	2450.00	5.00	881	77.91	40.00	3220.00	5.00	108	337.41	45.00	4550.00	5.00	5212	298.55	120.00	9490.00	5.00	368	81.18	30.00	1580.00	5.00	771	61.91	20.00	1900.00	5.00	943	60.19	5.00	2940.00	5.00	328	149.01	5.00	4390.00	5.00	81	5.00	5.00	5.00	5.00					
CL_XRF_ppm	9	113.33	100.00	420.00	30.00	947	223.10	160.00	2180.00	5.00	109	106.11	100.00	560.00	5.00	5212	228.33	170.00	4270.00	5.00	368	199.10	110.00	6350.00	10.00	771	129.20	80.00	2620.00	5.00	943	91.24	60.00	1680.00	5.00	328	133.25	80.00	2150.00	5.00	81	84.81	70.00	210.00	30.00					
CO_XRF_ppm	9	33.33	10.00	160.00	5.00	947	7.86	5.00	190.00	5.00	109	17.36	10.00	120.00	5.00	5212	25.27	20.00	910.00	5.00	368	15.39	10.00	70.00	5.00	771	12.77	10.00	150.00	5.00	943	8.09	5.00	110.00	5.00	328	9.16	5.00	160.00	5.00	81	5.62	5.00	30.00	5.00					
CR_XRF_ppm	9	51.67	50.00	120.00	5.00	940	117.04	70.00	2140.00	3.00	108	55.74	50.00	280.00	5.00	5212	124.45	90.00	2700.00	5.00	368	30.90	20.00	190.00	5.00	771	20.27	10.00	170.00	5.00	943	15.78	5.00	240.00	5.00	328	34.39	20.00	230.00	5.00	81	13.70	5.00	290.00	5.00					
CU_XRF_ppm	9	21.11	20.00	60.00	5.00	947	33.83	30.00	290.00	5.00	108	18.28	10.00	70.00	5.00	5212	60.36	50.00	3580.00	5.00	368	9.47	5.00	60.00	5.00	771	7.43	5.00	60.00	5.00	943	11.37	5.00	260.00	5.00	328	18.66	10.00	120.00	5.00	81	17.22	10.00	100.00	5.00					
NA_PPM	9	161.11	200.00	300.00	50.00	867	337.73	300.00	2080.00	20.00	105	140.00	100.00	600.00	50.00	5136	466.52	300.00	27400.00	50.00	339	259.88	200.00	4900.00	50.00	768	129.43	100.00	1400.00	50.00	893	126.23	100.00	2400.00	50.00	311	214.15	200.00	2100.00	50.00	8	406.25	450.00	700.00	50.00					
NI_XRF_ppm	9	31.67	30.00	70.00	5.00	947	39.60	30.00	350.00	5.00	108	55.93	50.00	200.00	10.00	5212	98.36	80.00	1430.00	5.00	368	24.70	20.00	100.00	5.00	771	23.50	20.00	120.00	5.00	943	17.57	10.00	130.00	5.00	328	24.60	20.00	180.00	5.00	81	15.19	10.00	100.00	5.00					
PB_XRF_ppm	9	8.33	5.00	30.00	5.00	947	32.12	20.00	220.00	5.00	108	6.90	5.00	30.00	5.00	5212	15.29	5.00	380.00	5.00	368	7.62	5.00	90.00	5.00	771	7.37	5.00	50.00	5.00	943	8.26	5.00	80.00	5.00	328	8.19	5.00	40.00	5.00	81	6.48	5.00	20.00	5.00					
SN_XRF_ppm	9	10.00	5.00	30.00	5.00	947	9.38	5.00	80.00	5.00	108	12.22	5.00	50.00	5.00	5212	13.45	5.00	140.00	5.00	368	7.84	5.00	40.00	5.00	771	9.38	5.00	50.00	5.00	943	6.15	5.00	50.00	5.00	328	6.63	5.00	50.00	5.00

Table A2.4 - GAI analysis BS3X and Lens G project areas

Element/oxide Analysis_Units	Count	CLA Mean	CLA Median	CLA Max	CLA Min	Count	CAL Mean	CAL Median	CAL Max	CAL Min	Count	DET ORE Mean	DET ORE Median	DET ORE Max	DET ORE Min	Count	DET WASTE Mean	DET WASTE Median	DET WASTE Max	DET WASTE Min	Count	DOR Mean	DOR Median	DOR Max	DOR Min	Count	JOF WASTE Mean	JOF WASTE Median	JOF WASTE Max	JOF WASTE Min	Count	WS HYD Mean	WS HYD Median	WS HYD Max	WS HYD Min	Count	WS ORE Mean	WS ORE Median	WS ORE Max	WS ORE Min	Count	WS WASTE Mean	WS WASTE Median	WS WASTE Max	WS WASTE Min	Count	DG HYD Mean	DG HYD Median	DG HYD Max	DG HYD Min
FE_XRF_pct	128	20.30	16.30	53.10	0.60	1314	17.39	15.87	54.25	0.44	1717	55.50	55.60	66.60	17.05	22511	34.64	33.80	61.70	0.30	331	23.32	21.60	60.64	4.60	27	24.65	20.51	33.03	3.79	66	16.37	17.52	63.57	43.21	25	56.76	59.05	64.59	51.43	355	34.01	36.07	61.75	1.00	207	59.50	59.80	64.74	17.30
AI2O3_pct	128	16.44	17.32	27.01	2.66	1314	4.45	3.16	30.35	0.24	1717	5.97	5.69	16.22	0.35	22511	9.93	9.08	31.64	0.03	331	20.37	21.64	33.26	1.63	27	2.35	2.03	6.17	0.48	66	3.77	3.42	12.03	0.73	25	3.23	2.88	7.19	1.03	355	6.05	4.20	33.18	0.20	207	2.76	2.30	27.56	0.51
P_XRF_pct	128	0.03	0.04	0.12	0.01	1314	0.01	0.01	0.06	0.00	1717	0.04	0.04	0.16	0.01	22511	0.04	0.04	0.34	0.00	331	0.05	0.06	0.11	0.00	27	0.05	0.06	0.11	0.01	66	0.13	0.13	0.31	0.05	25	0.16	0.16	0.40	0.08	355	0.11	0.11	0.33	0.01	207	0.12	0.10	0.30	0.04
TIO2_XRF_pct	128	0.33	1.00	1.46	0.13	1314	0.32	0.22	2.07	0.02	1717	0.56	0.50	5.11	0.02	22511	0.74	0.70	5.05	0.02	331	1.43	1.57	2.45	0.12	27	0.07	0.06	0.14	0.03	66	0.12	0.12	0.33	0.01	25	0.10	0.09	0.35	0.03	355	0.23	0.15	1.64	0.01	207	0.15	0.11	0.96	0.01
CAO_XRF_pct	128	0.23	0.16	3.33	0.02	1314	15.37	13.57	53.40	0.04	1717	0.12	0.07	4.66	0.01	22507	0.42	0.13	21.22	0.01	331	0.39	0.66	16.26	0.01	27	0.02	0.02	0.02	0.01	66	0.03	0.01	0.28	0.01	25	0.01	0.01	0.02	0.01	355	0.04	0.02	2.07	0.01	207	0.02	0.02	0.16	0.01
MN_XRF_pct	128	0.08	0.07	0.37	0.01	1314	0.06	0.03	4.30	0.01	1717	0.07	0.03	0.52	0.00	22511	0.06	0.04	20.20	0.01	331	0.26	0.09	15.80	0.01	27	0.06	0.07	0.12	0.01	66	0.03	0.03	0.09	0.00	25	0.05	0.02	0.22	0.01	355	0.15	0.03	3.75	0.00	207	0.02	0.02	0.43	0.00
MGO_XRF_pct	119	0.73	0.50	5.37	0.02	1311	0.23	7.24	34.60	0.21	1574	0.15	0.11	3.04	0.01	21575	0.31	0.19	13.80	0.01	331	0.48	0.20	3.97	0.05	27	0.11	0.03	0.26	0.04	66	0.03	0.02	0.10	0.01	25	0.01	0.01	0.03	0.01	355	0.06	0.04	0.64	0.01	207	0.03	0.02	0.12	0.01
S_XRF_pct	109	0.01	0.01	0.06	0.00	1655	0.01	0.01	0.03	0.00	1578	0.03	0.02	0.25	0.00	21634	0.02	0.02	3.04	0.00	331	0.02	0.01	0.08	0.00	27	0.01	0.01	0.02	0.01	66	0.07	0.05	0.46	0.02	25	0.12	0.04	0.61	0.01	355	0.06	0.02	2.65	0.00	207	0.04	0.04	0.16	0.01
MNO_XRF_pct	27	0.03	0.03	0.22	0.01	167	0.11	0.04	5.40	0.01	374	0.07	0.03	3.40	0.01	2368	0.06	0.04	3.33	0.01	12	0.22	0.10	0.74	0.01	1	0.04	0.04	0.12	0.01	19	0.03	0.03	0.29	0.02	138	0.07	0.02	2.17	0.01	180	0.03	0.02	0.63	0.01
K2O_XRF_pct	101	0.80	0.79	3.31	0.01	1750	0.06	0.03	2.39	0.00	1371	0.03	0.02	0.52	0.00	19712	0.23	0.19	2.94	0.00	319	0.40	0.24	4.16	0.01	27	0.30	0.06	0.93	0.02	66	0.02	0.01	0.16	0.00	25	0.03	0.01	0.21	0.00	355	0.22	0.02	7.18	0.00	202	0.01	0.01	0.18	0.00
ARS_XRF_ppm	101	40.53	40.00	220.00	5.00	1674	17.61	10.00	220.00	5.00	1371	37.53	30.00	240.00	5.00	19160	26.83	20.00	2210.00	5.00	319	9.37	5.00	70.00	5.00						53	36.79	30.00	100.00	20.00	19	13.47	20.00	40.00	10.00	138	27.54	20.00	150.00	5.00	175	26.05	20.00	90.00	5.00
BA_XRF_ppm	101	111.68	110.00	420.00	5.00	1673	62.65	5.00	2220.00	5.00	1366	37.68	20.00	2490.00	5.00	19082	88.80	60.00	6650.00	5.00	319	52.60	40.00	350.00	5.00						53	113.77	70.00	350.00	30.00	19	85.26	90.00	120.00	50.00	138	144.17	80.00	1040.00	5.00	175	81.06	60.00	580.00	5.00
CL_XRF_ppm	101	206.14	170.00	650.00	60.00	1674	123.92	110.00	1260.00	5.00	1367	123.10	100.00	730.00	5.00	19072	170.82	120.00	3500.00	5.00	319	266.52	200.00	1580.00	10.00						53	98.68	70.00	530.00	40.00	19	141.58	170.00	350.00	20.00	138	262.54	80.00	2420.00	10.00	175	132.57	70.00	730.00	30.00
CO_XRF_ppm	101	17.13	10.00	70.00	5.00	1674	14.23	5.00	670.00	5.00	1371	12.37	10.00	140.00	5.00	19160	9.93	5.00	650.00	5.00	319	13.40	10.00	220.00	5.00						53	6.60	5.00	20.00	5.00	19	5.00	5.00	5.00	5.00	138	5.11	5.00	10.00	5.00	175	7.37	5.00	20.00	5.00
CR_XRF_ppm	101	125.35	130.00	320.00	5.00	1674	32.22	10.00	500.00	5.00	1371	71.33	70.00	340.00	5.00	19160	133.72	130.00	2240.00	5.00	319	125.38	110.00	430.00	5.00						53	28.16	30.00	80.00	5.00	19	28.16	30.00	130.00	5.00	138	44.96	40.00	250.00	5.00	175	18.23	20.00	130.00	5.00
CU_XRF_ppm	101	51.68	50.00	90.00	5.00	1674	14.78	10.00	370.00	5.00	1371	17.25	10.00	320.00	5.00	19160	34.30	30.00	300.00	5.00	319	142.37	140.00	370.00	5.00						53	5.75	5.00	20.00	5.00	19	5.26	5.00	10.00	5.00	138	10.29	5.00	60.00	5.00	175	6.26	5.00	40.00	5.00
NA_PPM	101	721.78	800.00	1200.00	100.00	1750	267.26	200.00	1400.00	50.00	1371	228.94	200.00	1000.00	45.00	19712	491.68	500.00	8600.00	50.00	319	784.35	500.00	16800.00	50.00	27	120.67	148.00	223.00	74.00	66	141.58	126.00	668.00	4.00	25	145.44	89.00	757.00	4.00	355	223.41	148.00	2841.00	22.00	202	130.25	92.50	527.00	4.00
NL_XRF_ppm	101	65.83	70.00	120.00	5.00	1674	32.21	20.00	660.00	5.00	1371	30.48	30.00	320.00	5.00	19160	33.85	40.00	4310.00	5.00	319	65.34	60.00	220.00	5.00						53	13.02	5.00	80.00	5.00	19	8.16	5.00	30.00	5.00	138	15.18	5.00	300.00	5.00	175	12.63	5.00	150.00	5.00
PB_XRF_ppm	101	21.23	20.00	80.00	5.00	1674	8.43	5.00	90.00	5.00	1371	8.18	5.00	60.00	5.00	19160	12.67	5.00	300.00	5.00	319	6.77	5.00	60.00	5.00						53	6.51	5.00	30.00	5.00	19	8.74	5.00	30.00	5.00	138	16.34	5.00	80.00	5.00	175	6.71	5.00	150.00	5.00
SN_XRF_ppm	101	9.75	5.00	240.00	5.00	1674	26.38	5.00	180.00	5.00	1371	9.52	5.00	100.00	5.00	19160	7.89	5.00	100.00	5.00	319	6.36	5.00	70.00	5.00						53	7.74	5.00	20.00	5.00	19	7.37	5.00	20.00	5.00	138	5.94	5.00	20.00	5.00	175	8.77	5.00	30.00	5.00
SR_XRF_ppm	101	100.50	110.00	180.00	30.00	1671	39.58	100.00	300.00	5.00	1352	41.38	40.00	160.00	5.00	19021	82.91	80.00	250.00	5.00	319	75.00	70.00	350.00	5.00						53	31.32	30.00	110.00	5.00	19	67.11	50.00	220.00	5.00	138	61.27	50.00	390.00	5.00	175	14.29	5.00	120.00	5.00
V_XRF_ppm	101	151.09	160.00	360.00	20.00	1674	39.03	20.00	770.00	5.00	1371	93.37	80.00	430.00	5.00	19160	156.47	150.00	1080.00	5.00	319	357.34	350.00	890.00	30.00						53	23.02	20.00	90.00	5.00	19	25.53	20.00	70.00	5.00	138	53.44	40.00	260.00	5.00	175	22.51	20.00	140.00	5.00
ZN_XRF_ppm	101	258.71	80.00	2230.00	5.00	1674	191.40	50.00	7650.00	5.00	1371	120.76	20.00	1970.00	5.00	19160	77.12	40.00	14300.00	5.00	319	184.12	130.00	2040.00	5.00						53	17.92	20.00	70.00	5.00	19	23.68	30.00	100.00	5.00	138	18.15	10.00	100.00	5.00	175	15.29	20.00	70.00	5.00
ZR_XRF_ppm	101	177.43	190.00	330.00	30.00	1671	85.30	60.00	370.00	5.00	1352	106.05	100.00	380.00	5.00	19021	182.77	180.00	430.00	5.00	319	114.39	120.00	240.00	10.00						53	32.74	30.00	80.00	5.00	19	32.11	30.00	90.00	5.00	138	102.39	90.00	350.00	20.00	175	31.11	20.00	400.00	5.00

Element/oxide Analysis_Units	Crustal abundance mg/kg	CLA Mean	CLA Median	CLA Max	CLA Min	CAL Mean	CAL Median	CAL Max	CAL Min	DET ORE Mean	DET ORE Median	DET ORE Max	DET ORE Min	DET WASTE Mean	DET WASTE Median	DET WASTE Max	DET WASTE Min	DOR Mean	DOR Median	DOR Max	DOR Min	JOF WASTE Mean	JOF WASTE Median	JOF WASTE Max	JOF WASTE Min	WS HYD Mean	WS HYD Median	WS HYD Max	WS HYD Min	WS ORE Mean	WS ORE Median	WS ORE Max	WS ORE Min	WS WASTE Mean	WS WASTE Median	WS WASTE Max	WS WASTE Min	DG HYD Mean	DG HYD Median	DG HYD Max	DG HYD Min
FE_XRF_pct	41000	2	1	3	0	2	1	3		3	3	3	2	3	2	3		2	2	3		2	2	3		3	3	3	3	3	3	3	3	3	3	3		3	3	3	2
AI2O3_pct	309886																																								
P_XRF_pct	1000											0				1				1								0	0	1				1					1	
TIO2_XRF_pct	8343			0				1				2				2		0	0	1														0						
CAO_XRF_pct	57367					1	1	3								1																									
MN_XRF_pct	950			1				5				6				7		1		7												1		0		5			2	
MGO_XRF_pct	37540			0		1	0	3								1				1																				
S_XRF_pct	260			1				1				3				6				3						1	0	4						2	0	4			0		2
MNO_XRF_pct	1227			0				5				4				4		0		2												1				4			2	
K2O_XRF_pct	50583																																								
ARS_XRF_ppm	2	4	4	7	1	3	2	7	1	4	4	7	1	4	3	10	1	2	1	5	1					4	4	5	3	3	3	4	2	4	3	6	1	4	3	5	1
BA_XRF_ppm	500							2				2				3				0								0								0				
CL_XRF_ppm	130	0		2				3				2				4		0	0	3								1				0		4			2		
CO_XRF_ppm	20			1				4				4				4				3																				
CR_XRF_ppm	100			1				2				1				4				2														1						
CU_XRF_ppm	50			0				2				2				2		1	1	2																				
NA_PPM	23000																																								
NL_XRF_ppm	80			0				2				1				5				1																1				0	
PB_XRF_ppm	14	0		2				2				2				4				2				1				1						2				3	
SN_XRF_ppm	2	2	1	6	1	3	1	6	1	2	1	5	1	1	1	5	1	1	1	4	1					1	1	3	1	1	1	3	1	1	1	3	1	1	1	3	1
SR_XRF_ppm	370																																								
V_XRF_ppm	160			1				2				1				2		1	1	2																0				
ZN_XRF_ppm	75	1		4				6		0		4				7		1	0	4																				
ZR_XRF_ppm	190			0				0				0				1																				0				0	

Element/oxide Analysis_Units	Count	DG ORE Mean	DG ORE Median	DG ORE Max	DG ORE Min	Count	DG WASTE Mean	DG WASTE Median	DG WASTE Max	DG WASTE Min	Count	FWZ ORE Mean	FWZ ORE Median	FWZ ORE Max	FWZ ORE Min	Count	FWZ WASTE Mean	FWZ WASTE Median	FWZ WASTE Max	FWZ WASTE Min	Count	MCS WASTE Mean	MCS WASTE Median	MCS WASTE Max	MCS WASTE Min	Count	MTS WASTE Mean	MTS WASTE Median	MTS WASTE Max	MTS WASTE Min	Count	WF ORE Mean	WF ORE Median	WF ORE Max	WF ORE Min	Count	WF WASTE Mean	WF WASTE Median	WF WASTE Max	WF WASTE Min	Count	NEW HYD Mean	NEW HYD Median	NEW HYD Max	NEW HYD Min	Count	NEW ORE Mean	NEW ORE Median	NEW ORE Max	NEW ORE Min
FE_XRF_pct	325	60.26	61.77	66.32	26.71	1158	39.41	38.85	59.86	0.71	8	57.23	56.26	63.80	52.97	140	30.72	31.87	58.09	4.79	192	12.12	8.98	52.12	0.75	57	26.18	26.41	47.60	1.40	1966	55.22	55.48	64.82	32.09	10197	31.59	31.97	64.87	0.57	3062	57.19	57.68	65.76	28.54	7587	62.27	63.30	66.87	19.60
AI2O3_pct	325	2.52	1.62	23.06	0.32	1158	1.70	0.89	25.12	0.06	8	4.31	4.80	5.67	0.87	140	3.42	2.77	14.16	0.36	192	14.19	14.32	27.61	2.41	57	9.92	9.10	25.50	0.49	1966	4.76	4.41	18.63	0.57	10197	11.09	10.53	35.95	0.10	3062	3.00	2.60	21.28	0.35	7587	1.64	1.19	26.76	0.25
P_XRF_pct	325	0.16	0.15	0.38	0.04	1158	0.10	0.09	0.39	0.01	8	0.10	0.09	0.15	0.05	140	0.10	0.09	0.27	0.02	192	0.05	0.04	0.23	0.01	57	0.04	0.03	0.09	0.01	1966	0.06	0.05	0.17	0.01	10197	0.05	0.04	0.22	0.00	3062	0.05	0.05	0.16	0.01	7587	0.05	0.06	0.28	0.02
TIO2_XRF_pct	325	0.07	0.04	0.70	0.01	1158	0.06	0.03	1.25	0.01	8	0.18	0.16	0.35	0.05	140	0.14	0.09	0.73	0.01	192	0.51	0.53	1.20	0.07	57	0.43	0.34	1.66	0.01	1966	0.24	0.19	3.04	0.01	10197	0.59	0.54	5.36	0.01	3062	0.16	0.10	1.66	0.01	7587	0.05	0.03	1.87	0.01
CAO_XRF_pct	325	0.02	0.01	0.80	0.01	1158	0.02	0.02	0.55	0.01	8	0.03	0.04	0.05	0.02	140	0.03	0.02	0.29	0.01	192	0.33	0.04	8.48	0.01	57	0.05	0.04	0.20	0.01	1966	0.06	0.03	4.36	0.01	10197	1.49	0.09	40.50	0.01	3062	0.09	0.04	6.30	0.01	7586	0.02	0.02	0.75	0.01
MN_XRF_pct	325	0.03	0.02	0.83	0.00	1158	0.03	0.02	3.69	0.00	8	0.04	0.04	0.09	0.02	140	0.20	0.03	3.07	0.00	192	0.04	0.02	0.53	0.00	57	0.02	0.01	0.23	0.00	1966	0.26	0.10	13.90	0.01	10197	0.86	0.21	34.20	0.00	3062	0.10	0.03	23.90	0.01	7587	0.14	0.06	16.36	0.01
MGO_XRF_pct	325	0.03	0.03	0.23	0.01	1158	0.04	0.03	1.12	0.01	8	0.04	0.04	0.07	0.01	140	0.04	0.03	0.24	0.01	192	1.08	0.79	6.59	0.03	56	0.22	0.12	0.34	0.04	1909	0.15	0.11	2.71	0.01	3925	1.38	0.49	21.09	0.01	3028	0.09	0.06	3.02	0.01	7444	0.07	0.06	1.60	0.01
S_XRF_pct	325	0.03	0.02	0.20	0.00	1158	0.02	0.01	0.21	0.00	8	0.01	0.01	0.02	0.01	140	0.02	0.01	0.13	0.00	192	0.17	0.01	3.62	0.00	57	0.04	0.02	0.18	0.00	1909	0.02	0.02	0.16	0.00	3694	0.02	0.01	0.80	0.00	3028	0.04	0.03	2.04	0.00	7437	0.01	0.01	0.33	0.00
MNO_XRF_pct	263	0.04	0.02	1.07	0.01	650	0.04	0.02	4.76	0.01	8	0.06	0.06	0.11	0.02	84	0.38	0.03	3.36	0.01	115	0.06	0.03	0.63	0.01	48	0.03	0.01	0.30	0.01	82	0.25	0.12	4.10	0.01	571	0.53	0.08	13.82	0.01	120	0.06	0.05	0.96	0.01	265	0.23	0.12	23.70	0.01
K2O_XRF_pct	325	0.01	0.00	0.03	0.00	1154	0.03	0.02	0.74	0.00	8	0.09	0.01	0.01	0.00	139	0.03	0.01	0.44	0.00	175	2.11	2.20	4.46	0.01	26	0.46	0.18	1.63	0.03	1884	0.04	0.01	0.63	0.00	3655	0.57	0.23	7.71	0.00	3013	0.02	0.01	0.63	0.00	7344	0.01	0.00	0.50	0.00
ARS_XRF_ppm	269	22.10	20.00	70.00	5.00	646	16.88	10.00	80.00	5.00	8	56.25	55.00	70.00	40.00	83	33.86	30.00	170.00	5.00	110	173.55	140.00	670.00	5.00	26	105.18	65.00	370.00	5.00	1884	29.15	20.00	200.00	5.00	3455	41.33	40.00	370.00	5.00	3013	15.38	10.00	160.00	5.00	7344	11.64	10.00	700.00	5.00
BA_XRF_ppm	269	92.23	70.00	1130.00	20.00	646	55.45	30.00	5830.00	5.00	8	78.75	70.00	100.00	60.00	83	446.14	50.00	5820.00	5.00	110	149.27	130.00	740.00	10.00	26	47.88	45.00	120.00	5.00	1884	41.38	5.00	4560.00	5.00	3455	113.16	30.00	11500.00	5.00	2963	48.35	5.00	3820.00	5.00	7323	33.60	5.00	4040.00	5.00
CL_XRF_ppm	269	121.92	80.00	1130.00	20.00	646	93.67	60.00	1540.00	10.00	8	66.25	50.00	150.00	40.00	83	111.23	60.00	560.00	30.00	110	142.45	110.00	480.00	30.00	26	80.77	50.00	270.00	30.00	1884	102.15	90.00	1250.00	5.00	3455	136.08	120.00	1200.00	5.00	2390	173.73	100.00	1650.00	5.00	7326	66.13	70.00	1110.00	5.00
CO_XRF_ppm	269	9.46	10.00	30.00	5.00	646	5.54	5.00	50.00	5.00	8	11.25	10.00	20.00	10.00	83	8.13	5.00	60.00	5.00	110	9.66	8.00	70.00	5.00	26	7.50	5.00	20.00	5.00	1884	15.13	10.00	350.00	5.00	3455	23.63	10.00	1090.00	5.00	3013	11.30	10.00	280.00	5.00	7344	12.88	10.00	450.00	5.00
CR_XRF_ppm	263	15.31	10.00	70.00	5.00	646	12.15	5.00	110.00	5.00	8	30.63	30.00	50.00	5.00	83	21.20	10.00	130.00	5.00	110	35.03	100.00	230.00	5.00	26	44.04	40.00	90.00	5.00	1884	40.33	40.00	370.00	5.00	3455	31.16	80.00	1600.00	5.00	3013	22.86	10.00	160.00	5.00	7344	13.13	5.00	210.00	5.00
CU_XRF_ppm	263	7.81	5.00	50.00	5.00	646	6.50	5.00	40.00	5.00	8	16.88	20.00	20.00	5.00	83	16.63	20.00	50.00	5.00	110	56.00	50.00	220.00	5.00	26	36.54	30.00	90.00	10.00	1884	23.46	20.00	230.00	5.00	3455	43.00	30.00	750.00	5.00	3013	14.29	5.00	320.00	5.00	7344	11.20	5.00	400.00	5.00
NA_PPM	325	114.66	74.00	668.00	4.00	1154	110.23	74.00	364.00	4.00	8	162.38	167.00	269.00	45.00	133	163.88	141.00	1202.00	4.00	175	470.72	445.00	1632.00	37.00	26	215.08	200.00	401.00	53.00	1882	151.46	100.00	800.00	50.00	3611	301.54	300.00	2400.00	50.00	3004	244.19	200.00	2166.00	50.00	7343	105.76	50.00	1187.00	50.00
NL_XRF_ppm	263	16.30	10.00	90.00	5.00	646	10.31	5.00	90.00	5.00	8	11.88	10.00	20.00	5.00	83	10.48	5.00	60.00	5.00	110	44.77	30.00	240.00	5.00	26	20.36	10.00	120.00	5.00	1884	41.03	40.00	750.00	5.00	3455	15.35	60.00	1230.00	5.00	3013	24.84	20.00	200.00	5.00	7344	25.71	20.00	330.00	5.00
PB_XRF_ppm	263	9.24	5.00	110.00	5.00	646	9.28	5.00	90.00	5.00	8	5.00	5.00	5.00	5.00	83	13.92	5.00	60.00	5.00	110	36.35	30.00	480.00	5.00	26	58.46	50.00	120.00	10.00	1884	5.59	5.00	50.00	5.00	3455	10.46	5.00	270.00	5.00	3013	6.21	5.00	60.00	5.00	7344	6.52	5.00	90.00	5.00
S

Element/oxide		NEW WASTE				MAC WASTE					NAM WASTE					NAM ORE				
Analysis_Units	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	3603	34.10	32.76	63.42	0.49	2806	32.46	29.41	63.17	0.91	533	30.60	28.32	58.16	5.62	3	58.29	58.62	58.64	57.60
AL2O3_pct	3603	1.88	0.79	29.83	0.08	2806	3.41	2.60	25.16	0.11	533	2.75	1.74	14.36	0.33	3	1.40	1.27	1.81	1.11
P_XRF_pct	3603	0.04	0.04	0.13	0.00	2806	0.03	0.03	0.26	0.00	533	0.03	0.03	0.12	0.00	3	0.04	0.04	0.05	0.04
TIO2_XRF_pct	3604	0.10	0.03	2.27	0.01	2806	0.17	0.11	2.19	0.01	533	0.13	0.07	1.16	0.01	3	0.04	0.03	0.06	0.03
CAO_XRF_pct	3603	0.07	0.02	11.72	0.01	2806	0.14	0.03	11.52	0.01	533	0.15	0.04	4.83	0.01	3	0.01	0.01	0.01	0.01
MN_XRF_pct	3603	0.06	0.02	15.50	0.01	2806	0.07	0.02	26.50	0.00	533	0.04	0.01	1.40	0.01	3	0.04	0.04	0.04	0.03
MGO_XRF_pct	3357	0.52	0.05	11.60	0.01	2790	0.26	0.06	5.62	0.01	533	0.27	0.07	5.46	0.01	3	0.03	0.02	0.05	0.01
S_XRF_pct	3345	0.01	0.01	1.34	0.00	2735	0.03	0.02	0.86	0.00	533	0.04	0.02	0.66	0.00	3	0.09	0.09	0.12	0.06
MNO_XRF_pct	125	0.05	0.03	1.53	0.01	152	0.04	0.02	0.52	0.00	2	0.13	0.13	0.17	0.09					
K2O_XRF_pct	3154	0.03	0.01	4.82	0.00	2731	0.10	0.02	4.26	0.00	531	0.09	0.03	2.13	0.00					
ARS_XRF_ppm	3072	8.71	5.00	160.00	5.00	2680	12.10	10.00	110.00	5.00	515	3.64	10.00	50.00	5.00	3	13.33	10.00	20.00	10.00
BA_XRF_ppm	3016	29.54	5.00	9760.00	5.00	2627	44.82	5.00	3760.00	5.00	515	42.64	5.00	1320.00	5.00	3	16.67	20.00	20.00	10.00
CL_XRF_ppm	3011	73.67	60.00	6600.00	5.00	2637	176.89	110.00	1630.00	5.00	515	177.05	110.00	1710.00	5.00	3	136.67	140.00	150.00	120.00
CO_XRF_ppm	3072	8.69	5.00	150.00	5.00	2680	10.63	5.00	340.00	5.00	515	7.85	5.00	210.00	5.00	3	16.67	20.00	20.00	10.00
CR_XRF_ppm	3072	15.68	5.00	240.00	5.00	2680	28.05	20.00	280.00	5.00	515	22.95	10.00	160.00	5.00	3	5.00	5.00	5.00	5.00
CU_XRF_ppm	3072	16.34	10.00	670.00	5.00	2680	20.35	10.00	400.00	5.00	515	15.36	10.00	120.00	5.00	3	13.33	10.00	20.00	10.00
NA_PPM	3146	169.03	100.00	31100.00	50.00	2716	334.69	200.00	26400.00	50.00	529	362.51	300.00	4800.00	50.00	3	50.00	50.00	50.00	50.00
NI_XRF_ppm	3072	13.76	20.00	270.00	5.00	2680	26.19	20.00	240.00	5.00	515	20.96	20.00	140.00	5.00	3	36.67	40.00	40.00	30.00
PB_XRF_ppm	3072	9.51	5.00	160.00	5.00	2680	9.42	5.00	110.00	5.00	515	10.05	5.00	70.00	5.00	3	20.00	20.00	30.00	10.00
SN_XRF_ppm	3072	6.39	5.00	100.00	5.00	2680	7.62	5.00	110.00	5.00	515	6.70	5.00	50.00	5.00	3	10.00	5.00	20.00	5.00
SR_XRF_ppm	3002	70.24	70.00	250.00	5.00	2593	67.27	70.00	210.00	5.00	515	80.43	80.00	190.00	5.00	3	43.33	40.00	50.00	40.00
V_XRF_ppm	3072	21.56	5.00	720.00	5.00	2680	31.02	20.00	580.00	5.00	515	24.71	10.00	340.00	5.00	3	5.00	5.00	5.00	5.00
ZN_XRF_ppm	3072	61.11	30.00	2330.00	5.00	2680	55.30	40.00	2720.00	5.00	515	63.04	20.00	1450.00	5.00	3	26.67	30.00	30.00	20.00
ZR_XRF_ppm	3002	31.67	30.00	240.00	5.00	2593	46.91	40.00	210.00	5.00	515	33.27	30.00	200.00	5.00	3	26.67	30.00	30.00	20.00

Element/oxide	absadsacc	NEW WASTE					MAC WASTE					NAM WASTE					NAM ORE				
Analysis_Units	mg/kg	Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min		Mean	Median	Max	Min	
FE_XRF_pct	41000	2	2	3			2	2	3			2	2	3			3	3	3	3	
AL2O3_pct	309666																				
P_XRF_pct	1000			0					1												
TIO2_XRF_pct	9343			1					1												
CAO_XRF_pct	57367			0					0												
MN_XRF_pct	950			7					8					3							
MGO_XRF_pct	37540			1					1												
S_XRF_pct	260			5					4					4			1	1	2	1	
MNO_XRF_pct	1227			3					1												
K2O_XRF_pct	50530																				
ARS_XRF_ppm	2	2	1	6	1		2	2	6	1		2	2	4	1		3	2	3	2	
BA_XRF_ppm	100			4					2					1							
CL_XRF_ppm	100			5					5					5							
CO_XRF_ppm	20			5					4					3							
CR_XRF_ppm	100			1					1					0							
CU_XRF_ppm	50			3					2					1							
NA_PPM	20000																				
NI_XRF_ppm	80			1					1					0							
PB_XRF_ppm	14			3					2					2					1		
SN_XRF_ppm	2	1	1	5	1		1	1	5	1		1	1	4	1		2	1	3	1	
SR_XRF_ppm	370																				
V_XRF_ppm	160			2					1					1							
ZN_XRF_ppm	75			4					5					4							

Table A2.5 - GAI analysis BSMM project area

Element/oxide Analysis_Units	CLA					CAL					DET ORE					DET WASTE					DOR					DG RYD					FWZ WASTE					MCS WASTE					MTS WASTE					WF ORE				
	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	362	22.42	20.05	53.08	1.20	262	15.19	12.10	43.16	0.72	7694	57.18	57.19	67.45	11.70	8001	37.89	41.25	64.26	0.49	2300	18.49	17.77	55.67	0.89	6	14.09	15.28	18.05	4.63	16	43.84	45.55	52.35	30.94	36	30.48	31.06	50.41	10.52	81	34.15	33.34	53.10	2.22	1918	54.44	54.30	66.05	10.50
AlSiO3_pct	362	21.02	19.38	51.62	2.50	262	11.53	10.41	30.67	0.93	7694	4.65	4.12	24.65	0.07	8001	12.81	11.75	55.69	0.69	2300	19.71	20.12	48.50	0.56	6	3.41	3.45	5.11	1.03	16	5.18	5.21	10.13	0.96	36	14.73	15.26	25.91	3.34	81	13.67	13.22	33.13	0.93	1918	4.89	4.54	23.70	0.46
P_XRF_pct	362	0.05	0.04	0.26	0.01	262	0.01	0.01	0.08	0.00	7694	0.06	0.05	0.27	0.01	8001	0.04	0.03	0.46	0.00	2300	0.06	0.05	0.31	0.01	6	0.17	0.17	0.18	0.16	16	0.13	0.12	0.23	0.05	36	0.06	0.06	0.14	0.02	81	0.05	0.04	0.21	0.01	1918	0.06	0.07	0.46	0.02
TiO2_XRF_pct	362	1.48	1.09	9.88	0.01	262	0.97	0.71	3.57	0.06	7694	0.39	0.29	4.68	0.02	7994	0.97	0.81	15.70	0.03	2300	1.65	1.67	3.92	0.02	6	0.09	0.10	0.13	0.02	16	0.21	0.14	0.93	0.02	36	0.43	0.52	1.01	0.14	81	0.66	0.49	11.20	0.02	1915	0.22	0.18	1.76	0.01
CAO_XRF_pct	362	0.39	0.09	13.83	0.01	262	14.50	11.78	47.88	0.07	7693	0.17	0.05	8.65	0.01	8001	1.96	0.16	41.75	0.01	2300	1.20	0.17	20.30	0.01	6	0.06	0.06	0.09	0.01	16	0.07	0.06	0.19	0.01	36	0.30	0.13	1.69	0.03	81	0.08	0.05	0.46	0.01	1918	0.07	0.04	2.33	0.01
MN_XRF_pct	362	0.22	0.05	4.82	0.00	262	0.27	0.06	6.75	0.01	7694	0.09	0.04	9.64	0.00	8000	0.14	0.05	22.50	0.00	2300	0.52	0.16	18.00	0.01	6	0.02	0.02	0.04	0.02	16	0.03	0.02	0.17	0.01	36	0.03	0.02	0.13	0.01	81	0.04	0.02	0.29	0.01	1918	0.44	0.24	12.40	0.01
MGO_XRF_pct	362	0.60	0.36	3.31	0.07	262	5.62	5.26	19.45	0.20	7693	0.17	0.12	3.45	0.01	7994	0.73	0.30	19.50	0.01	2300	1.52	0.38	15.70	0.03	6	0.11	0.12	0.15	0.06	16	0.18	0.21	0.29	0.06	36	0.46	0.38	1.66	0.06	81	0.19	0.15	1.00	0.03	1915	0.19	0.16	1.05	0.01
S_XRF_pct	308	0.03	0.01	0.82	0.00	262	0.05	0.02	3.71	0.00	7406	0.02	0.02	1.00	0.00	7820	0.04	0.02	3.92	0.00	2298	0.02	0.01	2.22	0.00	6	0.02	0.02	0.03	0.01	16	0.02	0.02	0.04	0.01	36	0.02	0.02	0.08	0.01	81	0.01	0.01	0.04	0.00	1853	0.01	0.01	0.68	0.00
MNO_XRF_pct	56	0.13	0.06	1.05	0.01						297	0.24	0.05	12.45	0.01	83	0.24	0.10	1.68	0.01	2	0.01	0.01	0.01	0.01																								65	0.79	0.48	7.00	0.04
K2O_XRF_pct	306	0.35	0.11	3.17	0.01	262	0.16	0.05	2.40	0.01	7397	0.03	0.02	1.23	0.00	7395	0.23	0.03	4.28	0.00	2298	0.82	0.11	5.64	0.01	6	0.02	0.02	0.02	0.01	16	0.02	0.02	0.04	0.01	36	0.66	0.43	2.04	0.04	81	0.34	0.16	1.80	0.01	1853	0.05	0.02	1.33	0.00
AR3_XRF_ppm	306	53.45	40.00	540.00	5.00	262	19.35	10.00	160.00	5.00	7397	29.84	30.00	240.00	5.00	7395	42.67	35.00	520.00	5.00	2298	11.62	5.00	210.00	5.00	6	156.67	175.00	270.00	30.00	16	57.50	60.00	90.00	30.00	36	230.28	115.00	1300.00	40.00	81	67.53	60.00	230.00	5.00	1853	36.72	30.00	360.00	5.00
BA_XRF_ppm	306	202.21	30.00	2700.00	5.00	262	193.42	60.00	1630.00	5.00	7397	39.70	5.00	2610.00	5.00	7395	93.92	20.00	13200.00	5.00	2298	208.55	50.00	13250.00	5.00	6	12.50	12.50	20.00	5.00	16	21.56	5.00	70.00	5.00	36	70.00	50.00	320.00	5.00	81	33.77	30.00	760.00	5.00	1853	67.27	5.00	1600.00	5.00
CL_XRF_ppm	306	275.49	150.00	3360.00	10.00	262	332.23	190.00	3520.00	5.00	7397	176.70	120.00	2340.00	5.00	7395	341.92	165.00	5630.00	5.00	2298	259.90	150.00	12400.00	5.00	6	503.33	505.00	780.00	190.00	16	830.63	890.00	1720.00	250.00	36	372.83	260.00	1630.00	130.00	81	215.52	150.00	870.00	40.00	1853	107.21	80.00	2480.00	5.00
CO_XRF_ppm	306	17.09	10.00	130.00	5.00	262	42.27	30.00	380.00	5.00	7397	17.12	10.00	570.00	5.00	7395	18.22	10.00	450.00	5.00	2298	42.58	20.00	750.00	5.00	6	7.50	7.50	10.00	5.00	16	5.31	5.00	10.00	5.00	36	7.08	5.00	30.00	5.00	81	7.84	5.00	20.00	5.00	1853	20.68	10.00	240.00	5.00
CR_XRF_ppm	306	224.39	130.00	3080.00	30.00	262	94.97	70.00	510.00	2.00	7397	55.54	42.00	2380.00	2.00	7395	147.52	110.00	3360.00	2.00	2298	193.13	160.00	1585.00	2.00	6	8.33	5.00	20.00	5.00	16	25.31	20.00	50.00	5.00	36	82.36	80.00	160.00	5.00	81	87.53	80.00	230.00	5.00	1851	43.31	33.00	783.00	2.00
CU_XRF_ppm	306	54.25	40.00	380.00	5.00	262	75.76	20.00	190.00	5.00	7397	19.13	10.00	630.00	5.00	7395	36.27	20.00	1150.00	5.00	2298	96.39	50.00	1650.00	5.00	6	5.83	5.00	10.00	5.00	16	23.75	20.00	40.00	5.00	36	23.33	20.00	50.00	5.00	81	10.09	10.00	70.00	5.00	1853	26.11	20.00	230.00	5.00
NA_PPM	304	630.13	405.00	5600.00	100.00	262	1055.76	930.00	3700.00	200.00	7397	247.41	200.00	4010.00	20.00	7395	671.12	460.00	21200.00	20.00	2298	2118.91	500.00	######	20.00	6	400.00	400.00	600.00	200.00	16	591.25	550.00	1000.00	200.00	36	598.33	450.00	1100.00	200.00	81	411.11	300.00	1300.00	50.00	1851	168.82	120.00	1620.00	20.00
NL_XRF_ppm	306	97.65	70.00	460.00	5.00	262	85.15	60.00	550.00	5.00	7397	32.74	20.00	4100.00	5.00	7395	60.41	50.00	6450.00	5.00	2298	133.81	110.00	1500.00	5.00	6	31.67	35.00	40.00	20.00	16	22.81	20.00	70.00	5.00	36	36.67	30.00	80.00	10.00	81	40.37	40.00	160.00	10.00	1853	58.44	40.00	1160.00	5.00
PB_XRF_ppm	306	21.72	10.00	30.00	5.00	262	8.45	5.00	50.00	5.00	7397	10.47	5.00	4550.00	5.00	7395	14.54	5.00	190.00	5.00	2298	11.61	5.00	140.00	5.00	6	10.83	7.50	20.00	5.00	16	41.25	40.00	110.00	5.00	81	20.43	20.00	60.00	5.00	1853	17.27	5.00	4700.00	5.00
SN_XRF_ppm	306	16.76	10.00	90.00	5.00	262	17.08	5.00	120.00	5.00	7397	7.53	5.00	70.00	5.00	7395	8.04	5.00	110.00	5.00	2298	8.95	5.00	90.00	5.00	6	5.83	5.00	10.00	5.00	16	5.63	5.00	40.00	5.00	81	6.98	5.00	40.00	5.00	1853	7.80	5.00	50.00	5.00
SR_XRF_ppm	306	70.20	70.00	700.00	5.00	262	66.19	70.00	440.00	5.00	7397	17.53	5.00	420.00	5.00	7395	42.36	30.00	520.00	5.00	2298	54.08	30.00	650.00	5.00	6	30.00	30.00	40.00	20.00	16	53.13	50.00	90.00	30.00	36	60.83	50.00	130.00	20.00	81	62.35	50.00	160.00	5.00	1853	15.42	5.00	290.00	5.00
V_XRF_ppm	306	214.30	150.00	1080.00	10.00	262	93.24	75.00	600.00	5.00	7397	74.33	60.00	510.00	5.00	7395	150.63	150.00	1680.00	5.00	2298	348.77	340.00	790.00	5.00	6	25.83	25.00	60.00	5.00	16	51.88	35.00	210.00	5.00	36	100.83	95.00	200.00	30.00	81	83.71	80.00	470.00	5.00	1853	41.27	30.00	350.00	5.00
ZN_XRF_ppm	306	114.28	70.00	640.00	5.00	262	125.34	40.00	1480.00	5.00	7397	25.96	20.00	1410.00	5.00	7395	70.55	30.00	2730.00	5.00	2298	152.42	100.00	2650.00	5.00	6	40.00	45.00	60.00	20.00	16	30.63	30.00	50.00	20.00	36	81.11	65.00	230.00	20.00	81	50.43	60.00	270.00	5.00	1853	163.62	70.00	2380.00	5.00
ZR_XRF_ppm	306	228.73	200.00	1030.00	40.00	262	131.37	100.00	400.00	5.00	7397	63.51	60.00	460.00	5.00	7395	152.63	140.00	1560.00	5.00	2298	111.75	110.00	380.00	5.00	6	40.00	45.00	60.00	20.00	16	67.50	55.00	170.00	20.00	36	174.44	165.00	350.00	50.00	81	141.05	120.00	1310.00	5.00	1853	33.68	30.00	230.00	5.00

Element/oxide Analysis_Units	Crystal obsedance eg/kg	CLA				CAL				DET ORE				DET WASTE				DOR				DG RYD				FWZ WASTE				MCS WASTE				MTS WASTE				WF ORE			
		Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min	Mean	Median	Max	Min
FE_XRF_pct	41000	2	2	3		1	1	3		3	3	3	1	3	3	3		2	2	3		3	3	3	3	3	3	3	2	2	2	3	1	2	2	3		3	3	3	1
AlSiO3_pct	309886			0												0				0																				
P_XRF_pct	1000			1								1				2				1		0	0	0	0			1						0			2			
TiO2_XRF_pct	9343	0		3				1				2				3		0	0	1														3			0			
CAO_XRF_pct	57367			1		1	0	2				0				2				1														1						
MN_XRF_pct	950	1		5		1		6				6				7		2	0	7								0						1			2	1	6	
MGO_XRF_pct	37540			1		0		2								2				1																				
S_XRF_pct	260			4		0		7				5		0		7				6								0				1		0			4			
MNO_XRF_pct	1227			3						0		6		0		3																					2	1	5	
K2O_XRF_pct	50593																																								
AR3_XRF_ppm	2	5	4	8	1	3	2	5	1	4	4	7	1	4	4	8	1	2	1	7	1	6	6	7	4	5	5	5	4	7	6	9	4	5	5	7	1	4	4	7	1
BA_XRF_ppm	500			2				3				2				4				5														0			3			
CL_XRF_ppm	130	0		4		1		4				4		1		5		0		4		1	1	2		2	2	3	0	1	0	3		0		2				4	
CO_XRF_ppm	20		0	2		0	0	4				4				4		1		5																				3	
CR_XRF_ppm	100	1	0	4				2				4				5		0	0	3																1			2		
CU_XRF_ppm	50			2				1				3				4		1	1	4																			2		
NA_PPM	23000																			0																					
NL_XRF_ppm	80			2				2				5				6		0		4														0			3			
PB_XRF_ppm	14	0		2				1				6				3				4										1	1	2				2			6		
SN_XRF_ppm	2	2	2	5	1	2	1	5	1	1	1	4	1	1	1	5	1	1	1	5	1	1	1	3	1	1	1	2	1	1	1	4	1	1	1	4	1	1	1	4	1
SR_XRF_ppm	370			0												0																									
V_XRF_ppm	160			2				1				1				3		1	1	2														1			1			
ZN_XRF_ppm	75	0		3		0		4				4				5		0	0	5														1			4			
ZR_XRF_ppm	130			2				0				1				2				0														2						

Element/oxide Analysis_Units	WF WASTE					MEV RYD					MEV ORE					MEV WASTE					MAC WASTE					RAM WASTE					RAM ORE					FOR - Waste				
	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min	Count	Mean	Median	Max	Min
FE_XRF_pct	48963	28.06	24.41	60.66	0.43	4094	15.05	15.08	61.43	10.39	52962	62.19	63.19	67.97	19.56	9946	31.63	34.16	64.01	0.55	34603	31.90	32.62	64.16	1.50	2931	33.43	33.71	60.67	3.60	891	51.63	50.66	64.20	33.71	760	35.76	35.52	53.22	8.60
AlSiO3_pct	48963	10.41	10.72	58.69	0.52	4094	3.61	3.21	39.90	0.45	52962	1.16	1.00	21.20	0.07	9946	1.49	0.70	28.90	0.08	34603	4.18	3.24	28.49	0.08	2931	2.69	1.76	25.50	0.29	891	3.07	2.59	15.41	0.61	760	11.91	10.60	36.96	0.73
P_XRF_pct	48963	0.07	0.07	0.61	0.00	4094	0.05	0.05	0.37	0.01	52962	0.01	0.00	0.40	0.00	9946	0.04	0.04	0.25	0.00	34603	0.04	0.03	0.20	0.00	2931	0.05	0.04	0.24	0.00	891	0.03	0.03	0.15	0.02	760	0.03	0.03	0.34	0.00
TiO2_XRF_pct	48963	0.64	0.63	10.50	0.01	4095	0.11	0.10	2.52	0.01	52940	0.05	0.04	1.62	0.01	9936	0.07	0.02	3.05	0.01	34603	0.09	0.10	1.92	0.01	2931	0.11	0.07	4.59	0.01	891	0.13	0.06	0.86	0.01	760	1.34	1.26	5.63	0.03
CAO_XRF_pct	48963	0.91	0.09	14.32	0.01	4094	0.19	0.05	9.07	0.01	52951	0.03	0.02	2.35	0.01	9946	0.08	0.02	19.10	0.01	34603	0.21	0.04	12.52	0.01	2931	0.21	0.04	19.90	0.01	891	0.12	0.04	2.65	0.01	760	0.69	0.16	19.72	0.01
MN_XRF_pct	48951	2.47	0.60	46.47	0.00	4094	0.59	0.04	18.40	0.00	52951	0.21	0.06	9.50	0.00	9946	0.16	0.04	25.00	0.00	34603	0.69	0.05	24.20	0.00	2931	0.31	0.04	22.50	0.00	891	0.33	0.04	19.65	0.01	760	0.16	0.10	4.81	0.00
MGO_XRF_pct	48944	0.71	0.45	21.50	0.00	4095	0.11	0.11	5.81	0.00	52229	0.10	0.09	1.24	0.00	9930	0.10	0.06	4.75	0.00	34603	0.22	0.05	7.59	0.00	2931	0.22	0.05	19.60	0.01	891	0.14	0.12	1.41	0.03	760	0.35	1.22	15.90	0.03
S_XRF_pct	47736	0.62	0.01	19.40	0.00	4077	0.03	0.02	0.70	0.00	12755	0.01	0.01	0.17	0.00	9922	0.01	0.00	0.54	0.00	33392	0.03	0.02	1.26	0.00	2931	0.02	0.01	0.35	0.00	891	0.01	0.01	0.05	0.00	760	0.09	0.02	5.00	0.00
MNO_XRF_pct	671	0.41	0.60	13.93	0.01	24	0.01	0.01	0.05	0.01	166	0.30	0.10	3.40	0.01	124	0.24	0.10	1.93	0.01	11	0.03	0.03	0.05	0.02																	
K2O_XRF_pct	47732	0.95	0.70	7.30	0.00	4070	0.03	0.02	0.50	0.00	12755	0.01	0.00	0.79	0.00	9922	0.02	0.01	1.75	0.00	33392	0.05	0.02	1.63	0.00	2931	0.05	0.02	3.89	0.00	891	0.02	0.01	0.50	0.00	760	0.03	0.10	5.31	0.00
AR3_XRF_ppm	47732	60.28	50.00	1600.00	5.00	4070	14.56	10.00	150.00	5.00	12755	18.11	5.00	240.00	5.00	9922	9.63	5.00	370.00	5.00	33392	14.63	10.00	150.00	5.00	2931	12.45	10.00	240.00	5.00	891	19.53	15.00	160.00	5.00	760	22.65	10.00	230.00	5.00
BA_XRF_ppm	47732	479.62	130.00	46169.00	5.00	4070	37.01	5.00	1360.00	5.00	12755	31.71	5.00	10660.00	5.00	9922	44.31	5.00	1920.00	5.00	33392	61.60	5.00	13000.00	5.00	2931	70.09	5.00	6460.00	5.00	891	160.53	5.00	6440.00	5.00	760	127.35	50.00	4260.00	5.00
CL_XRF_ppm	47732	247.33	190.00	16550.00	5.00	4070	234.51	150.00	5150.00	5.00	12755	85.05	60.00	2160.00	5.00	9922	73.83	50.00	1640.00	5.00	33392	181.19	120.00	9420.00	5.00	2931	163.80	110.00	1920.00	5.00	891	194.61	160.00	1920.00	5.00	760	129.39	70.00	2650.00	5.00
CO_XRF_ppm	47732	31.23	20.00	2240.00	5.00	4070	14.56	10.00	170.00	5.00	12755	16.05	10.00	410.00	5.00	9922	11.83	5.00	1640.00	5.00	33392	18.15	10.00	260.00	5.00	2931	15.62	10.00	420.00	5.00	891	25.83	20.00	270.00	5.00	760	29.39	20.00	320.00	5.00
CR_XRF_ppm	47732	97.23	70.00	4600.00	5.00	4070	72.89	50.00	1000.00	5.00	12755	56.05	40.00	1220.00	5.00	9922	70.83	50.00	1640.00	5.00	33392	84.77	60.00	1640.00	5.00	2931	73.62	50.00	1640.00	5.00	891	87.64	70.00	1640.00	5.00	760	70.39	50.00	1640.00	5.00
CU_XRF_ppm	47732	50.05	50.00	4600.00	5.00	4070	39.55	30.00	430.00	5.00	12755	16.65	10.00	320.00	5.00	9922	15.22	10.00	770.00	5.00	33392	21.20	20.00	450.00	5.00	2931	20.74	10.00	320.00	5.00	891	33.27	30.00	320.00	5.00	760	55.27	50.00	320.00	5.00
NA_PPM	47065	426.89	340.00	15660.00	20.00	4070	336.47	300.00	3780.00	20.00	12653	130.76	100.00	6560.00	20.00	9915	163.11	100.00	9560.00	20.00	33164	265.45	200.00	21660.00	20.00	2927	502.32	200.00	21660.00	20.00	891	222.54	200.00	1590.00	20.00	760	2066.92	550.00	21660.00	20.00
NL_XRF_ppm	47732	101.42	90.00	1200.00	5.00	4070	29.52	20.00	4460.00	5.00	12755	28.25	20.00	2550.00	5.00	9922	23.20	10.00	2170.00	5.00	33392	39.73	20.00	5240.00	5.00	2931	29.51	20.00	4460.00	5.00	891	42.70	20.00	1120.00	5.00	760	125.90	100.00	1750.00	5.00
PB_XRF_ppm	47732	23.19	10.00	4720.00	5.00	4070	12.89	5.00	1460.00	5.00	12755	15.19	5.00	390.00	5.00	9922	17.19	5.00	4560.00	5.00	33392	14.77	5.00	160.00	5.00	2931	13.27	5.00	190.00	5.00	891	15.54	5.00	160.00	5.00	760	13.11	5.00	160.00	5.00
SN_XRF_ppm	47732	9.39	5.00	2480.00	5.00	4070	6.68	5.00	50.00	5.00	12755	10.50	5.00	60.00	5.00	9922	8.63	5.00	60.00	5.00	33392	7.62	5.00	60.00	5.00	2931	6.53	5.00	60.00	5.00	891	7.53	5.00	60.00	5.00	760	8.45	5.00	60.00	5.00
SR_XRF_ppm	47732	65.82	50.00	2160.00	5.00	4070	16.81	10.00	520.00	5.00	12755	13.05	5.00	460.00	5.00	9922	16.29	10.00	410.00	5.00	33392	16.29	10.00	240.00	5.00	2931	13.56	10.00	270.00	5.00	891	16.36	10.00	160.00	5.00	760	16.92	10.00	700.00	5.00
V_XRF_ppm	47732	152.23	100.00	9460.00	5.00	4070	33.73	20.00	470.00	5.00	12755	12.39	5.00	320.00	5.00	9922	13.60	5.00	540.00	5.00	33392	33.45	20.00	750.00	5.00	2931	23.62	10.00	430.00	5.00	891	23.21	10.00	430.00	5.00	760	111.52	20.00	1210.00	5.00
ZN_XRF_ppm	47732	237.92	110.00	6790.00	5.00	4070	22.26	20.00	1290.00	5.00	12755	23.52	20.00	3090.00	5.00	9922	26.73	20.00	3440.00	5.00	33392	49.52	30.00	1620.00	5.00	2931	33.44	20.00	2270.00	5.00	891	41.93	40.00	270.00	5.00	760	114.48	100.00	2760.00	5.00
ZR_XRF_ppm	47732	193.45	150.00	1530.00	5.00	4070	50.75	20.00	350.00	5.00	12755	11.94	5.00	180.00	5.00	9922	24.61	20.00	240.00	5.00

Appendix 3 – AMD Hazard Scorecard

Project Name	Greater Brockman - BS1
Assessment Date	1/01/2021
Compiled by	Sam McHarg
Final ARD Hazard Assessment	**MODERATE**

Version Date: 01/01/21
Version Number: 1

RTIO ARD Hazard Score

1. Preliminary Assessment (Order of Magnitude/Exploration)

A. Preliminary Geology Hazard

	Select Relevant Option Below	Score	Option Details
Ore Deposit Type	D) Enriched Dales Gorge Member mined below the water table (un-oxidised Mt McRae shale likely present)	19	
Host & Country Rock Neutralising Potential	None (<5%)	10	Conservatively assume no significant mass of dolomite or calcrete in proximity to the area.
Brownfield's / Greenfields	Brownfield		
Known ARD Issues on Site	No	0	
	Geology Hazard Score	**29**	

Complete following sections

B. Incipient ARD Risk

	Select Relevant Option Below	Score
Operation Age	< 5 years	5

**By default, all new projects should receive a <5 years value*

C. Scale of Disturbance

	Select Relevant Option Below	Score	
Total Waste Stored	250 - 1 billions tonnes	10	
Footprint	1000 - 3000 hectares	8	1500 Ha

D. Transport Pathways

	Select Relevant Option Below	Score	
Project / Exploration?	Yes		
Precipitation / Areal Potential Evapo-transpiration Ratio	1/10 to 1/3 ratio_mining below the water table in a rock mass that is connected to a regionally significant aquifer	5	40% BWT

**All new projects should respond Yes to Project / Exploration*

E. Sensitivity of Receiving Environment

	Select Relevant Option Below	Score	
Distance to Perennial/Ephemeral Water Bodies	>2000 metres	0	Boolgeeda Creek situated 2.7 km south east
Alkalinity	>35 mg/L	1	Estimated
Distance to closest protected / permanently inhabited area	>10000 metres	0	

Preliminary Hazard Assessment

Preliminary Hazard Score	58
Preliminary Risk Assessment	**MODERATE**

2. Detailed Assessment (Pre Feasibility/ Feasibility/Mining)

This assessment should be completed by an ARD expert

Pit	**Greater Brockman - BS1**

F. Geochemical Hazard (Interrogate the drill hole database)

	Select Relevant Option Below	Score	Option Details
Waste sulfur risk	Total number of waste samples with S>0.1% is less than 3%	0	2.46% of in-pit waste samples have sulfur values greater than 0.1%.
Ore grade sulfur risk	Total number of ore grade samples with S>0.1% is less than 3%	0	2.35%
Spatial distribution of sulfur	Sulfur concentrated within one or two lithologies (i.e. MCS and FWZ)	5	
Chemical enrichment	Enrichments of contaminants that are unlikely to mobilise into groundwater	1	Assume SCARD Management

G. Mine Planning Hazard

	Select Relevant Option Below	Score	Option Details
PAF material management	PAF waste dumps will be in pit and out of pit	4	Possible in and out of pit
Bulk NPR (Mass of neutralising material x mean ANC) / (Percent of lithology greater than 0.1% x tonnes of lithology x mean sulfur concentration for all data greater than 0.1 x 30.6 + repeat for each PAF lithologies)	>3	0	Based on assessment of in-pit drillhole data NPR = 58
PAF rock mass disturbed or exposed (waste tonnes with S>0.1%)/(total tonnes of waste)*100	< 3% of the total disturbed mass	0	PAF material makes up ~ 2.73% of total waste
Pit backfilling	Pit will not be backfilled	5	Conservative assumption.

H. Water Management Hazard

	Select Relevant Option Below	Score	Option Details
Dewatering volume	0 to 80 ML/day	1	
Surface water	Isolated pit	0	
Water treatment during Operation	Water treatment or special water management may be needed during operation	3	Need to investigate AMD potential for PAFexposures on pit wall.
Final void management	3% to 10% PAF exposed	7	7.43% exposure of Risk 2 and 3

Combined Hazard Assessment

Preliminary Assessment Score	58
Detailed Assessment Score	26
Combined Hazard Score	41
Risk Ranking	**MODERATE**

This risk ranking score card is relevant for Pilbara based iron ore operations and the ranking system can be used to assess the relative risk of each operation. The ranking system is likely to overestimate the risk if compared to porphry copper or some coal deposits.

For RTIO internal distribution only. The manager of Technical Projects and Development will need to review and approve this prior to external release.
This risk assessment should be read in conjunction with the detailed ARD Risk Assessment

Valid for 30 days after the assessment date

Project Name	Greater Brockman - BS2
Assessment Date	1/01/2021
Compiled by	Sam McHarg
Final ARD Hazard Assessment	**MODERATE**

Version Date: 01/01/21
Version Number: 1

RTIO ARD Hazard Score

1. Preliminary Assessment (Order of Magnitude/Exploration)

A. Preliminary Geology Hazard

	Select Relevant Option Below	Score	Option Details
Ore Deposit Type	D) Enriched Dales Gorge Member mined below the water table (un-oxidised Mt McRae shale likely present)	19	
Host & Country Rock Neutralising Potential	None (<5%)	10	Conservatively assume no significant mass of dolomite or calcrete in proximity to the area.
Brownfield's / Greenfields	Brownfield		
Known ARD Issues on Site	No	0	
	Geology Hazard Score	**29**	

Complete following sections

B. Incipient ARD Risk

	Select Relevant Option Below	Score
Operation Age	< 5 years	5

**By default, all new projects should receive a <5 years value*

C. Scale of Disturbance

	Select Relevant Option Below	Score	
Total Waste Stored	50 - 250 million tonnes	5	
Footprint	100 - 250 hectares	3	180 Ha

D. Transport Pathways

	Select Relevant Option Below	Score	
Project / Exploration?	Yes		
Precipitation / Areal Potential Evapo-transpiration Ratio	1/10 to 1/3 ratio_mining below the water table in a rock mass that is connected to a regionally significant aquifer	5	10% BWT

**All new projects should respond Yes to Project / Exploration*

E. Sensitivity of Receiving Environment

	Select Relevant Option Below	Score	
Distance to Perennial/Ephemeral Water Bodies	500 - 2000 metres	1	
Alkalinity	>35 mg/L	1	Confirmed from AAR
Distance to closest protected / permanently inhabited area	>10000 metres	0	

Preliminary Hazard Assessment

Preliminary Hazard Score	49	
Preliminary Risk Assessment	**MODERATE**	

Not undertaken as no pit information available

2. Detailed Assessment (Pre Feasibility/ Feasibility/Mining)

This assessment should be completed by an ARD expert

This risk ranking score card is relevant for Pilbara based iron ore operations and the ranking system can be used to assess the relative risk of each operation. The ranking system is likely to overestimate the risk if compared to porphry copper or some coal deposits.

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This risk assessment should be read in conjunction with the detailed ARD Risk Assessment

Project Name	Greater Brockman - BS3 and BS4
Assessment Date	1/01/2021
Compiled by	Sam McHarg
Final ARD Hazard Assessment	**MODERATE**

Version Date: 01/01/21
Version Number: 1

RTIO ARD Hazard Score

1. Preliminary Assessment (Order of Magnitude/Exploration)

A. Preliminary Geology Hazard

	Select Relevant Option Below	Score	Option Details
Ore Deposit Type	D) Enriched Dales Gorge Member mined below the water table (un-oxidised Mt McRae shale likely present)	19	
Host & Country Rock Neutralising Potential	None (<5%)	10	Conservatively assume no significant mass of dolomite or calcrete in proximity to the area.
Brownfield's / Greenfields	Brownfield		
Known ARD Issues on Site	No	0	
	Geology Hazard Score	**29**	

Complete following sections

B. Incipient ARD Risk

	Select Relevant Option Below	Score
Operation Age	< 5 years	5

**By default, all new projects should receive a <5 years value*

C. Scale of Disturbance

	Select Relevant Option Below	Score	
Total Waste Stored	50 - 250 million tonnes	5	
Footprint	250 - 1000 hectares	6	740 Ha

D. Transport Pathways

	Select Relevant Option Below	Score	
Project / Exploration?	Yes		
Precipitation / Areal Potential Evapo-transpiration Ratio	1/10 to 1/3 ratio_mining below the water table in a rock mass that is connected to a regionally significant aquifer	5	10% BWT

**All new projects should respond Yes to Project / Exploration*

E. Sensitivity of Receiving Environment

	Select Relevant Option Below	Score	
Distance to Perennial/Ephemeral Water Bodies	< 100 metres	5	
Alkalinity	>35 mg/L	1	Confirmed from AAR
Distance to closest protected / permanently inhabited area	>10000 metres	0	

Preliminary Hazard Assessment

Preliminary Hazard Score	56
Preliminary Risk Assessment	**MODERATE**

2. Detailed Assessment (Pre Feasibility/ Feasibility/Mining)

This assessment should be completed by an ARD expert

Pit	**Greater Brockman - BS3 and BS4**

F. Geochemical Hazard (Interrogate the drill hole database)

	Select Relevant Option Below	Score	Option Details
Waste sulfur risk	Total number of waste samples with S>0.1% is between 3% and 10%	7	3.45% of in-pit waste samples have sulfur values greater than 0.1%.
Ore grade sulfur risk	Total number of ore grade samples with S>0.1% is between 3% and 10% but less than 0.5% of the samples have S>0.3%	2	4.12%
Spatial distribution of sulfur	Sulfur scattered throughout the pit and through numerous lithologies	3	
Chemical enrichment	Enrichments of contaminants that are unlikely to mobilise into groundwater	1	Assume SCARD Management

G. Mine Planning Hazard

	Select Relevant Option Below	Score	Option Details
PAF material management	PAF waste dumps will be out of pit	5	
Bulk NPR (Mass of neutralising material x mean ANC) / (Percent of lithology greater than 0.1% x tonnes of lithology x mean sulfur concentration for all data greater than 0.1 x 30.6 + repeat for each PAF lithologies)	>3	0	Based on assessment of in-pit drillhole data NPR = 3.83
PAF rock mass disturbed or exposed (waste tonnes with S>0.1%)/(total tonnes of waste)*100	< 3% of the total disturbed mass	0	PAF material makes up ~ 0.28% of total waste
Pit backfilling	Pit will not be backfilled	5	Conservative assumption.

H. Water Management Hazard

	Select Relevant Option Below	Score	Option Details
Dewatering volume	0 to 80 ML/day	1	
Surface water	Isolated pit	0	
Water treatment during Operation	Water treatment or special water management may be needed during operation	3	Unlikely water treatment will be required
Final void management	Less than 3% PAF exposed	2	0.97% exposure of Risk 2 and 3

Combined Hazard Assessment

Preliminary Assessment Score	56
Detailed Assessment Score	29
Combined Hazard Score	43
Risk Ranking	**MODERATE**

This risk ranking score card is relevant for Pilbara based iron ore operations and the ranking system can be used to assess the relative risk of each operation. The ranking system is likely to overestimate the risk if compared to porphry copper or some coal deposits.

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This risk assessment should be read in conjunction with the detailed ARD Risk Assessment

Project Name	Greater Brockman - BS3X Lens G
Assessment Date	1/01/2021
Compiled by	Sam McHarg
Final ARD Hazard Assessment	**LOW**

Version Date: 01/01/21
Version Number: 1

RTIO ARD Hazard Score

1. Preliminary Assessment (Order of Magnitude/Exploration)

A. Preliminary Geology Hazard

	Select Relevant Option Below	Score	Option Details
Ore Deposit Type	C) Enriched Marra Mamba Formation and Joffre Member, and/or channel and detrital ore bodies mined below the water table (un-oxidised lignite and black shales other than Mt McRae may be present). Enriched Dales Gorge Member mined above the water table only	14	
Host & Country Rock Neutralising Potential	None (<5%)	10	Conservatively assume no significant mass of dolomite or calcrete in proximity to the area.
Brownfield's / Greenfields	Brownfield		
Known ARD Issues on Site	No	0	
		Geology Hazard Score	**24**

Complete following sections

B. Incipient ARD Risk

	Select Relevant Option Below	Score
Operation Age	< 5 years	5

**By default, all new projects should receive a <5 years value*

C. Scale of Disturbance

	Select Relevant Option Below	Score	
Total Waste Stored	250 - 1 billions tonnes	10	
Footprint	1000 - 3000 hectares	8	1373 Ha

D. Transport Pathways

	Select Relevant Option Below	Score	
Project / Exploration?	Yes		
Precipitation / Areal Potential Evapo-transpiration Ratio	1/10 to 1/3 ratio_mining below the water table in a rock mass that is connected to a regionally significant aquifer	5	45% BWT

**All new projects should respond Yes to Project / Exploration*

E. Sensitivity of Receiving Environment

	Select Relevant Option Below	Score	
Distance to Perennial/Ephemeral Water Bodies	500 - 2000 metres	1	1.6km from Boolgeeda Creek
Alkalinity	>35 mg/L	1	Confirmed from AAR
Distance to closest protected / permanently inhabited area	>10000 metres	0	

Preliminary Hazard Assessment

Preliminary Hazard Score	54
Preliminary Risk Assessment	**MODERATE**

2. Detailed Assessment (Pre Feasibility/ Feasibility/Mining)

This assessment should be completed by an ARD expert

Pit	**Greater Brockman - BS3X Lens G**

F. Geochemical Hazard (Interrogate the drill hole database)

	Select Relevant Option Below	Score	Option Details
Waste sulfur risk	Total number of waste samples with S>0.1% is less than 3%	0	0.89% of in-pit waste samples have sulfur values greater than 0.1%.
Ore grade sulfur risk	Total number of ore grade samples with S>0.1% is less than 3%	0	1.34% of ore samples have S>0.1%
Spatial distribution of sulfur	Sulfur scattered throughout the pit and through numerous lithologies	3	
Chemical enrichment	Enrichments of contaminants that are unlikely to mobilise into groundwater	1	Assume SCARD Management

G. Mine Planning Hazard

	Select Relevant Option Below	Score	Option Details
PAF material management	PAF waste dumps will be in pit and out of pit	4	
Bulk NPR (Mass of neutralising material x mean ANC) / (Percent of lithology greater than 0.1% x tonnes of lithology x mean sulfur concentration for all data greater than 0.1 x 30.6 + repeat for each PAF lithologies)	>3	0	Based on assessment of in-pit drillhole data NPR = 40
PAF rock mass disturbed or exposed (waste tonnes with S>0.1%)/(total tonnes of waste)*100	< 3% of the total disturbed mass	0	PAF material makes up ~ 0.29% of total waste
Pit backfilling	Pit will not be backfilled	5	Conservative assumption.

H. Water Management Hazard

	Select Relevant Option Below	Score	Option Details
Dewatering volume	0 to 80 ML/day	1	
Surface water	Isolated pit	0	
Water treatment during Operation	No water treatment or special management for ARD needed	0	Unlikely water treatment will be required
Final void management	No PAF rock exposures likely on final pit shell	0	

Combined Hazard Assessment

Preliminary Assessment Score	54
Detailed Assessment Score	14
Combined Hazard Score	28
Risk Ranking	**LOW**

This risk ranking score card is relevant for Pilbara based iron ore operations and the ranking system can be used to assess the relative risk of each operation. The ranking system is likely to overestimate the risk if compared to porphry copper or some coal deposits.

For RTIO internal distribution only. The manager of Technical Projects and Development will need to review and approve this prior to external release.
This risk assessment should be read in conjunction with the detailed ARD Risk Assessment

Valid for 30 days after the assessment date

Project Name	Greater Brockman - BSMO, BSMQ and BSMR
Assessment Date	1/01/2021
Compiled by	Sam McHarg
Final ARD Hazard Assessment	**MODERATE**

Version Date: 01/01/21
Version Number: 1

RTIO ARD Hazard Score

1. Preliminary Assessment (Order of Magnitude/Exploration)

A. Preliminary Geology Hazard

	Select Relevant Option Below	Score	Option Details
Ore Deposit Type	C) Enriched Marra Mamba Formation and Joffre Member, and/or channel and detrital ore bodies mined below the water table (un-oxidised lignite and black shales other than Mt McRae may be present). Enriched Dales Gorge Member mined above the water table only	14	
Host & Country Rock Neutralising Potential	None (<5%)	10	Conservatively assume no significant mass of dolomite or calcrete in proximity to the area.
Brownfield's / Greenfields	Brownfield		
Known ARD Issues on Site	No	0	
		Geology Hazard Score	**24**

Complete following sections

B. Incipient ARD Risk

	Select Relevant Option Below	Score
Operation Age	< 5 years	5

**By default, all new projects should receive a <5 years value*

C. Scale of Disturbance

	Select Relevant Option Below	Score	
Total Waste Stored	250 - 1 billions tonnes	10	
Footprint	250 - 1000 hectares	6	740 Ha

D. Transport Pathways

	Select Relevant Option Below	Score	
Project / Exploration?	Yes		
Precipitation / Areal Potential Evapo-transpiration Ratio	1/10 to 1/3 ratio_mining below the water table in a rock mass that is connected to a regionally significant aquifer	5	19% BWT

**All new projects should respond Yes to Project / Exploration*

E. Sensitivity of Receiving Environment

	Select Relevant Option Below	Score	
Distance to Perennial/Ephemeral Water Bodies	500 - 2000 metres	1	1.8km from Boolgeeda Creek
Alkalinity	>35 mg/L	1	Confirmed from AAR
Distance to closest protected / permanently inhabited area	>10000 metres	0	

Preliminary Hazard Assessment

Preliminary Hazard Score	52
Preliminary Risk Assessment	**MODERATE**

2. Detailed Assessment (Pre Feasibility/ Feasibility/Mining)

This assessment should be completed by an ARD expert

Pit	**Greater Brockman - BSMO, BSMQ and BSMR**

F. Geochemical Hazard (Interrogate the drill hole database)

	Select Relevant Option Below	Score	Option Details
Waste sulfur risk	Total number of waste samples with S>0.1% is less than 3%	0	1.95% of in-pit waste samples have sulfur values greater than 0.1%.
Ore grade sulfur risk	Total number of ore grade samples with S>0.1% is less than 3%	0	0.38% of ore samples have S>0.1%
Spatial distribution of sulfur	Sulfur concentrated within one or two lithologies (i.e. MCS and FWZ)	5	
Chemical enrichment	Enrichments of contaminants that are unlikely to mobilise into groundwater	1	Assume SCARD Management

G. Mine Planning Hazard

	Select Relevant Option Below	Score	Option Details
PAF material management	PAF waste dumps will be out of pit	5	
Bulk NPR (Mass of neutralising material x mean ANC) / (Percent of lithology greater than 0.1% x tonnes of lithology x mean sulfur concentration for all data greater than 0.1 x 30.6 + repeat for each PAF lithologies)	>3	0	Based on assessment of in-pit drillhole data NPR = 8.44
PAF rock mass disturbed or exposed (waste tonnes with S>0.1%)/(total tonnes of waste)*100	< 3% of the total disturbed mass	0	PAF material makes up ~ 0.24% of total waste
Pit backfilling	Pit will not be backfilled	5	Conservative assumption.

H. Water Management Hazard

	Select Relevant Option Below	Score	Option Details
Dewatering volume	0 to 80 ML/day	1	
Surface water	Isolated pit	0	
Water treatment during Operation	No water treatment or special management for ARD needed	0	Unlikely water treatment will be required
Final void management	Less than 3% PAF exposed	2	0.21% exposure of Risk 2 and 3

Combined Hazard Assessment

Preliminary Assessment Score	52
Detailed Assessment Score	19
Combined Hazard Score	32
Risk Ranking	**MODERATE**

This risk ranking score card is relevant for Pilbara based iron ore operations and the ranking system can be used to assess the relative risk of each operation. The ranking system is likely to overestimate the risk if compared to porphry copper or some coal deposits.

For RTIO internal distribution only. The manager of Technical Projects and Development will need to review and approve this prior to external release.
This risk assessment should be read in conjunction with the detailed ARD Risk Assessment

Valid for 30 days after the assessment date

Appendix 17: Silvergrass East – Groundwater Management Closure Considerations

RioTinto

Silvergrass East

Groundwater management closure considerations

2022



Palm Springs (Mallu Mallu)

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1. Context

Impacts to groundwater levels from dewatering at Silvergrass East (SGE) are being observed down gradient along Caves Creek, where the ecosystem in some locations is highly dependent on groundwater baseflows.

In 2012, the following key points were outlined in the Nammuldi-Silvergrass Expansion Project Public Environmental Review (Strategen, 2012):

- A predicted continuous clay layer (aquitard) persists throughout the length of Narraminju (Caves Creek), creating a distinct hydraulic separation between shallow and deep aquifers,
- Targeted dewatering from the deep aquifer at Silvergrass East would not result in more than 2m drawdown over approximately 15km along Caves Creek where riparian vegetation persists (noting that natural fluctuations of up to 5m are observed),
- Drawdown will not affect Palm Springs due to the distance (28km) from the Expansion Proposal", given the presence of the clay aquitard mitigating downward leakage from the shallow aquifer. Palm Springs is fed by a calcrete aquifer that is disconnected from the orebody (deep) aquifer.
- There are no groundwater dependent ecosystems in the vicinity of Silvergrass.

Since 2016 when operations commenced and active dewatering began, the hydrogeological understanding of Narraminju and its GDE's has evolved. The clay aquitard that was thought to persist throughout Narraminju is now understood to be discontinuous and observed pressure gradients in some areas show an upward pressure gradient allowing groundwater to flow upward from depth to support the shallow aquifer, which in turn supports the persistence of several known GDE's in the area.

Currently, no dewatering impacts have been observed at Palm Springs (a particularly significant GDE known as "Mallu Mallu" to the Eastern Guruma, Robe River Kuruma and Puutu Kunti Kurrama traditional owners). With an approximately 1m vertical head difference from the deep to the shallow aquifer, Mallu Mallu is understood to be highly dependent on deeper groundwaters which feed it. Impacts to the shallow aquifer are however being observed at (Cockle Springs), a GDE some 16 km downstream from active dewatering operations at SGE (fig. Recent groundwater modelling suggests that drawdown will continue to propagate downstream and impact Palm Springs by the early 2030's unless this drawdown can be offset to return the aquifers water balance to baseline conditions.

This memo describes the current conceptual hydrogeological understanding and the mitigation actions that are being considered to ensure the health and abundance of GDE's along Narraminju, including Mallu Mallu, are protected from long term impacts as a result of dewatering SGE.

2. Hydrogeological Conceptualisation

Hydrogeological investigations in the Caves Creek catchment have been undertaken since 1998. Assessment of long-term monitoring data (extensive hydrochemical and isotope sampling, catchment groundwater levels, as well as groundwater level response to abstraction at SGE since 2016) have allowed for the development of a conceptual model that consists of the following (summarised from IGS 2021; also Figure 1):

- A shallow aquifer, comprised of alluvium, colluvium, calcrete / dolocrete and clay. Composition is variable, and of note, calcrete is extensive in outcrop to the west of the Homestead area.

- A deep aquifer, comprising karstic Wittenoom Formation, mineralised Marra Mamba Iron Formation (primarily the Mount Newman Member), and lower Tertiary detrital sediments.

- The deep aquifer is largely separated from the shallow aquifer by a low permeability Tertiary clay and is bounded at depth by the low permeability Mount Sylvia Formation / Mount McRae Shale, as well as unmineralised banded iron formation of the Marra Mamba Iron Formation.

- Aquifer compartmentalisation exists throughout the deep aquifer due to a number of observed and inferred intrusive dykes within the bedrock units only.

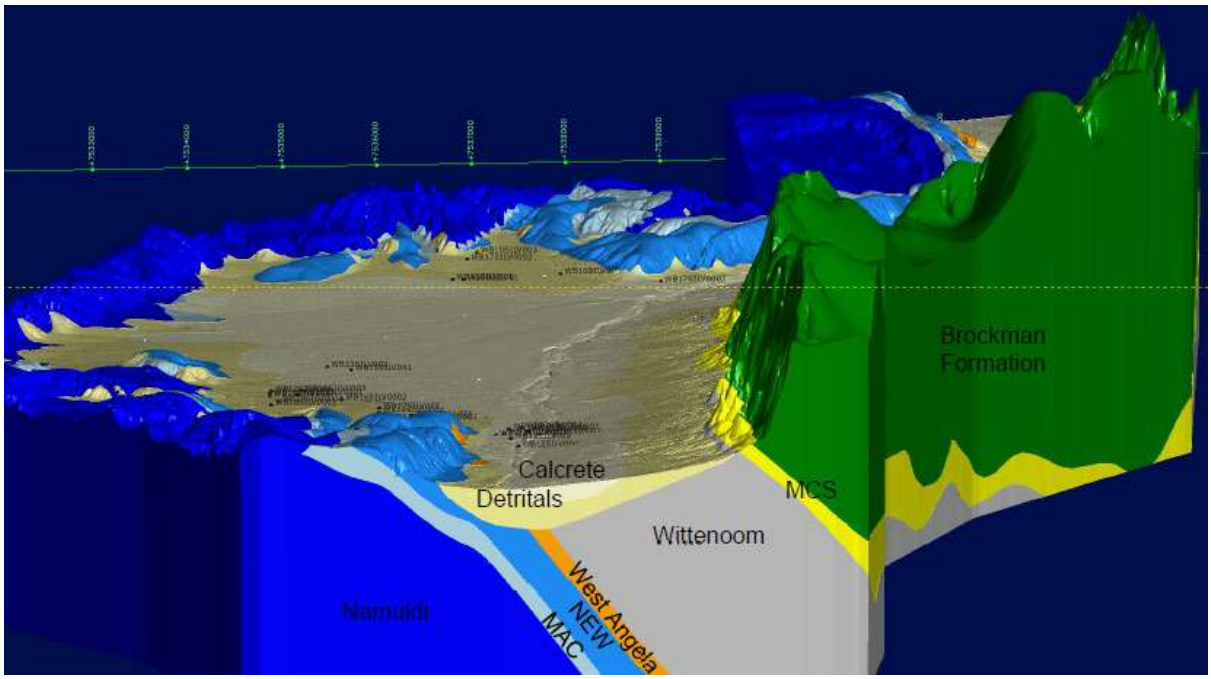


Figure 1 - Typical valley hydrostratigraphic cross-section near SGE

Pre-mining water levels flowed from east to west, and vertical hydraulic connectivity between the shallow and deep aquifers is variable, owing to a discontinuous low permeability Tertiary clay aquitard. In general:

- a downward gradient was observed at SGE prior to 2016, which increased with time,

- a slight upward gradient at Silvergrass West (SGW), with some reversal of trends from upward to downward since 2016,

- variable upward and downward gradients through the Homestead region, and

- an upward gradient adjacent (approx. 1m head difference) at Palm Springs (Mallu Mallu).

A hydrochemical analysis was reported by IGS (2021) which further supported the concept that mixing occurs between the shallow and deep aquifers (Figure 2).

Both aquifers show responses to rainfall events within the catchment, with greater responses observed in the shallow aquifer proximal to the Caves Creek channel, and a subdued response in the deep aquifer (Figure 3), further supporting evidence of the concept of vertical connectivity.

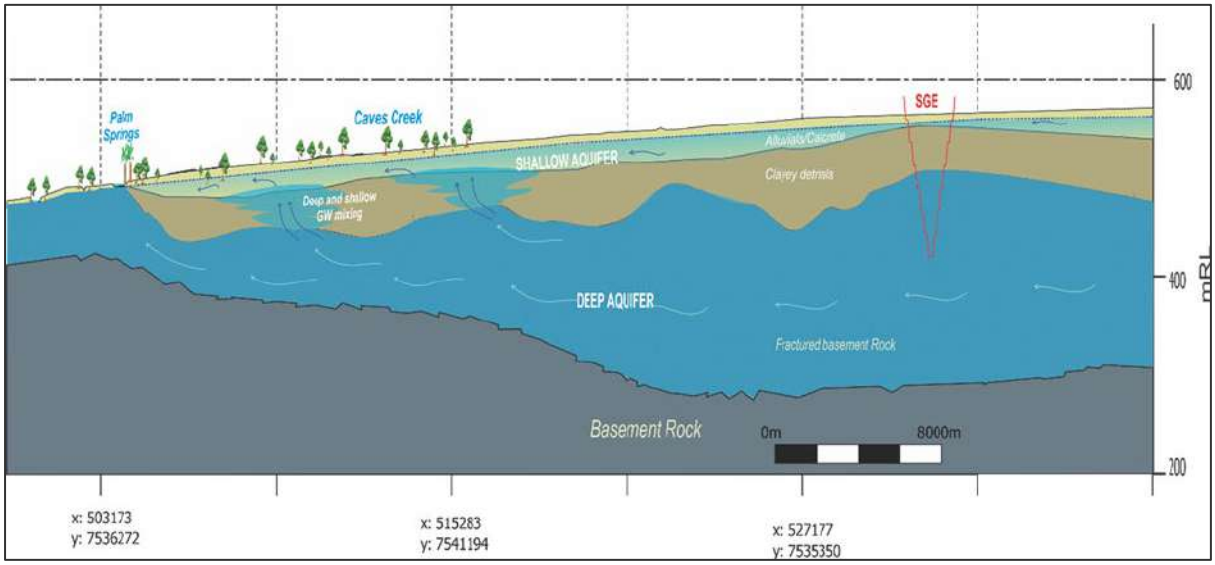


Figure 2 - Conceptual cross-section between Silvergrass to Palm Springs, showing upward flow from deep to shallow aquifers under pre-mining conditions, as well as horizontal flow from East to West.

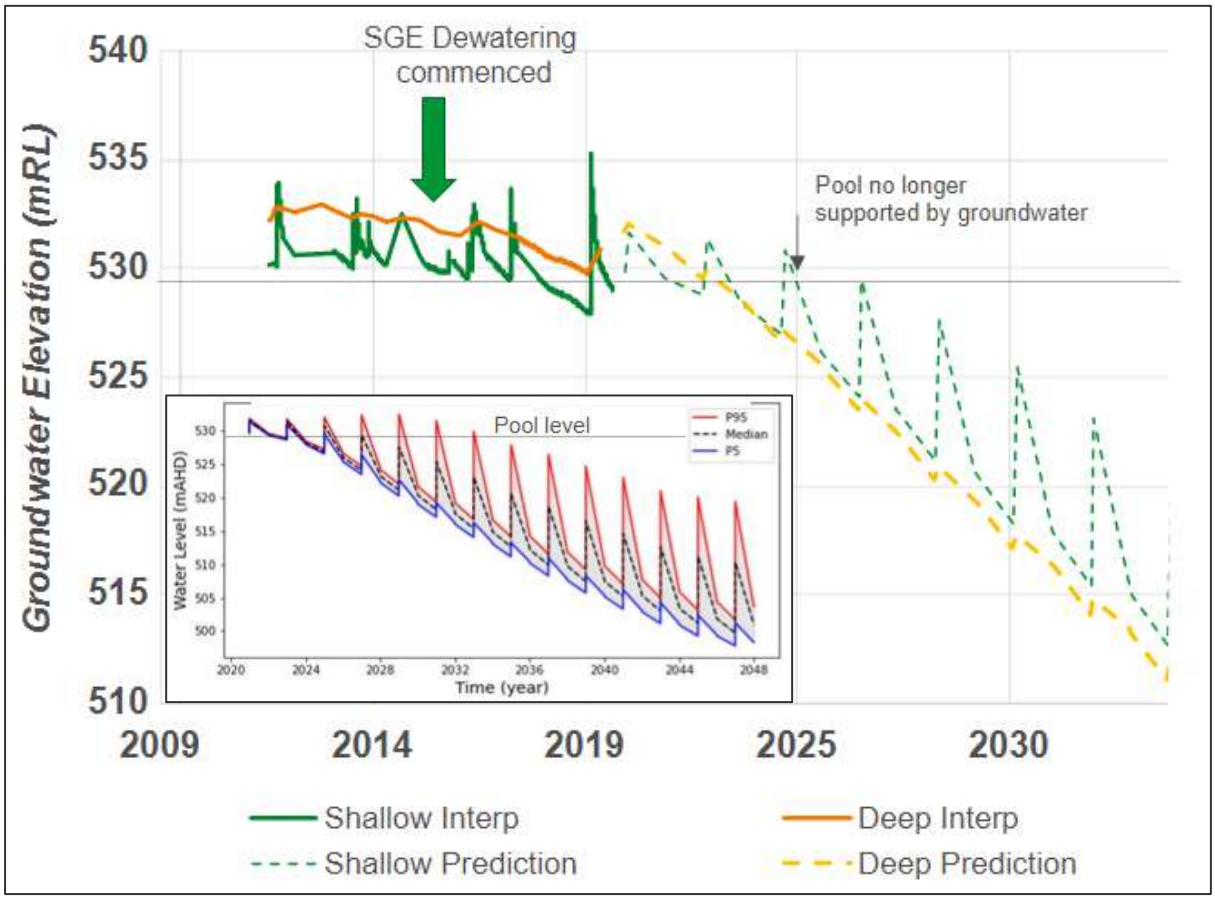


Figure 3 - Predicted impacts (unmitigated) to Cockle Spring. Short-term groundwater level variability due to recharge events. Graph inset shows long-range forecast with uncertainty percentiles.

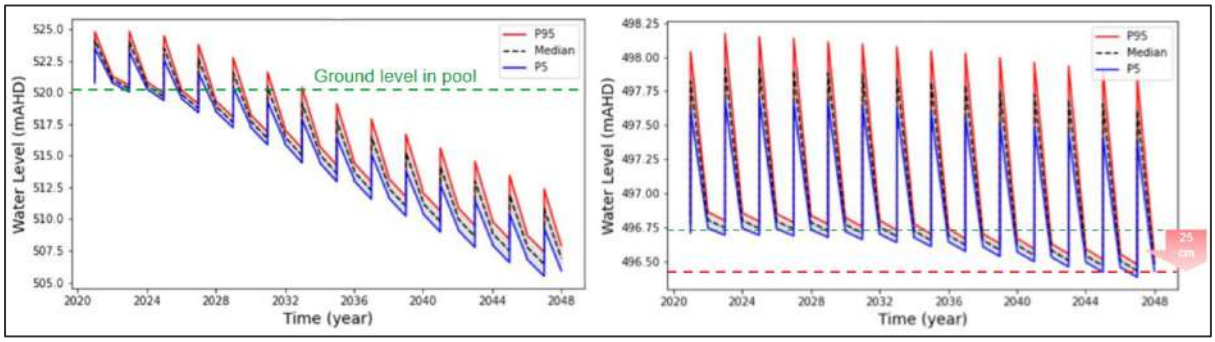


Figure 4 – Predicted water levels and uncertainty at Pancake Spring (left) and Palm Spring (right) with uncertainty percentiles

Since dewatering commenced in 2016, horizontal hydraulic gradients have reversed locally around SGE due to the lowering of water table, with local groundwater flows toward the dewatered pits. Currently, impacts from drawdown in the shallow aquifer is propagating westward with time (Figure 5), with the groundwater divide currently located approximately 8km west of SGE.

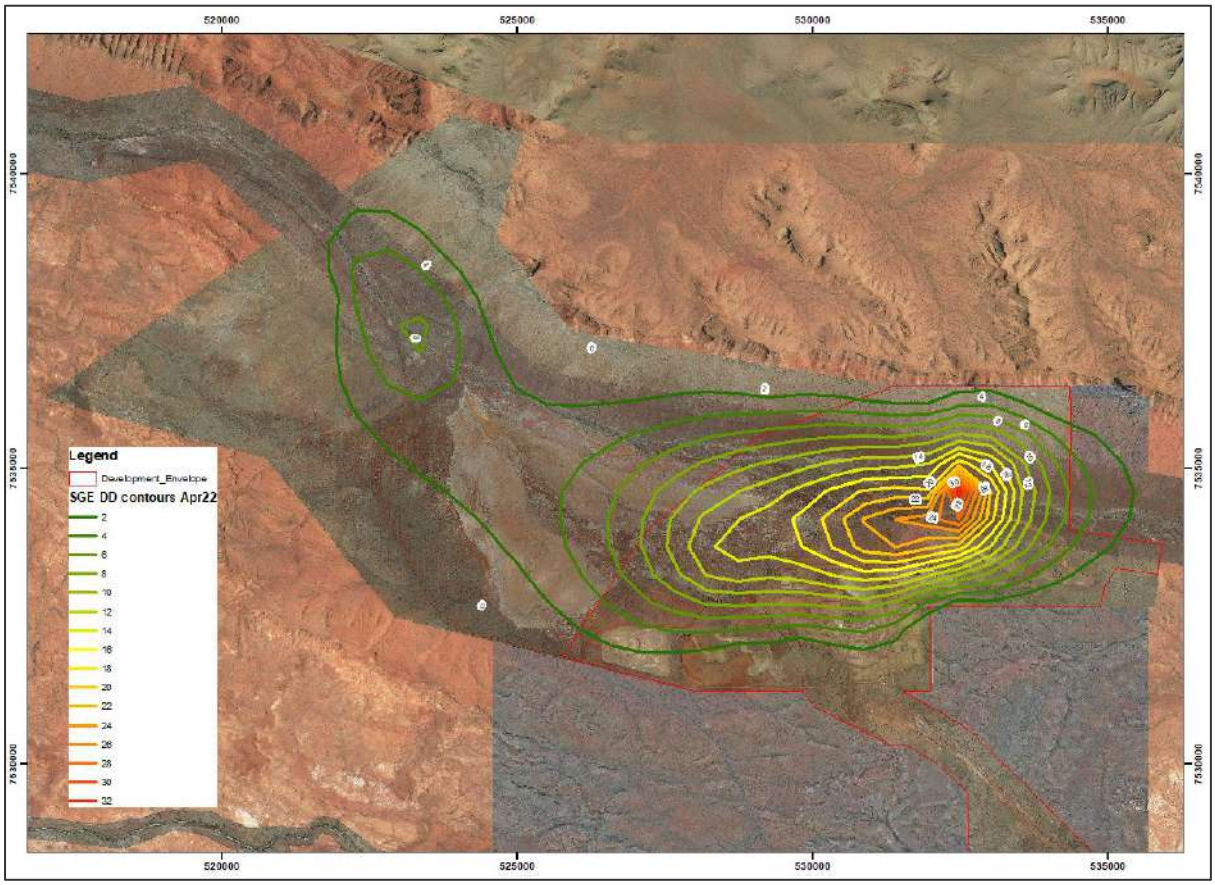


Figure 5 - Shallow aquifer drawdown observed at SGE since dewatering commenced in 2016

The mode of occurrence of the pool at Palm Springs is understood to be due to lateral groundwater flow through the deep aquifer being impeded by low permeability Marra Mamba Iron Formation, causing groundwater to express and discharge at surface (Figure 6). Structural controls may also contribute to pool development. It is likely that there are other sources (shallow aquifer discharge and surface runoff) that contribute to the pool water balance.

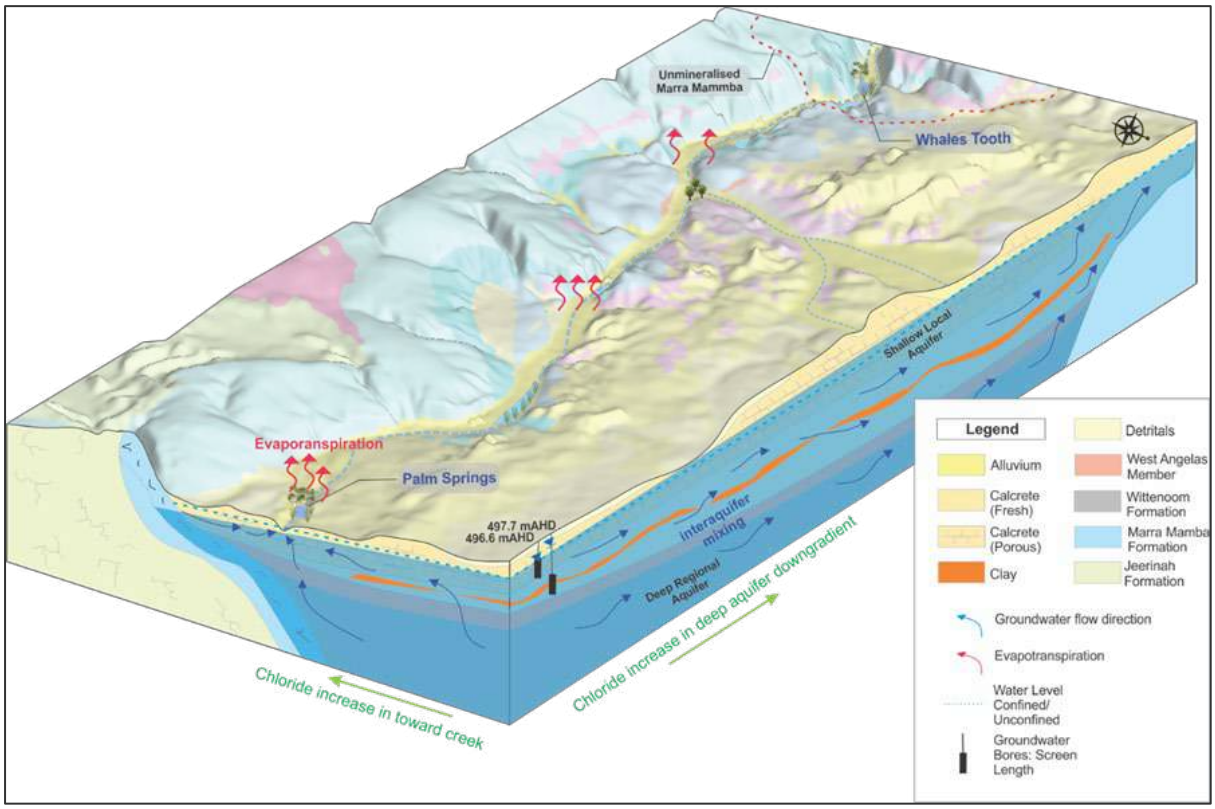


Figure 6 - Conceptual diagram of groundwater flow pathways and pool occurrences

3. Numerical Modelling

3.1 Objectives

In response to the observed impacts to the shallow aquifer near Cockle Springs, a numerical groundwater model was first developed in 2019, and later updated in 2021 to predict dewatering associated drawdown at Silvergrass East and along the aquifer underlying Caves Creek to Palm Springs in the West (Torkzaban, 2021). The modelling approach can be summarised as follows:

- Incorporate the simplified conceptual hydrogeological model of the Silvergrass and Homestead area, which comprise three hydrostratigraphic units, namely, a shallow and deep aquifer separated by a variable-thickness low permeable layer
- Calibrate the numerical model by matching model-generated heads with observed heads at the observation bores in the area to estimate the hydraulic parameters
- Employ the calibrated model to assess the influence of dewatering (required to meet 2021 LoM plan) on the shallow aquifer beneath the Caves creek
- Determine the total volume that will need to be replaced at closure to assure no impact to Palm Springs

3.2 Results

A summary of the main modelling results are as follows:

- An average recharge rate of around 10 ML/d through MAR is needed in the Homestead area from 2023 to 2050 in order to prevent current drawdown impacts propagating further down Narraminju and likely impacting Palm Springs

- To avoid impact to Palm Spring post-closure, an estimated 230GL is required to return groundwater levels in the mining area to the pre-mining baseline condition, which under natural conditions will take over 150 years to achieve

- To continue mitigating impacts on Palm Springs and Narraminju, and to reduce the natural recovery timeframe, MAR will be required to continue into closure.

4. Groundwater Management Options

From a closure perspective, RTIO is in the early phases of exploring several initiatives aimed at improving alignment to the Water Management Strategy (WMS) hierarchy of use (Figure 7). These include:

- Integrating the B2NS conveyance network with nearby Brockman 4 (B4) - collectively referred to as GBO. This concept will allow the conveyance of water from areas of surplus to areas of deficit, providing a more agile network that can buffer temporal needs more effectively (Figure 8)

- Investigating the potential to use disused pits for in-pit water storage, either backfilled or left open. Across B2NS there are some pits that have been identified as potentially suitable in the latter half of 2020's that would allow storage during periods of surplus that can be used during deficit.

- Backfilling of some below water table pits to reduce evaporative losses as water levels recover

- Conducting a Managed Aquifer Recharge (MAR) trial, using a number of various injection and infiltration bore designs to demonstrate the ability to successfully mitigate groundwater drawdown impacts from occurring in the Caves Creek aquifer system

- Direct aquifer storage and recovery (ASR), a technique conceptually similar to MAR for the purpose of temporary storage and later recovery, as opposed to managing aquifer levels for typically environmental purposes.

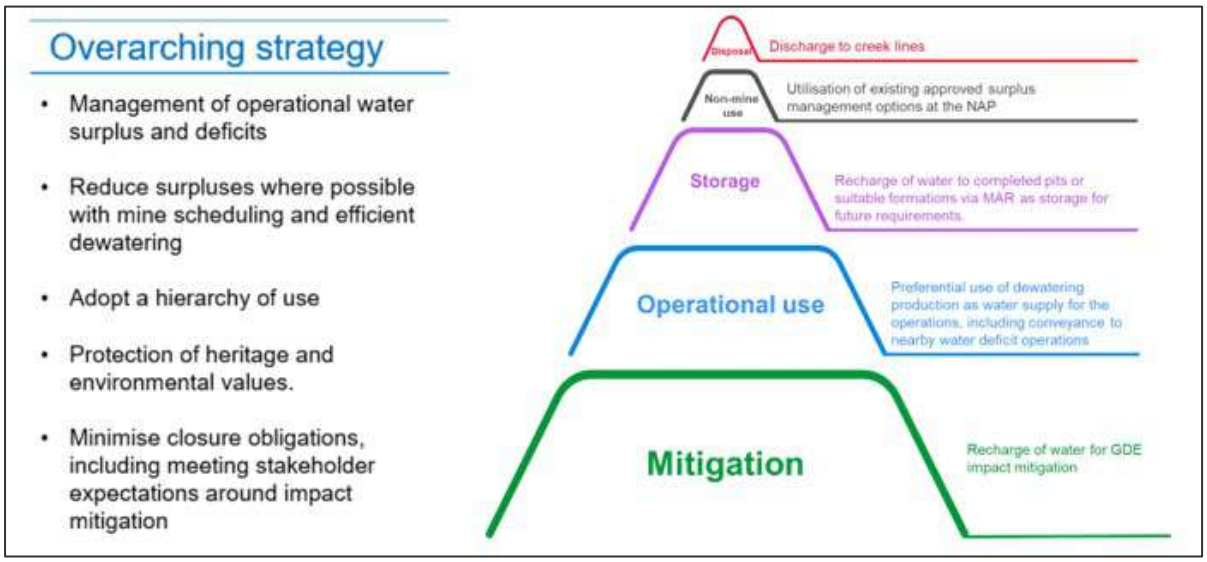


Figure 7 - WMS surplus water Heirarchy of Use. Source – GBO LoM Water Management Strategy, 2022.

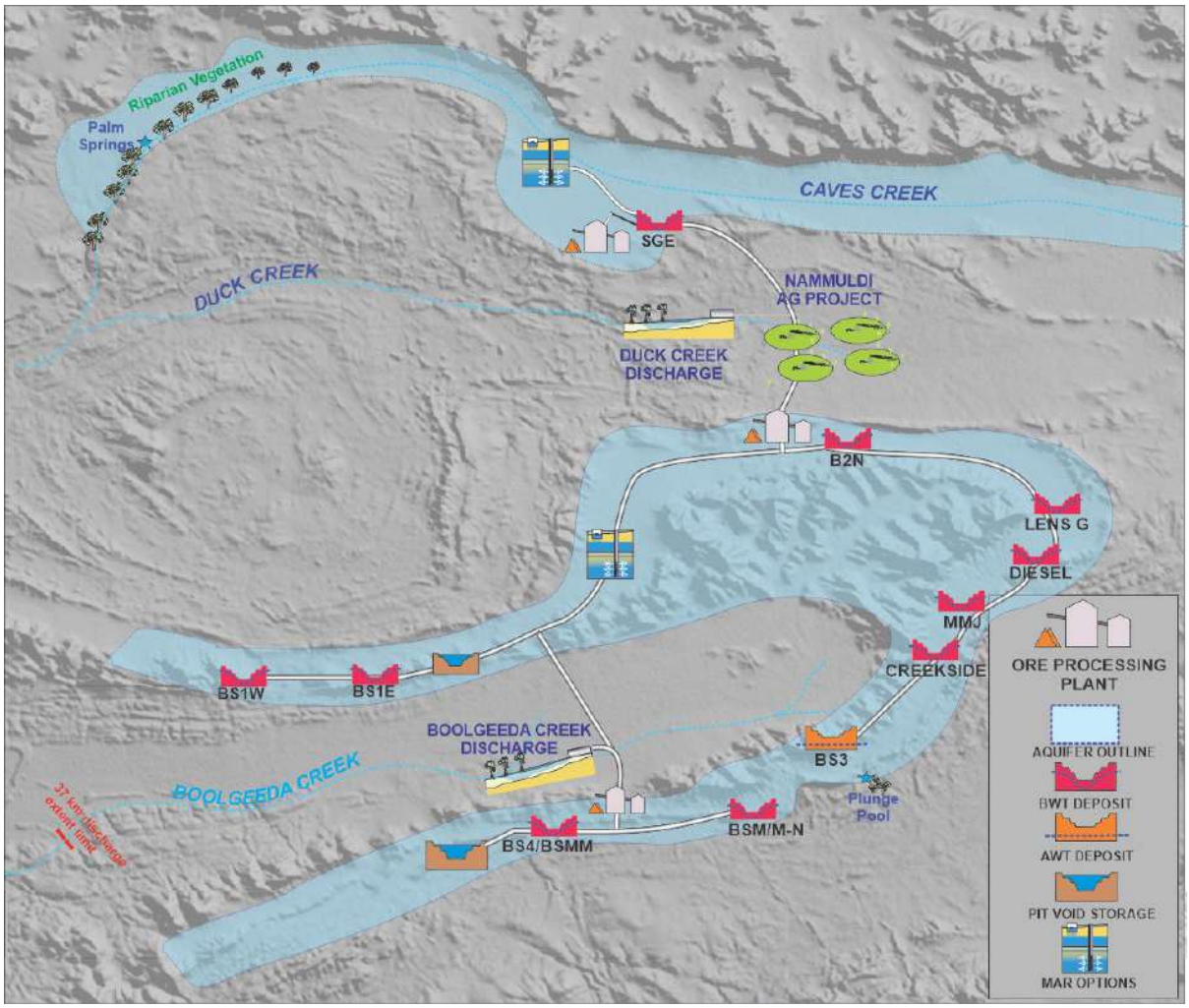


Figure 8 - Integrated water conveyance network across the Brockman Syncline. Source – GBO Water Management Strategy (2022)

Since the impacts to Caves Creek became apparent through both observed water level data and modelling predictions, RTIO is currently developing a MAR trial about 8km West of SGE (Figure 9) which is aimed proving the viability of MAR in mitigating drawdown impacting Palm Springs. Should this trial demonstrate a successful mitigation option, an expansion may be built to achieve the required 200L/s recharge rate needed to offset the impacts of drawdown during the operational phase.

Prior to the closure of SGE, RTIO will identify an appropriate water source to supply water to Caves Creek in the closure phase. Appropriate approvals for this water source will be sought.

Water quality analyses across the Brockman Syncline shows a very similar hydrochemical composition between aquifers within the Brockman Syncline and Caves Creek (Figure 10), and as such there are not expected to be any issues with mixing of water types. Water quality sampling results from monitoring undertaken along Caves Creek at Silvergrass and Homestead monitoring bore and production bore locations between 2009-2022 are presented in Table 4-1.

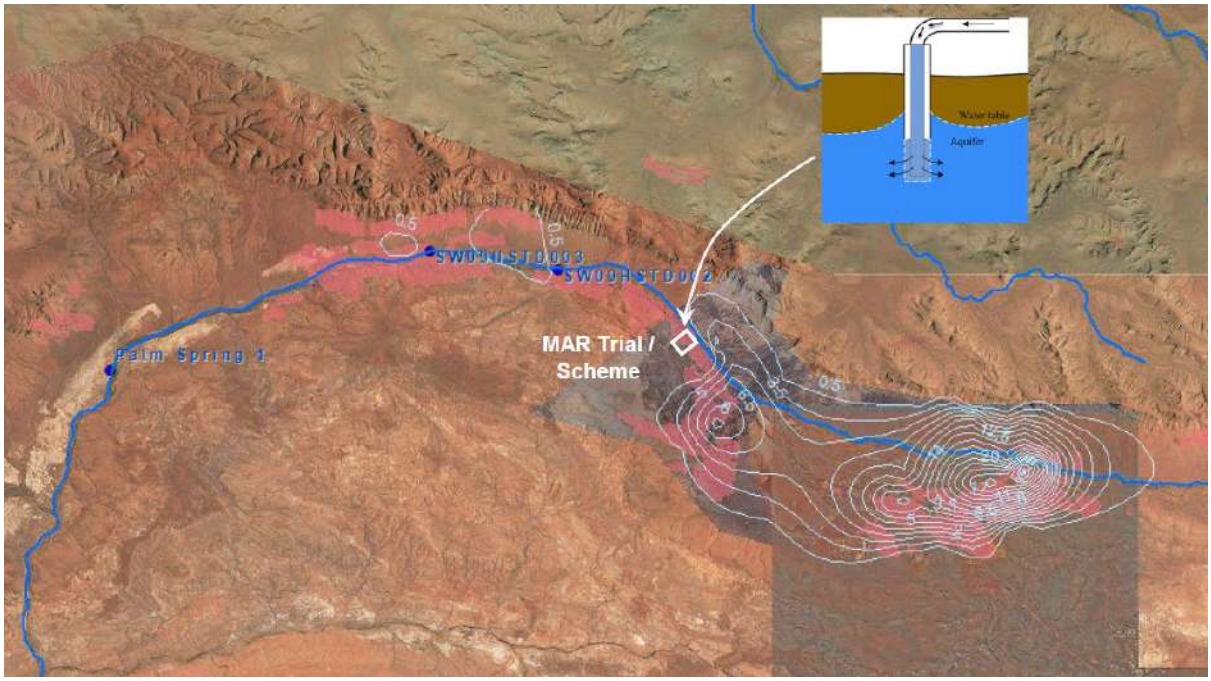


Figure 9 - 2022 Managed Aquifer Recharge (MAR) trial location. Contours show groundwater level change since Jan 2016, propagating toward Mallu Mallu (Palm Springs).

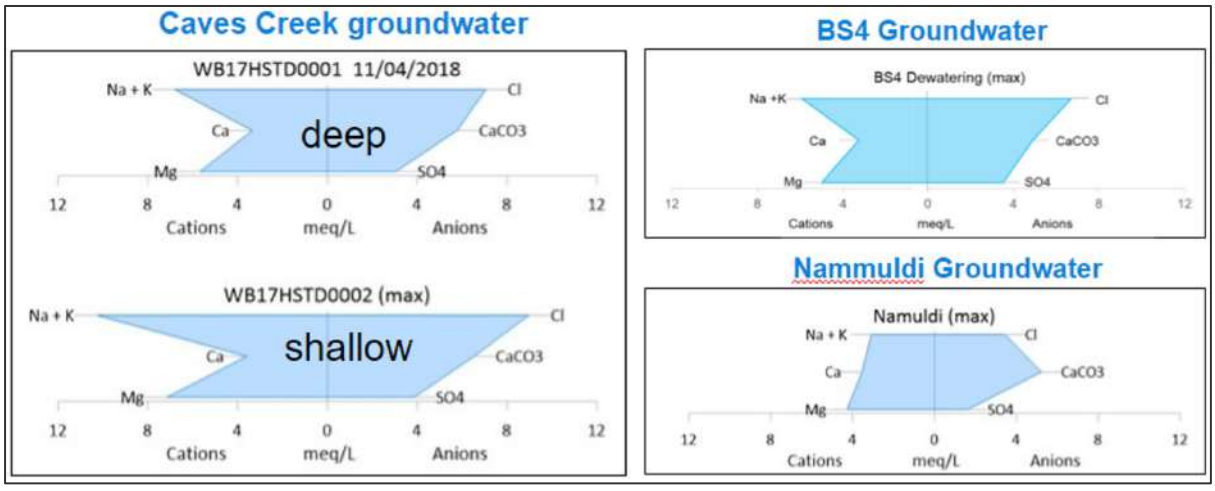


Figure 10 - Stiff-diagrams showing groundwater chemistry similarities between Brockman Syncline and Caves Creek aquifers

Table 4-1:Summary of physical chemistry and major ion concentrations of the Caves Creek aquifers (2009-2022)

Groundwater sampling Caves Creek											
Pumping water bores											
Statistic	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Fe mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	pH	EC uS/cm	TDS mg/L
Mean	124	8	59	53	0.2	351	100	176	8.1	1,212	771
Minimum	66.0	4.8	6.3	27.0	0.0	140	2	93.0	7.3	640	390
Maximum	160.0	13.0	79.0	65.5	5.1	470	138	236.0	9.3	1,490	8,000
Monitoring bores											
Statistic	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Fe mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	pH	EC uS/cm	TDS mg/L
Mean	152	13	65	69	0.08	426	131	238	7.7	1390	846
Minimum	56	5	3	17	0.002	190	29	96	6.5	579	361
Maximum	480	23	160	150	2.7	750	459	610	9.1	3300	5,070

5. Closure Groundwater Management Risks

The common risk shared by each of the above options is that water sourced from multiple locations across GBO will in concept be blended together to form a composite quality. As Figure 9 shows, the water quality is very similar in composition across the Brockman Syncline and Caves Creek groundwater catchments. There are however other risks specific to the management options being considered during the closure phase.

5.1 Managed Aquifer Recharge (MAR) / Aquifer Storage and Recovery (ASR)

Both MAR and ASR are effectively the same process of artificially increasing recharge rates by either direct injection or infiltration, to the aquifer matrix. MAR is the term applied to scenarios where the objective is typically to replenish an over-abstracted aquifer, in order to satisfy the groundwater dependency of various ecosystems. ASR however is used when the objective is primarily to store or “bank” water in the geological matrix, for the primary purpose of abstraction for later use.

The key risk for either option being carried out is the potential for clogging to occur in the bore casing or aquifer itself. These typically occur due to the precipitation of minerals from solution in water when highly saturated in elements such as iron and carbonates. Various designs will be investigated during the trial to ensure the clogging potential is minimised, however, there are a number of techniques that can be employed to remediate these bores if clogging were to occur (such as mechanical scrubbing, flushing, jetting and chemical dosing with sodium hypochlorite or citric acid). Ensuring that the source water is of a similar chemical composition, has a low turbidity and minimal aeration will reduce the likelihood of these risks occurring.

Excessive groundwater mounding is also a risk that will be mitigated through effective monitoring and operational controls to ensure surrounding water levels do not adversely impact the health of surrounding ecosystems.

5.2 In-Pit Storage

Both open or backfilled pits are options that carry some risks that will need to be considered in assessing site suitability, for example:

- Hydrochemical evolution of pit lake water due to evapoconcentration (which can be mitigated by backfilling to prevent an exposed water body) and acidification particularly where PAF minerals are present and in contact with water
- Migration of pit lake water into the surrounding groundwater system where the pit lake level is mounded above surrounding groundwater levels, leading to changes to the quality of the receiving groundwater system
- Geotechnical stability issues from both erosion due to fluctuating water levels and increased pore pressures
- Potential for recirculation to areas of active dewatering where hydraulic connectivity exists

5.3 Integrated GBO water conveyance network

The interconnection of the B2NS and B4 conveyance system may carry the following risks that will need to be considered:

- Inadequate approvals or access to the network for ongoing maintenance
- Damage from operating outside the operational design limits leading to pipeline failures
- Damage from fires or impacts from mobile assets
- Insufficient maintenance on valves or other fittings leading to leaks and/or failures
- Impact to end users who may be sensitive to changes in water quality, pressure or volumes being supplied
- Inadequate water metering leading to water balance errors
- Incompatible with cultural value of water

6. Closure Monitoring Requirements

RTIO will submit to its regulator a Groundwater Operating Strategy (GWOS) to detail the proposed monitoring requirements to ensure sufficient oversight and transparency is provided and ensure adverse impacts are adequately managed in the closure phase. This may include setting a series of operational triggers at specific receptors where sensitivities to groundwater fluctuations are known, and regular reporting of operating data to relevant regulatory bodies.

7. Summary

Currently, RTIO is developing a MAR trial as the first in a series of water management options being investigated to ensure its closure impacts can be managed effectively. RTIO will continue to:

- Complete the MAR trial in order to refine the scale and efficacy of the MAR schemes needed to reduce its current closure liability, and return the groundwater system at Caves Creek to pre-mining conditions,
- Investigate the feasibility of both in-pit storage and ASR schemes in the region
- Carry forward an adaptive management process of continued groundwater monitoring and model validations to ensure the quantity and timing of closure needs are well understood,
- Investigate and adopt any emerging technologies as appropriate to help meet the closure objectives.

8. References

IGS 2020, Innovative Groundwater Solutions (IGS) (2020). Hydrogeological Conceptualisation of the Caves Creek Catchment. 18 January 2021.

RTIOa, 2022 , Greater Brockman Life of Mine Water management strategy 2022 https://riotinto.sharepoint.com/sites/GTPGPOTests/Shared%20Documents/General/Groundwater%20Modelling/Model%20Reports/B2NS/Caves_Creek_%20Aquifer%20modelling%20memo_2022.docx?web=1

RTIOb, 2022, Caves Creek Groundwater modelling investigation of dewatering impacts and MAR mitigation (https://riotinto.sharepoint.com/sites/GTPGPOTests/Shared%20Documents/General/Groundwater%20Modelling/Model%20Reports/B2NS/Caves_Creek_%20Aquifer%20modelling%20memo_2022.docx?web=1)


RioTinto

Appendix 18: Brockman Syncline Pit Lake Modelling. Addendum to the *Brockman Syncline Regional Groundwater Model – Cumulative Impact Assessment*

MEMO

Date: 1 February 2022
To: Paul Hedley
From: Cassie Turvey
Pages: 4 inc. this page, plus attachment
Regarding: EWP19192.003 Brockman Syncline Pit Lake Modelling

Brockman Syncline Pit Lake Modelling

1 INTRODUCTION

Groundwater modelling to assess the cumulative impact of proposed mining within the Brockman Syncline has been undertaken by RPS. Part of this modelling included prediction of the water level recovery post mining. Two closure options are possible, one being to leave mine voids open, whereby groundwater recovery has the potential to rise above the pit floor and form a pit lake; and the other involving partial backfilling of the pits with spoil. Modelling of the predicted water level rise within backfilled voids was reported in RPS 2021 (to which this memorandum forms an addendum). Long term recovered water levels predicted by the groundwater model at 300 years post mining are shown in Figure 1. However, for pit voids, the model is only able to predict groundwater inflow rates and an additional water balance assessment is required to determine an equilibrium lake level that takes into account the other expected water inflows and outflows at the lakes. This water balance information and a simplified evapoconcentration for lake water quality evolution is presented herein.

2 METHOD

2.1 Pit Lake Water Balance

A simple analytical method has been used to calculate the post-closure pit lake water balance for the pits proposed to be mined below water table. The water balance follows the general law of conservation of mass whereby:

$$\sum \text{Inflows} - \sum \text{Outflows} = \Delta \text{Storage}$$

Inflows include direct precipitation onto the lake surface, runoff from pit walls above the pit lake surface and groundwater inflow from the regional groundwater aquifers. No seepage from a TSF or other water source is included as a potential input volume, nor surface water inflow from any catchment area outside of the closure bunding (which is planned to fully encircle the pit rims), nor any interflow from groundwater that may occur after large rainfall events through shallow alluvial sediments. The only outflow considered is the evaporation from the lake surface, assuming that the pit lakes remain as a groundwater sink (i.e. groundwater gradient is towards the pit).

The stage/volume/area relationship was used to determine the lake stage and surface area in each pit, using a daily timestep to calculate the change in lake volume after accounting for inflows and outflows at that timestep. Daily rainfall and evaporation values were obtained from SILO data for a central location at the Brockman Syncline over the period 1960 to 2019, with the sequence repeated to fill a time series for 300 years. Direct rainfall and evaporation to/from the lake are a function of the lake surface area at a given

timestep, increasing as the lake area increases; while the rate of groundwater inflow and volume of pit wall runoff are a function of the lake stage, both decreasing as the lake stage increases.

Pit wall runoff is estimated to be 30% of the net rainfall (i.e. daily rainfall minus daily evaporation) that falls on exposed pit wall area. This is likely to be conservative in the initial stages of pit lake development after mine closure as runoff is often trapped on individual benches with the majority unlikely to make it to the pit lake prior to evaporating or infiltrating, except during major rain events. Pit wall runoff of 30% is considered to be a more reasonable approximation at later times due to a combination of wall erosion and increased lake levels reducing the potential for stranded water storage on individual benches.

An evaporation co-efficient of 0.7 times pan evaporation was used, being the median of typically used coefficients to convert pan evaporation to lake evaporation of between 0.65 to 0.75.

Groundwater inflow is equal to that predicted in recovery modelling for the relevant stage of the lake (Appendix D of modelling report). The rate of inflow calculated in the groundwater model is commensurate to the interaction between the cone of depression resulting from dewatering at the various pit voids, therefore the inflow rate may change if the mine plan is significantly altered from that which was modelled.

It is important to note that this modelling is preliminary in nature and considers the lake formed within each final pit void as being a single connected feature. It is likely that in reality discrete lakes will form at separate areas of the pit floor, particularly within the larger pits where there are multiple pockets of deep excavation, and these individual lakes may behave differently in terms of water level and chemical evolution due to local variations in surface area for evaporation and runoff capture.

2.2 Evapoconcentration

As the only outflow from the lake is evaporation (of fresh water), the change in TDS over time can be simply calculated as the sum of incoming TDS at each time step from the relative inputs added to the total from the previous time step, dived by the lake volume. This is a simplistic scenario that assumes uniform lake mixing, no precipitation of solids and no reaction with pit wall minerals, but is considered sufficient to provide a high level overview of the rate of evapoconcentration. Inflowing groundwater was assumed to have a TDS of 600 mg/L (average of data presented in Nammuldi and Brockman Syncline 4 Triennial Aquifer Reviews), rainfall TDS 30mg/L and pit wall runoff 100mg/L.

2.3 Climate variability

The pit lake level and evapoconcentration was predicted using a sequence of historical climate from 1960 to 2019. To test for uncertainty in future climate, two additional climate scenarios were used, being a “wetter” climate (10% increase in rainfall, 10% decrease in evaporation), and a “drier” climate (10% decrease in rainfall, 10% increase in evaporation).

3 RESULTS

Based on a combination of the groundwater modelling and the analytical water balance method, permanent pit lakes are predicted to form in 7 of the 11 below water table pits currently proposed to remain as open voids. Pits currently proposed to remain as open voids within the Nammuldi hub include Lens B, Lens CD, Lens EF and Lens G. Lens A is proposed to be a capped in-pit TSF. The groundwater level is not predicted to recover to the base of Lens B due to drawdown from other pits in the Nammuldi area. Within the BS4 hub pits of the BSMM and BSMN deposit will remain as voids. Of these, groundwater levels at pits BSMM O2, O3 and Q are not expected to recover to the base level of the lake due to drawdown from deeper pits. Rainfall may pond for a short duration at the base of these pits and ultimately infiltrate into the unsaturated zone below the pit or evaporate. It is unlikely that any long-term connection will form with groundwater at these pits. However, if this does occur the water quality is expected to be fresher than groundwater (excluding interaction with any potentially reactive pit wall minerals).

MEMO

Date: 1 February 2022
Regarding: EWP19192.003 Brockman Syncline Pit Lake Modelling

Equilibrium lake levels and long-term TDS values predicted for the pits are presented in Table 1. Graphs showing the predicted evolution of lake stage and TDS since the time of closure for these pits are presented in Attachment A.

Table 1: Pit lake evolution for below water table pits where groundwater recovers above pit floor.

Pit	Equilibrium Level (mAHD)	Min Level (mAHD)	Max Level (mAHD)	TDS at 300 years post closure	Min TDS at 300 years post closure	Max TDS at 300 years post closure
BS4 Hub						
BS4MM - O1	428	427	429	16,940	9,861	25,446
BS4MN- M2	484	484	485	59,765	40,952	75,884
BS4MN- N1	482	482	482	82,112	58,719	122,616
BS4MN- N2	481	480	482	29,903	22,260	34,969
Nammuldi						
Lens CD	442	437	449	7,461	5,566	9,485
Lens EF	492	489	495	11,062	8,447	13,807
Lens G	503	497	510	24,279	12,605	63,982

If clarification or additional information is required, please do not hesitate to contact the undersigned.

Cassie Turvey
Senior Groundwater Modeller
cassie.turvey@rpsgroup.com.au

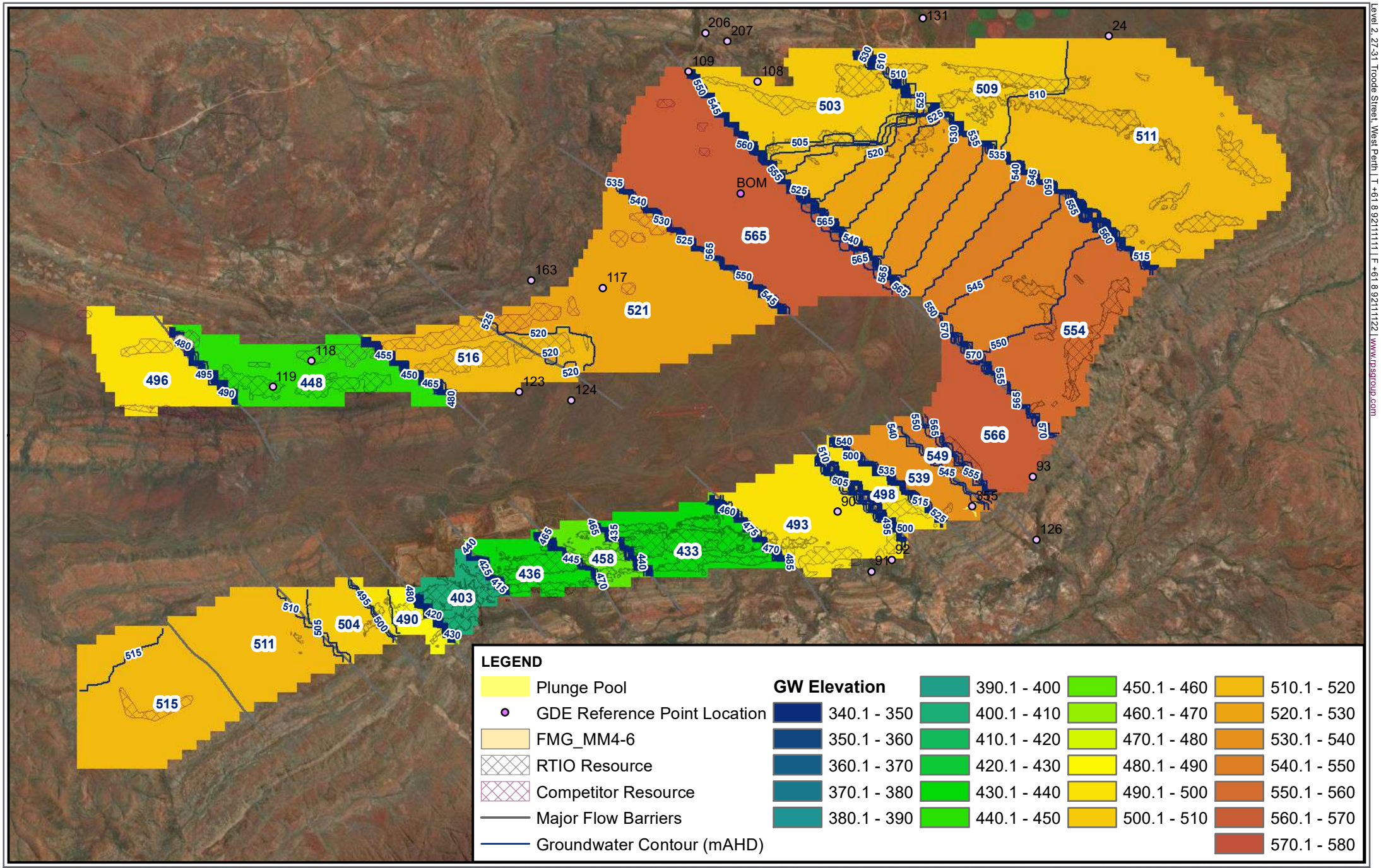


Figure 1

Predicted Regional Groundwater Elevation at 2350

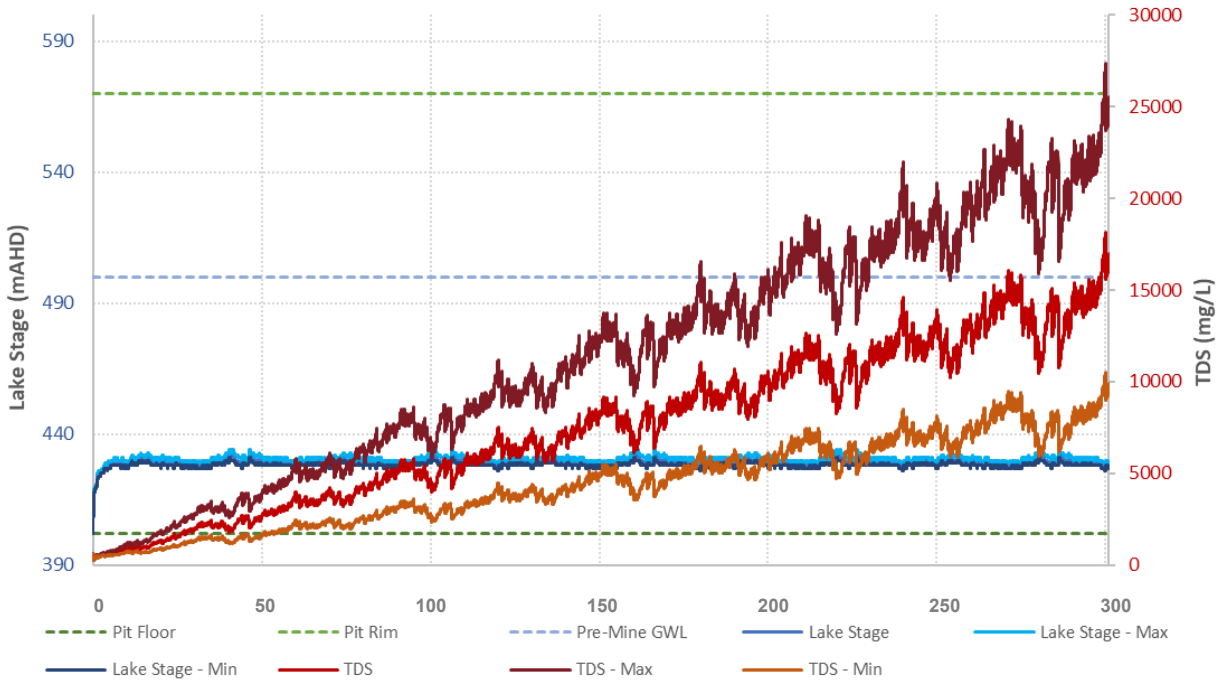
GDA 1994 MGA Zone 50

0 2,000 4,000 8,000 m

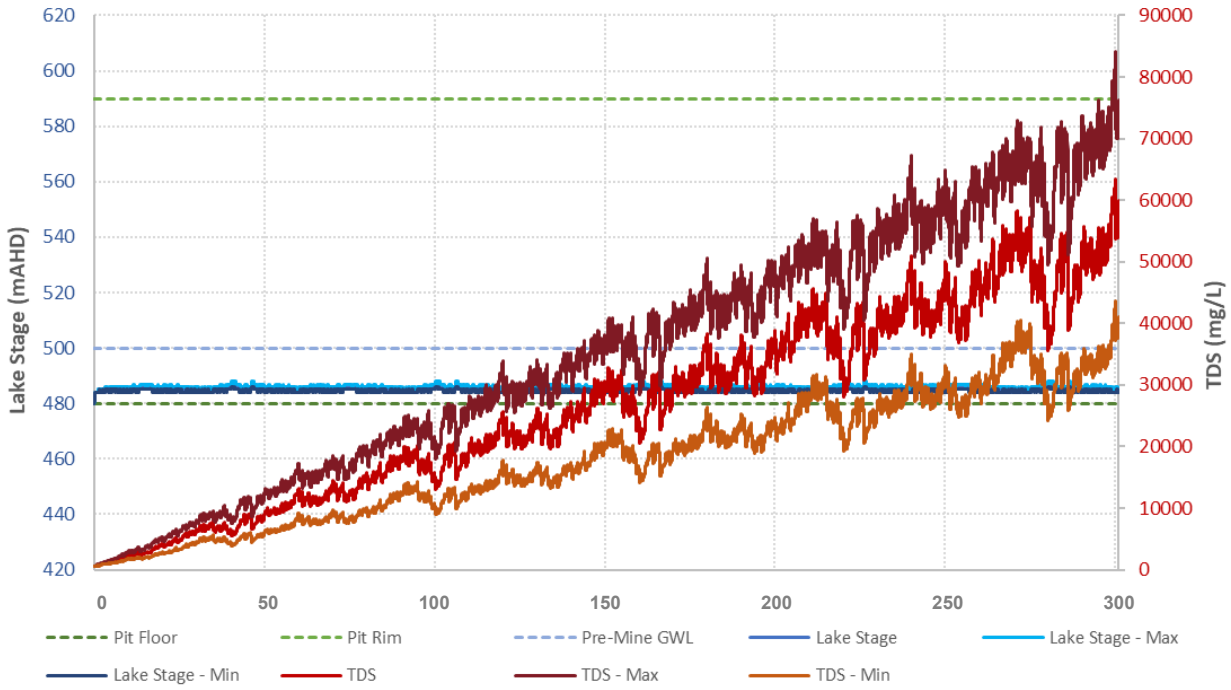
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Doc Number: 001
Date: 01.02.22
Scale: 1:200,000 @ A4
Created by: CT

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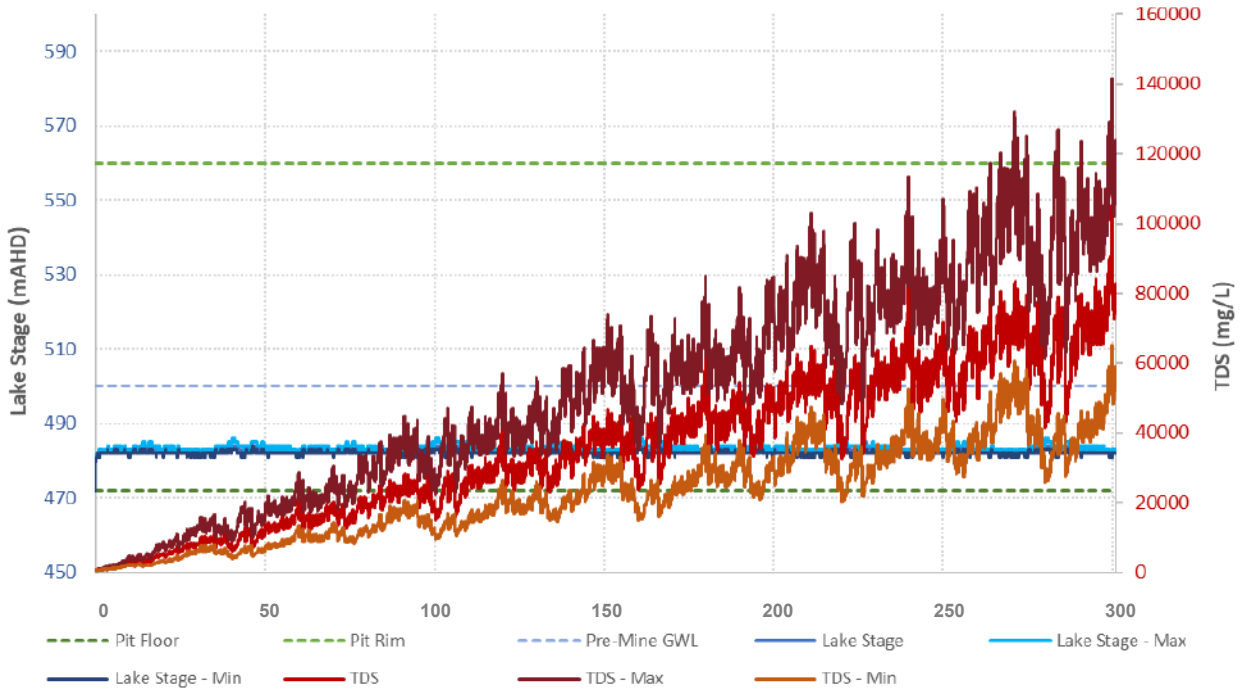
Attachment A: PIT LAKE HYDROGRAPHS



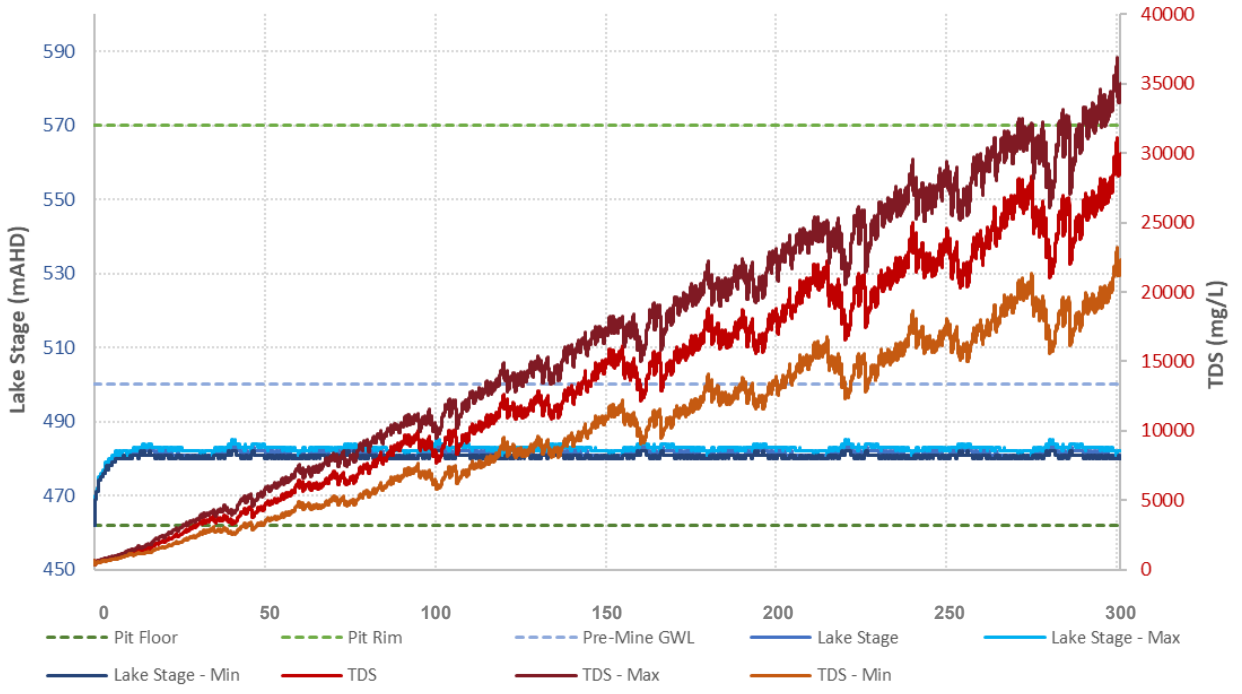
BS4MM O1 Lake stage and TDS evolution



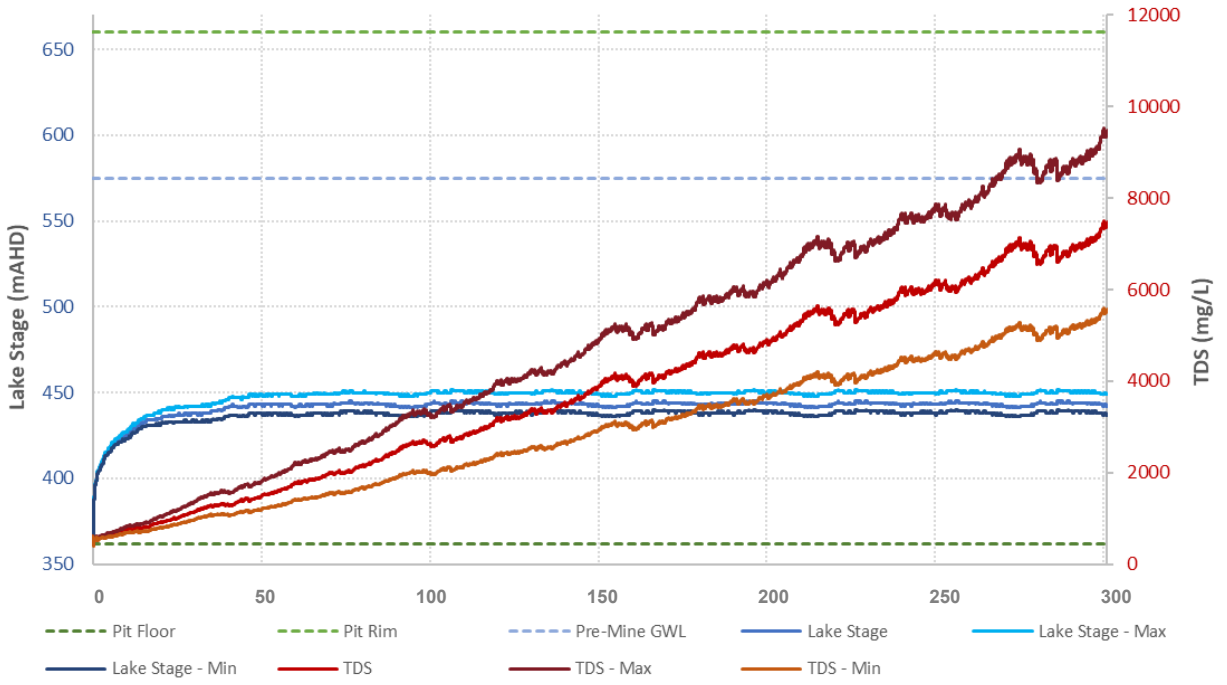
BS4MN M2 Lake stage and TDS evolution



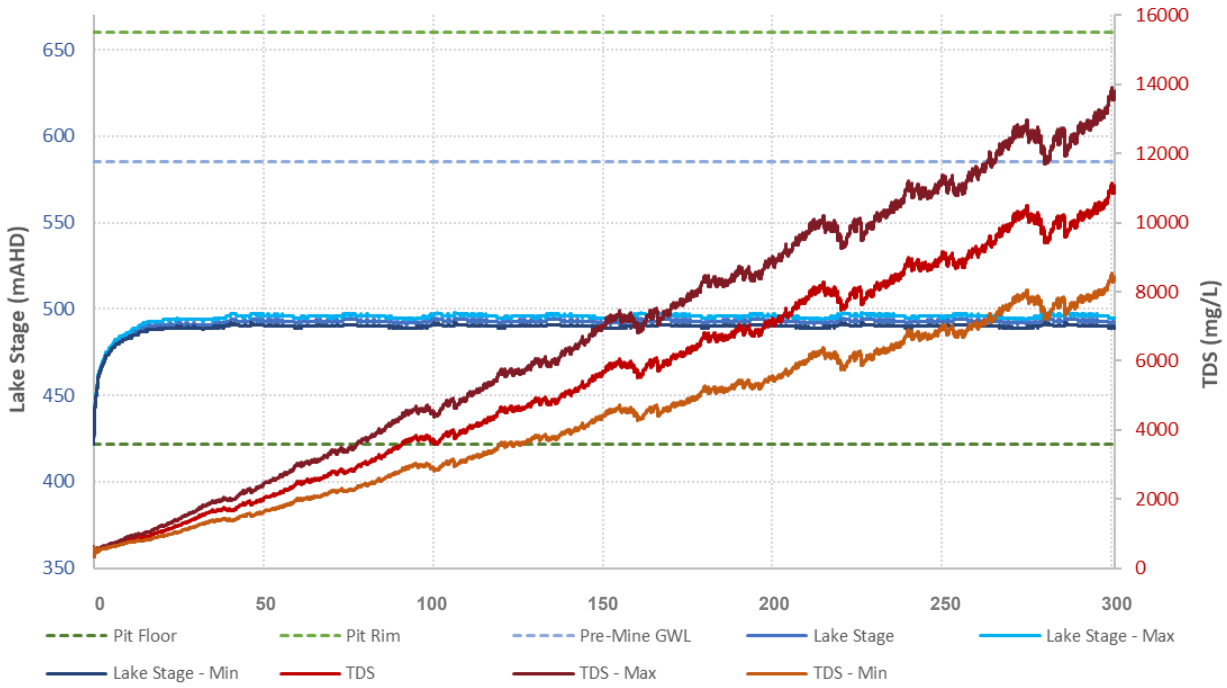
BS4MN N1 Lake stage and TDS evolution



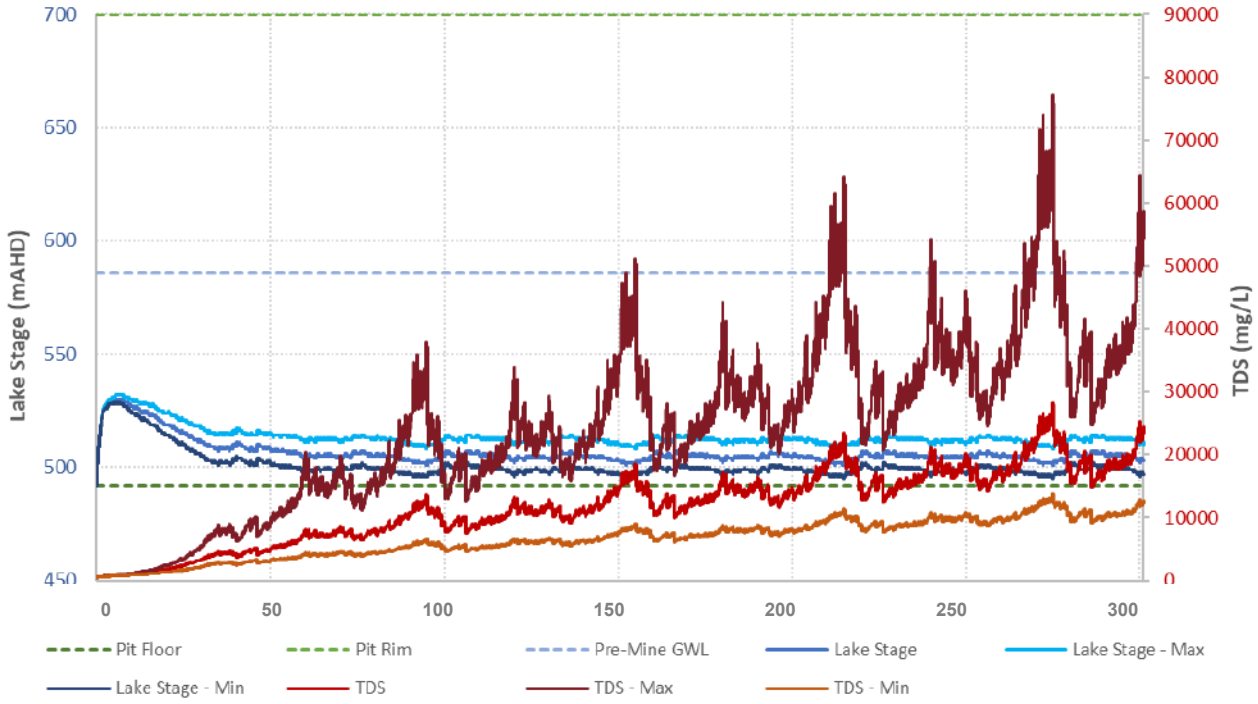
BS4MN N2 Lake stage and TDS evolution



Lens CD Lake stage and TDS evolution



Lens EF Lake stage and TDS evolution



Lens G Lake stage and TDS evolution

Appendix 19: Nammuldi Lens CD Preliminary Pit Lake Assessment

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Internal memo

From: Sam McHarg

Department: WRE – Mineral Waste

To: Steven Lee

CC: Hamish Penno, Tammy Savage

Reference: RTIO-PDE-0187892

Date: January 2022

Nammuldi Lens CD Preliminary Pit Lake Assessment

1 Introduction

Following a review of the acid and metalliferous drainage (AMD) risk for the Nammuldi Lens CD deposit (RTIO, 2021) and ongoing work regarding groundwater recovery levels post mining operations, it is likely that a pit lake will form within the Lens CD pit once mining activities have ceased.

Due to the presence of elevated sulfur concentrations within rock formations (lignite) that will be present in the final pit walls, there is the possibility that water quality of the pit lake will be impacted by AMD. This Preliminary Pit Lake Assessment aims to review the existing data for Lens CD with an aim of providing a preliminary assessment of the risks of impacting pit lake water quality.

2 Background

A full AMD Risk Assessment was undertaken by Rio Tinto in 2010 and updated in 2021. Details of the mine models and pit shells used in the 2010 and 2021 reporting are presented in Table 1 and Figure 1. The 2010 Assessment and 2021 Review identified the overall AMD risk of mining Lens C as Moderate.

Table 1 – Comparison of mine models and pit shells

Date of Assessment	Mine Model	Pit Shells
2010	namiprd_lcd_20100704_001	lensb_bwt_09pfs2_c.00t bc_2023.00t
2021	nbamipr_lcd_20200914_017	lcdbwt_us1003.00t

3 Potentially Acid Forming Formations

Utilising the block model nbamipr_lcd_20200914_017, it was calculated that approximately 9,700 m^2 of Sulfide Risk 2 (SR2) and 20,100 m^2 of Sulfide Risk 3 (SR3) (lignite) material will be exposed in the final pit geometry (Table 2).

Table 2 –Sulfide Risk areas of Lens CD

Pit	Total pit surface area (m^2)	Base of pit RL (m)	Sulfide Risk 2			Sulfide Risk 3		
			SR2 area (m^2)	SR2 % of pit	RL of exposure	SR3 area (m^2)	SR3 % of pit	RL of exposure
Lens CD	2.9 M	360	9,700	0.33 %	485 - 530	20,100	0.69 %	481 - 527

4 Modelled In-Pit Post Closure Water levels

Groundwater modelling to assess the cumulative impact of proposed mining within the Brockman Syncline was undertaken by RPS and included prediction of the water level recovery post mining (RPS, 2021). A simple analytical method was been used to calculate the post-closure pit lake water balance for the pits. Inflows include direct precipitation onto the lake surface, runoff from pit walls above the pit lake surface and groundwater inflow from the regional groundwater aquifers. No seepage from a TSF or other water source is included as a potential input volume, nor surface water inflow from any catchment area outside of the closure bunding (which is planned to fully encircle the pit rims), nor any interflow from groundwater that may occur after large rainfall events through shallow alluvial sediments. The only outflow considered is the evaporation from the lake surface, assuming that the pit lakes remain as a groundwater sink (i.e. groundwater gradient is towards the pit).

Utilising a time series for 150 years, the modelling suggests that an equilibrium level of 442 mAHD for the Lens CD pit. Figure 3 presents this water level considering the pit shell detailed in Table 1. All exposures are situated approximately 43 m above the modelled post mining recovery water level (Figure 3)

5 Acid and Metalliferous Pit Lake (AMPL) Risk Assessment Model

The Rio Tinto Iron Ore (RTIO) Acid and Metalliferous Pit Lake (AMPL) Risk Assessment tool was developed as a transparent way to evaluate the risks of potential pit lake formation at sites within RTIO Pilbara operations. Use of the AMPL Excel-based spreadsheet provides a clear indication of the factors that have the greatest effect on pit lake formation, the development of acidic or metalliferous drainage, and the potential impact on the receiving environment. It can also be used to determine which sites will require additional pit-lake modelling or strategic changes in mine/closure planning.

The AMPL Assessment can be used to identify pit lakes that would have the potential to develop an environmental risk. Sites that are calculated to be low risk should not require any further specialized management or predictive modelling. Moderate risk sites require further investigation into the parameters that have the highest contribution to the risk ranking. Evaluation of methods to mitigate these hazards and lower the risk ranking should be explored. If options are not available, further predictive modelling and management practices will need to be investigated. Pits that pose a high or critical risk of generating an acidic pit lake that would impact the surrounding environment should not be further modelled until the risks are evaluated and strategic solutions are explored within the life-of-mine plan. Options would include changes to the pit shell to limit sulfide exposures, covering of sulfide exposures, and backfilling the pit to prevent pit lake formation. Further predictive modelling steps could then be taken to evaluate the potential effectiveness of the management options.

5.1 AMPL Assessment – Lens CD

The AMPL assessment of Lens CD is presented in Appendix A and summarised in Table 3. Two models were investigated, a no backfill model which will see water levels recover to 442 mRL within 150 years of cessation of mining activities and a backfill to AWT option. The backfill option will potentially still result in an ephemeral lake developing during high rainfall events.

Table 3 – AMPL Assessment Result, Lens CD

Backfill Model	Overall Risk	Likelihood	Consequence
No backfill	Moderate	Possible	Medium
Backfill to AWT	Moderate	Possible	Medium

6 Discussion and Conclusions

The Acid and Metalliferous Pit Lake (AMPL) Risk Assessment Model is a preliminary assessment tool for assessing potential risks associated with a pit lake forming in mine voids. The overall risk of Moderate for both backfill and no backfill suggests further investigation is required to understand the risks associated with a pit lake.

7 References

RTIO, 2010, Nammuldi ARD and Geochemical Risk Assessment September 2010 (Update from February 2010), RTIO-PDE-0068358, September 2010.

RTIO, 2021, Nammuldi AMD Risk Assessment Review, Internal Memo, RTIO-PDE-0184848, December 2021.

RTIO, 2021, Nammuldi AMD Risk Assessment Review 2021, RTIO-PDE-0184848, December 2021

RPS, 2021, Brockman Syncline Pit Lake Modelling, EWP19192, November 2021

8 Figures

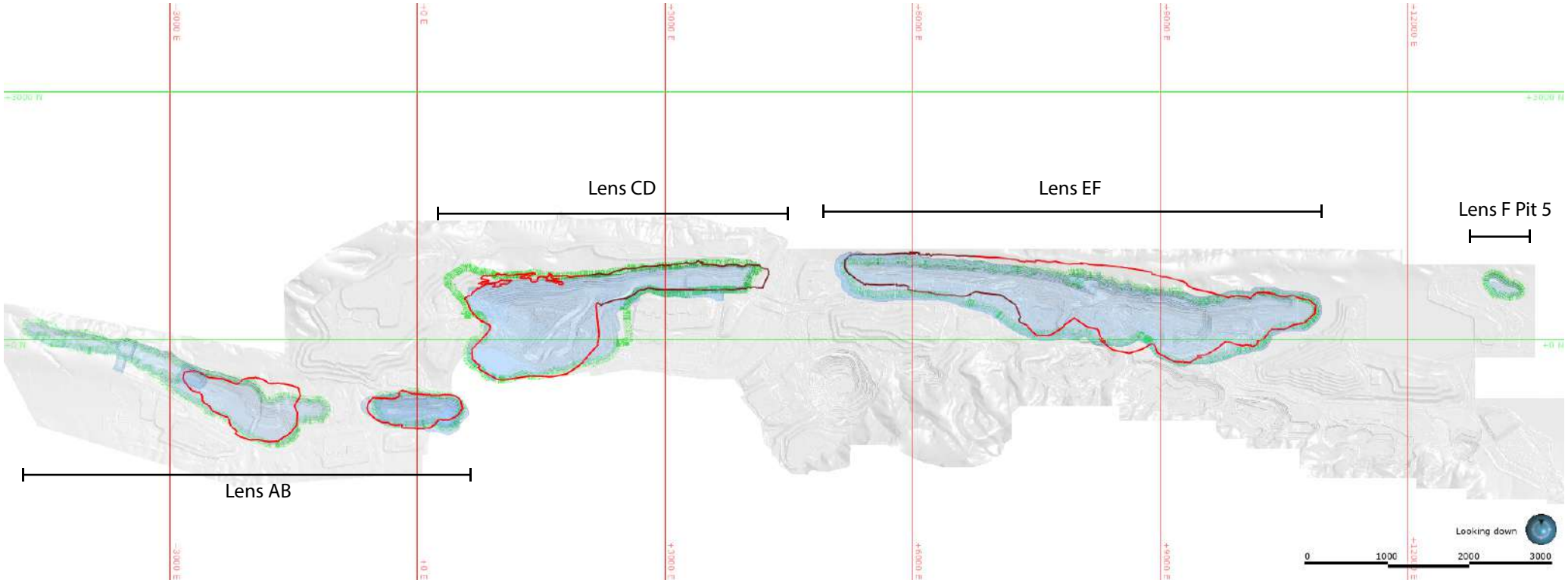


Figure 1 - Lens CD Pit Nomenclature

Legend

2010 Pit outline plan

2021 Pit outline plan

2021 Closure Pit outline plan

N

0 2,000

Metres

Map units in metres

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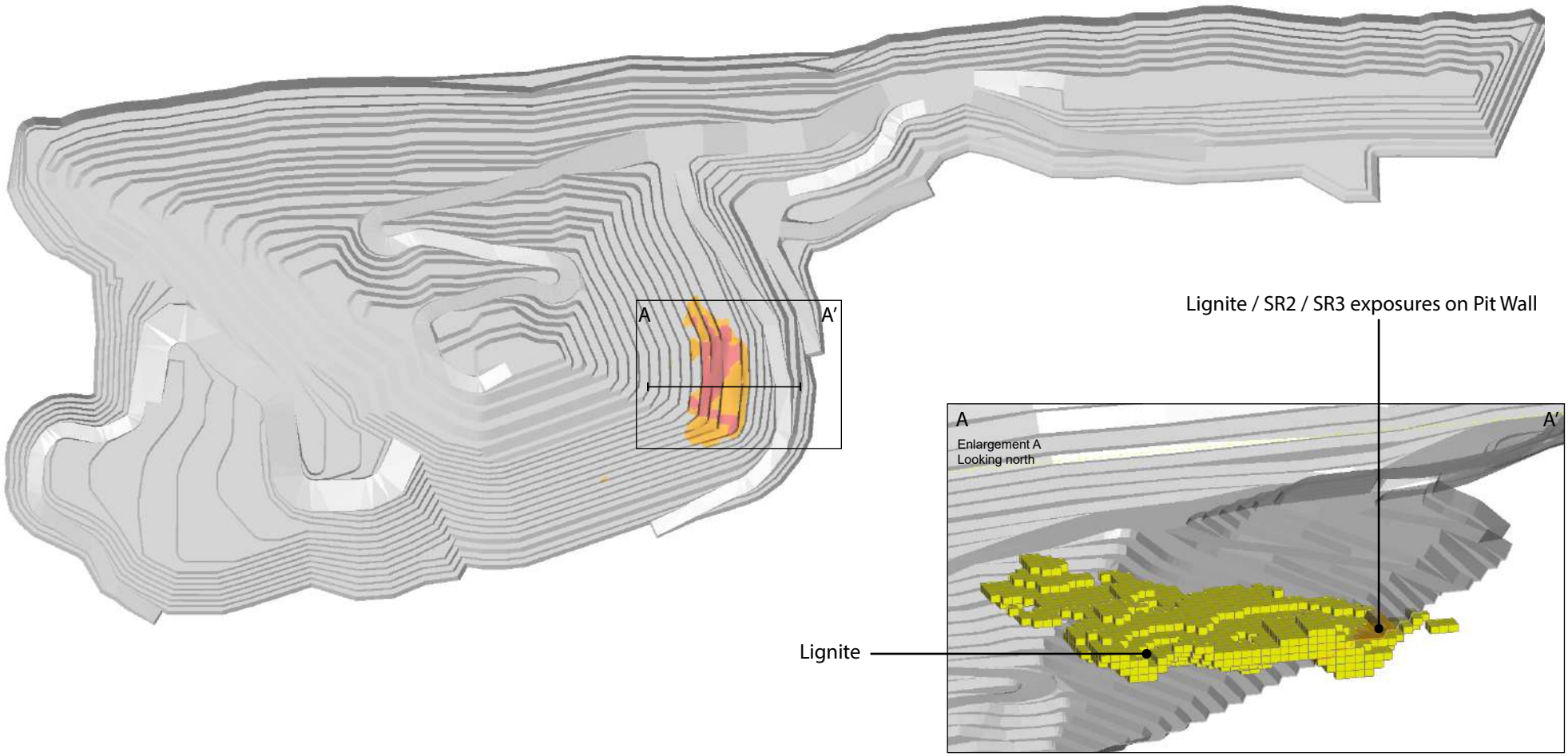


Figure 2 - Lens CD Sulfide Risk Exposures

Legend

Sulfur Risk 2 Areas

Sulfur Risk 3 Areas

Drawn: Sam McHarg

Date: Jan 2022

N

Map units in metres

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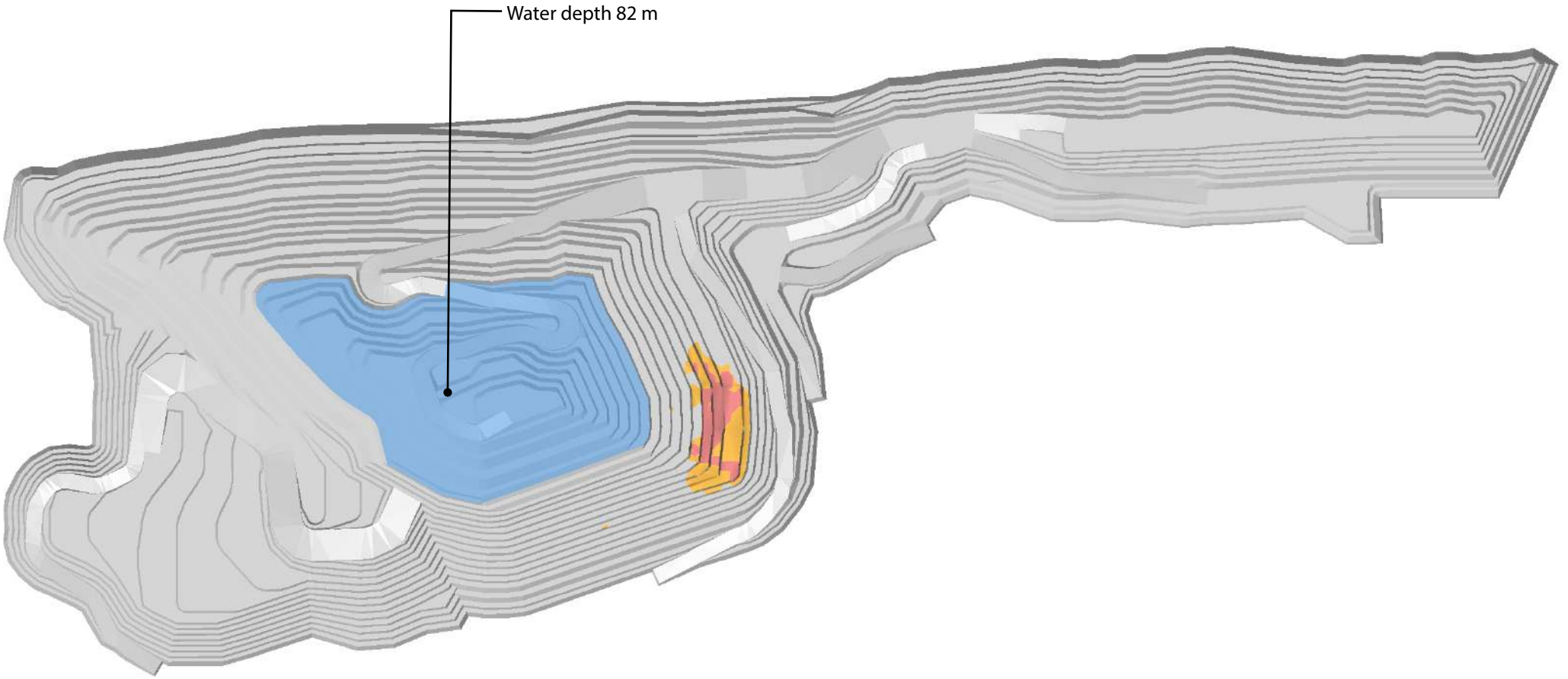


Figure 3 - Lens CD Sulfide Risk Exposures and Groundwater Recovery level

Legend

Sulfide Risk 2 Areas

Sulfide Risk 3 Areas

442 mRL post mining water recovery level

Drawn: Sam McHarg

Date: Jan 2022

N

0 500

Metres

Map units in metres

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9 Appendix A – AMPL Assessment

Assessment Date	Lens CD_backfill_to_AWT (442mRL)
Compiled by	19/01/2022 Sam Mcharg
Likelihood of AMD Lake Development	POSSIBLE
Potential Consequence	MEDIUM
Overall Risk	MODERATE

Version Date: 18/02/2013
Version Number: 1

Uncertainty
Low

RTIO Acid and Metalliferous Pit Lake Risk Assessment

Preliminary Assessment

A. Physical

	Select Relevant Option Below
Flow mechanism	Sink

	Select Relevant Option Below	Consequence Score	Likelihood Score
Surface Area of Lake	Ephemeral/Seasonal	0.2	0.2
Depth of lake	Ephemeral/Seasonal	0.2	0.2
Relative Depth	#N/A		
Backfill	Backfill to above pre-mining WT		
Backfill Material	Inert backfill	0.2	0.2
Neutralising Capacity in Backfill	NPR > 3	1	0.2
Time for Pit Lake to Reach Recovery WT	Slow water recovery (100+ years)	5	3
Physical Risk Score	43.1	22.0	21.1
Physical Risk Rank	LOW	MEDIUM	UNLIKELY

B. Surface Water

		Select Relevant Option Below	Consequence Score	Likelihood Score
Surface Water Management Hazard	Catchment area above the pit		0.5	3
Sulfur exposure on pit wall above post mining water table (AWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Sulfur exposure on pit wall below post mining water table (BWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Covering pit wall exposure	No cover		0.4	8
Pit wall sulfide stability	Medium stability		0.2	4

Surface water percentage contribution	10%			
Surface Water Risk Score	28.0		8.5	19.5
Surface Water Risk Rank	LOW		MINOR	UNLIKELY

C. Groundwater Contamination

	Select Relevant Option Below	Consequence Score	Likelihood Score
Sulfides in Drawdown Cone	<1%	0.1	1
Hydraulic conductivity of sulfidic material in cone of depression	Medium (1-10 m/day)	0.2	24
Groundwater Alkalinity	>300 mg/L CaCO3	0.1	1

Groundwater percentage contribution	90%		
Groundwater Contamination Risk Score	40.5	8.0	32.5
Groundwater Contamination Risk Rank	LOW	MINOR	POSSIBLE

D. Receptors

		Consequence Score	Likelihood Score
Density driven flow	Pit surrounded by moderate conductive material (1-10m/day)	1	0.1
Distance to Perennial Water Bodies	>2000 metres	1	0.05
Distance to Ephemeral Water Bodies	>2000 metres	0.1	0.05
Distance to closest protected / permanently inhabited area	3000 - 10000 metres	2	0.1
Ecosystem receptors affected	Not affected	1	0.05
Alkalinity of receptor	>300 mg/L CaCO3	0.1	0.05
Receptors Risk Score	16.9	14.9	2.0
Receptors Risk Rank	LOW	MEDIUM	RARE

Environmental, social or heritage concerns that would immediately prevent approval if pit lake forms?	No	

E. Constituents of Concern

Populate the heat map worksheet based on site-specific or analogous data available. Data should be from 2:1 liquid extracts of sulfidic and inert lithologies.

Analyte	Sulfide Lithologies			Inert Lithologies		
	n=	# > ADWG	% > ADWG	*n*=	# > ADWG	% > ADWG
TDS	*0*	0	0%	*0*	0	0%
SO_4	*0*	0	0%	*0*	0	0%
HCO_3	*0*	0	0%	*0*	0	0%
Al	*28*	14	50%	*28*	6	21%
As	*20*	20	100%	*10*	2	20%
Ba	*20*	2	10%	*28*	3	11%
B	*20*	20	100%	*22*	3	14%
Cd	*20*	20	100%	*10*	2	20%
Cl	*20*	0	0%	*28*	0	0%
Co	*20*	1	5%	*8*	1	13%
Cr	*20*	2	10%	*10*	1	10%
Cu	*20*	0	0%	*17*	0	0%
F	*20*	0	0%	*20*	1	5%
Fe	*20*	12	60%	*8*	5	63%
Hg	*16*	0	0%	*0*	0	0%
Mn	*20*	14	70%	*25*	4	16%
Mo	*20*	1	5%	*22*	0	0%
Ni	*20*	4	20%	*8*	3	38%
Pb	*20*	6	30%	*10*	1	10%
Sb	*20*	20	100%	*11*	6	55%
Se	*20*	20	100%	*8*	3	38%
Zn	*16*	0	0%	*28*	2	7%
NO_3	*0*	0	0%	*0*	0	0%

Overall Likelihood of Acidic Lake Developing

Score	29.2
Likelihood of Acidic Lake Developing	POSSIBLE
Likely pH range	pH 4.8-6.3
Concentrations requiring further investigation	Fe,Sb

Overall Potential Consequence of Pit Lake

Score	13.4
Consequence	MEDIUM

Assessment Date	Lens CD_no_backfill_based on 442mRL recovery 19/01/2022
Compiled by	Sam Mcharg
Likelihood of AMD Lake Development	POSSIBLE
Potential Consequence	MEDIUM
Overall Risk	MODERATE

Version Date: 18/02/2013
Version Number: 1

Uncertainty
Low

RTIO Acid and Metalliferous Pit Lake Risk Assessment

Preliminary Assessment

A. Physical

	Select Relevant Option Below
Flow mechanism	Sink

	Select Relevant Option Below	Consequence Score	Likelihood Score
Surface Area of Lake	200, 000 - 400, 000 m2	2	2
Depth of lake	80m+	10	1
Relative Depth	>11%		
Backfill	No backfill		
Backfill Material	Inert backfill	0.2	0.5
Neutralising Capacity in Backfill	NPR > 3	1	0.2
Time for Pit Lake to Reach Recovery WT	Slow water recovery (100+ years)	5	3
Physical Risk Score	97.9	60.7	37.2
Physical Risk Rank	CRITICAL	MAJOR	LIKELY

B. Surface Water

		Select Relevant Option Below	Consequence Score	Likelihood Score
Surface Water Management Hazard	Catchment area above the pit		0.5	3
Sulfur exposure on pit wall above post mining water table (AWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Sulfur exposure on pit wall below post mining water table (BWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Covering pit wall exposure	No cover		0.4	8
Pit wall sulfide stability	Medium stability		0.2	4
Surface water percentage contribution	10%			
Surface Water Risk Score	28.0		8.5	19.5
Surface Water Risk Rank	LOW		MINOR	UNLIKELY

C. Groundwater Contamination

	Select Relevant Option Below	Consequence Score	Likelihood Score
Sulfides in Drawdown Cone	<1%	0.1	1
Hydraulic conductivity of sulfidic material in cone of depression	Medium (1-10 m/day)	0.2	24
Groundwater Alkalinity	>300 mg/L CaCO3	0.1	1
Groundwater percentage contribution	90%		
Groundwater Contamination Risk Score	40.5	8.0	32.5
Groundwater Contamination Risk Rank	LOW	MINOR	POSSIBLE

D. Receptors

		Consequence Score	Likelihood Score
Density driven flow	Pit surrounded by moderate conductive material (1-10m/day)	1	0.1
Distance to Perennial Water Bodies	>2000 metres	1	0.05
Distance to Ephemeral Water Bodies	>2000 metres	0.1	0.05
Distance to closest protected / permanently inhabited area	3000 - 10000 metres	2	0.1
Ecosystem receptors affected	Not affected	1	0.05
Alkalinity of receptor	>300 mg/L CaCO3	0.1	0.05
Receptors Risk Score	16.9	14.9	2.0
Receptors Risk Rank	LOW	MEDIUM	RARE

Environmental, social or heritage concerns that would immediately prevent approval if pit lake forms?	No

E. Constituents of Concern

Populate the heat map worksheet based on site-specific or analogous data available. Data should be from 2:1 liquid extracts of sulfidic and inert lithologies.

Analyte	Sulfide Lithologies			Inert Lithologies		
	n=	# > ADWG	% > ADWG	*n*=	# > ADWG	% > ADWG
TDS	*0*	0	0%	*0*	0	0%
SO_4	*0*	0	0%	*0*	0	0%
HCO_3	*0*	0	0%	*0*	0	0%
Al	*28*	14	50%	*28*	6	21%
As	*20*	20	100%	*10*	2	20%
Ba	*20*	2	10%	*28*	3	11%
B	*20*	20	100%	*22*	3	14%
Cd	*20*	20	100%	*10*	2	20%
Cl	*20*	0	0%	*28*	0	0%
Co	*20*	1	5%	*8*	1	13%
Cr	*20*	2	10%	*10*	1	10%
Cu	*20*	0	0%	*17*	0	0%
F	*20*	0	0%	*20*	1	5%
Fe	*20*	12	60%	*8*	5	63%
Hg	*16*	0	0%	*0*	0	0%
Mn	*20*	14	70%	*25*	4	16%
Mo	*20*	1	5%	*22*	0	0%
Ni	*20*	4	20%	*8*	3	38%
Pb	*20*	6	30%	*10*	1	10%
Sb	*20*	20	100%	*11*	6	55%
Se	*20*	20	100%	*8*	3	38%
Zn	*16*	0	0%	*28*	2	7%
NO_3	*0*	0	0%	*0*	0	0%

Overall Likelihood of Acidic Lake Developing

Score	32.1
Likelihood of Acidic Lake Developing	POSSIBLE
Likely pH range	pH 4.8-6.3
Concentrations requiring further investigation	Fe,Sb

Overall Potential Consequence of Pit Lake

Score	25.0
Consequence	MEDIUM

Valid for 30 days after the assessment date

Appendix 20: Nammuldi Lens EF Preliminary Pit Lake Assessment

Pilbara Iron Company (Services) Pty Ltd
Level 18
Central Park
152-158 Georges Terrace
Perth WA 6000
Australia
T +61 (8) 327 2000

Internal memo

From: Sam McHarg

Department: WRE – Mineral Waste

To: Steven Lee

CC: Hamish Penno, Tammy Savage

Reference: RTIO-PDE-0187890

Date: January 2022

Nammuldi Lens EF Preliminary Pit Lake Assessment

1 Introduction

Following a review of the acid and metalliferous drainage (AMD) risk for the Nammuldi Lens EF deposit (RTIO, 2021) and ongoing work regarding groundwater recovery levels post mining operations, it is likely that a pit lake will form within the Lens EF pit once mining activities have ceased.

Due to the presence of elevated sulfur concentrations within rock formations (lignite and Wittenoom Formation) that are predicted to be present in the final pit walls, there is the possibility that water quality of the pit lake will be impacted by AMD. This Preliminary Pit Lake Assessment aims to review the existing data for Lens EF with an aim of providing a preliminary assessment of the risks of impacting pit lake water quality.

2 Background

A full AMD Risk Assessment was undertaken by Rio Tinto in 2010 and updated in 2021. Details of the mine models and pit shells used in the 2010 and 2021 reporting are presented in Table 1 and Figure 1. The 2010 Assessment and 2021 Review identified the overall AMD risk of mining Lens EF as Low.

Table 1 – Comparison of mine models and pit shells

Date of Assessment	Mine Model	Pit Shells
2010	namipr_lef_20100420_001	ensef_bwt_09pfs5_c.00t
2021	namiprdp_lef_20200914_015	lef_uf25.00t

3 Potentially Acid Forming Formations

Sulfidic lignite and siderite have been found within detritals at Nammuldi (Figure 2). A characterisation study undertaken by SRK (2013) involved 20 lignite samples and were found to contain 0.28 – 7.5 % S and generated between 0.4 – 248 kgH_2SO_4/tonne of acidity. There is some neutralising potential within the lignite but this is insufficient to counteract the acidity produced. Utilising the block model namiprdp_lef_20200914_015, it was calculated that approximately 3,790 m^2 of Sulfide Risk 2 (SR2) (Wittenoom Formation) and 6,931 m^2 of Sulfide Risk 3 (SR3) (lignite) material will be exposed in the final pit geometry (Table 2).

Table 2 –Sulfide Risk areas of Lens EF

Pit	Total pit surface area (m^2)	Base of pit RL (m)	Sulfide Risk 2			Sulfide Risk 3		
			SR2 area (m^2)	SR2 % of pit	RL of exposure	SR3 area (m^2)	SR3 % of pit	RL of exposure
Lens EF	5.5 M	449	3,790	0.07	479 - 517	6,931	0.13	489 - 535

Characterisation test work was undertaken on the calcite and dolomite sequences likely to be encountered within the Nammuldi deposits (SRK, 2010 and SRK 2013). The characterisation work suggests Acid Neutralising Capacity (ANC) of the calcite is between 230 – 963 kgH_2SO_4/tonne with the majority of ANC present as carbonate and readily available for neutralisation. The dolomite recorded higher ANC (668 – 870 kgH_2SO_4/tonne) than the calcite, however ABCC tests suggests readily available neutralising capacity is only 50% of the ANC. Both calcite and dolomite are expected to be present as rock exposures overlying the lignite on the final pit shells. The ability of AWT exposures to neutralise acid generated by the oxidation of lignite is likely to be limited due to the short residence time during rainfall events with only minor dissolution of calcite or dolomite.

4 Modelled In-Pit Post Closure Water levels

Groundwater modelling to assess the cumulative impact of proposed mining within the Brockman Syncline was undertaken by RPS and included prediction of the water level recovery post mining (RPS, 2021). A simple analytical method was been used to calculate the post-closure pit lake water balance for the pits. Inflows include direct precipitation onto the lake surface, runoff from pit walls above the pit lake surface and groundwater inflow from the regional groundwater aquifers. No seepage from a TSF or other water source is included as a potential input volume, nor surface water inflow from any catchment area outside of the closure bunding (which is planned to fully encircle the pit rims), nor any interflow from groundwater that may occur after large rainfall events through shallow alluvial sediments. The only outflow considered is the evaporation from the lake surface, assuming that the pit lakes remain as a groundwater sink (i.e. groundwater gradient is towards the pit).

Utilising a time series for 150 years, the modelling suggests that an equilibrium level of 492 mAHD for the Lens EF pit. Figure 3 presents this water level considering the pit shell detailed in Table 1. Considering the final geometry of the pit floor, several smaller pit lakes are likely to form, rather than a single water body. This will have implications for water quality as different physiochemical conditions will be present in each water body. The model developed in the following section assumes a single water body of the maximum depth of the pit.

The Sulfide Risk exposures situated in the western portion of the pit will be partially inundated by the rising water level (Enlargement A, Figure 3). The SR3 exposures in the eastern portion of the pit are located approximately 18 m above the modelled recovery level of 492 mRL.

5 Acid and Metalliferous Pit Lake (AMPL) Risk Assessment Model

The Rio Tinto Iron Ore (RTIO) Acid and Metalliferous Pit Lake (AMPL) Risk Assessment tool was developed as a transparent way to evaluate the risks of potential pit lake formation at sites within RTIO Pilbara operations. Use of the AMPL Excel-based spreadsheet provides a clear indication of the factors that have the greatest effect on pit lake formation, the development of acidic or metalliferous drainage, and the potential impact on the receiving environment. It can also be used to determine which sites will require additional pit-lake modelling or strategic changes in mine/closure planning.

The AMPL Assessment can be used to identify pit lakes that would have the potential to develop an environmental risk. Sites that are calculated to be low risk should not require any further specialized management or predictive modelling. Moderate risk sites require further investigation into the parameters that have the highest contribution to the risk ranking. Evaluation of methods to mitigate these hazards and lower the risk ranking should be explored. If options are not available, further predictive modelling and management practices will need to be investigated. Pits that pose a high or critical risk of generating an acidic pit lake that would impact the surrounding environment should not be further modelled until the risks are evaluated and strategic solutions are explored within the life-of-mine plan. Options would include changes to the pit shell to limit sulfide exposures, covering of sulfide exposures, and backfilling the pit to prevent pit lake formation. Further predictive modelling steps could then be taken to evaluate the potential effectiveness of the management options.

5.1 AMPL Assessment – Lens EF

The AMPL assessment of Lens EF is presented in Appendix A and summarised in Table 3. Two models were investigated, a no backfill model which will see water levels recover to 492 mRL within 150 years of cessation of mining activities and a backfill to AWT option. The backfill option will potentially still result in an ephemeral lake developing during high rainfall events.

Table 3 – AMPL Assessment Result, Lens EF

Backfill Model	Overall Risk	Likelihood	Consequence
No backfill	Moderate	Possible	Medium
Backfill to AWT	Moderate	Possible	Medium

6 Discussion and Conclusions

The Acid and Metalliferous Pit Lake (AMPL) Risk Assessment Model is a preliminary assessment tool for assessing potential risks associated with a pit lake forming in mine voids. The overall risk of Moderate for both backfill and no backfill suggests further investigation is required to understand the risks associated with a pit lake.

7 References

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RTIO, 2021, Nammuldi AMD Risk Assessment Review 2021, RTIO-PDE-0184848, December 2021

RPS, 2021, Brockman Syncline Pit Lake Modelling, EWP19192, November 2021

SRK, 2010, Nammuldi Calcretes - Assessment of Neutralising Potential (RTIO-PDE-0080862).

SRK, 2013, Geochemical characterisation of Nammuldi / BS2 Low Sulfur material, RTS056, June 2013.

8 Figures

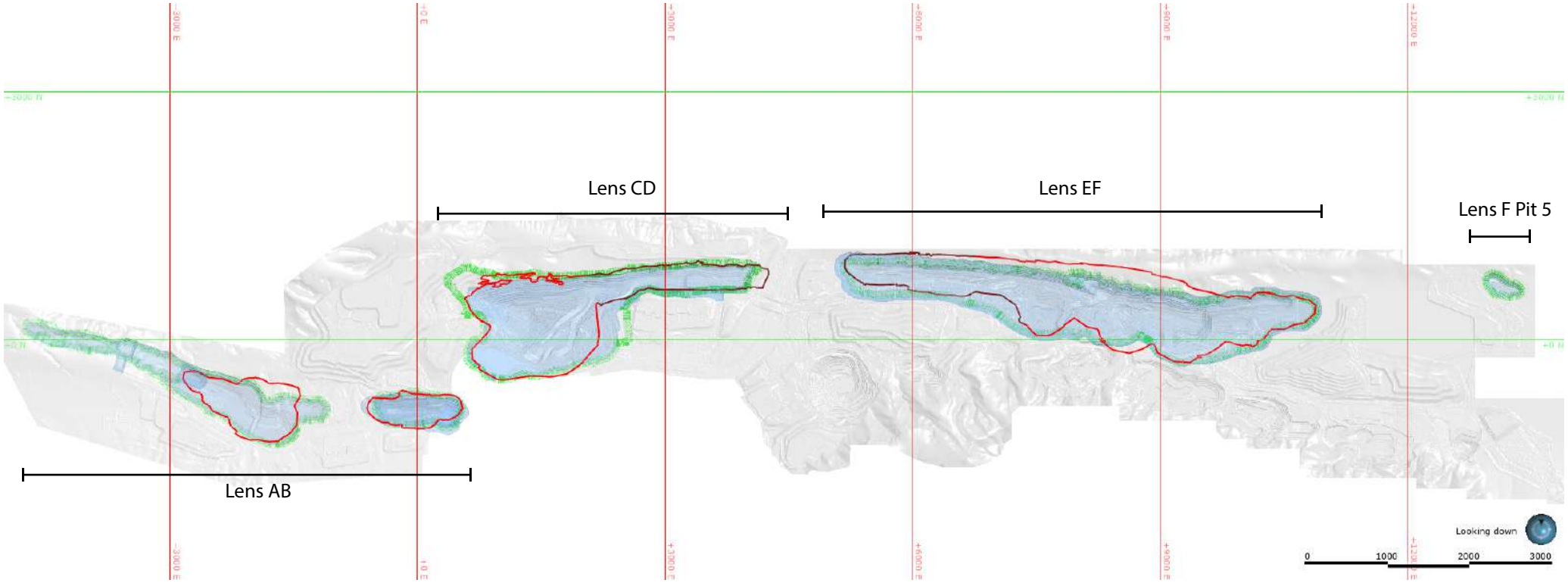


Figure 1 - Lens EF Pit Nomenclature

Legend

2010 Pit outline plan

2021 Pit outline plan

2021 Closure Pit outline plan

N

0 2,000

Metres

Map units in metres

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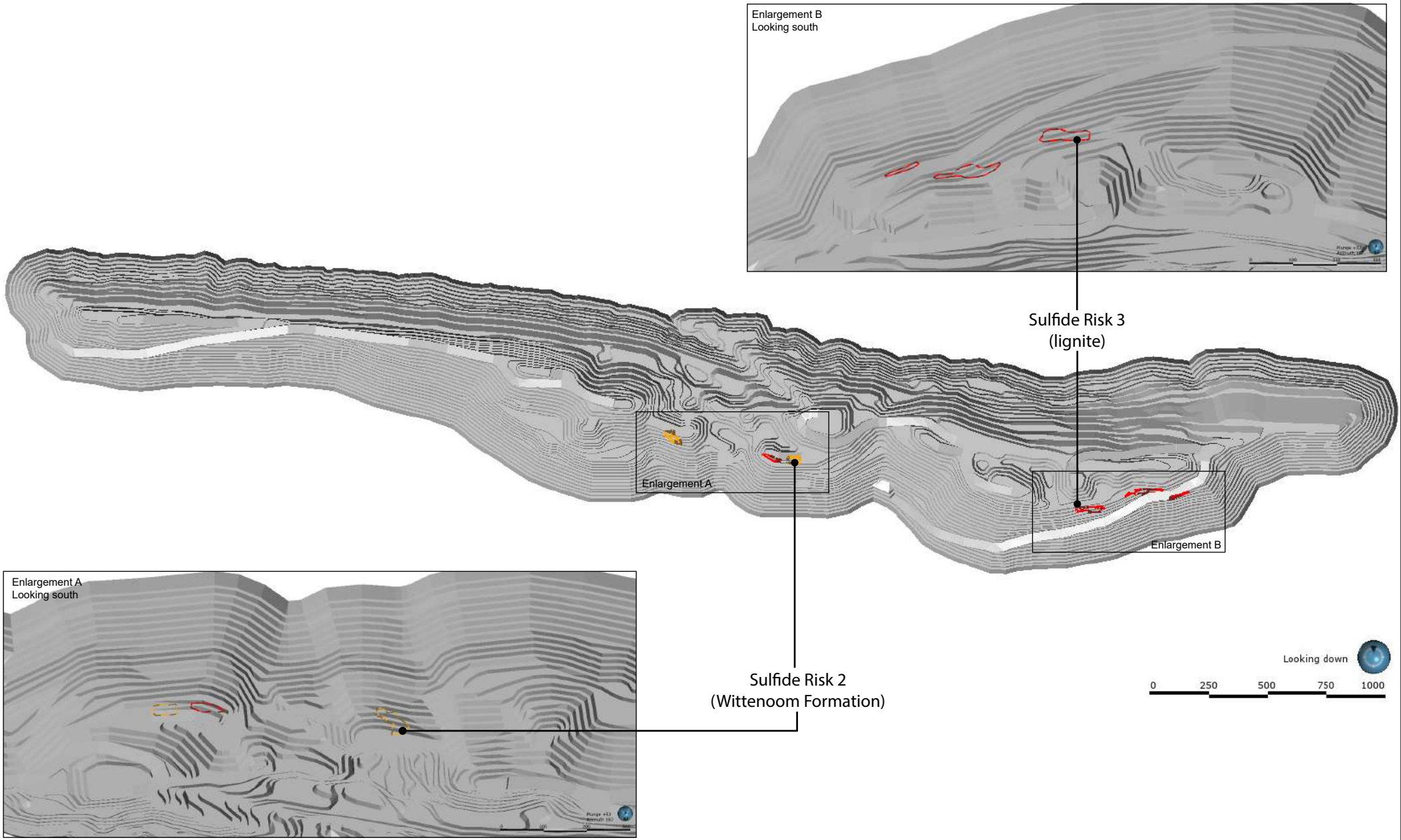


Figure 2 - Lens EF Sulfide Risk Exposures

Legend

- Sulfur Risk 2 Areas
- Sulfur Risk 3 Areas

Drawn: Sam McHarg

Date: Jan 2022

N

Map units in metres

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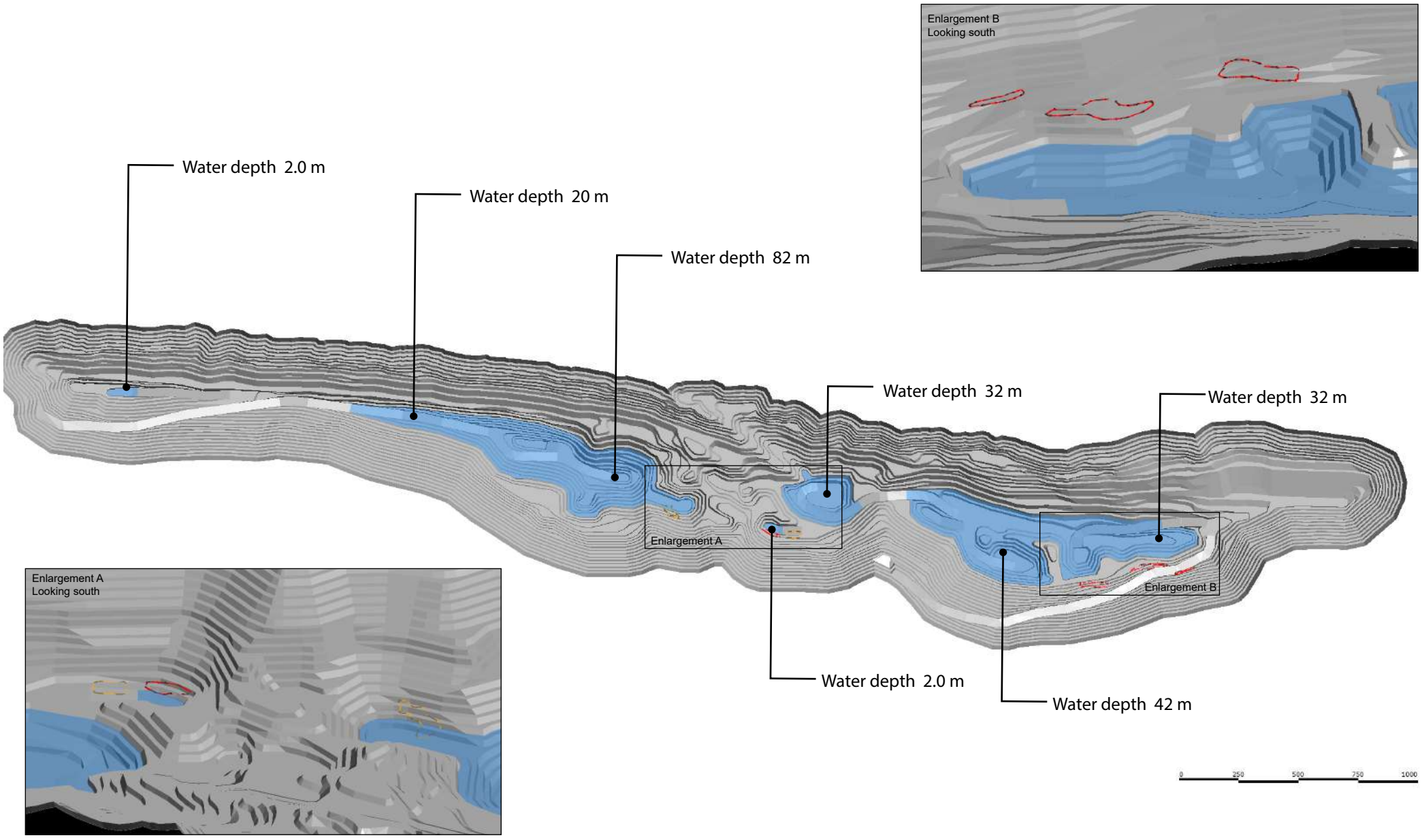


Figure 3 - Lens EF Sulfide Risk Exposures and Groundwater Recovery level

Legend

- Sulfur Risk 2 Areas
- Sulfur Risk 3 Areas
- 492 mRL post mining water recovery level

Drawn: Sam McHarg

Date: Jan 2022

N

Map units in metres

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9 Appendix A – AMPL Assessment

	Lens EF_backfill_to_AWT (492mRL)
Assessment Date	7/01/2022
Compiled by	Sam Mcharg
Likelihood of AMD Lake Development	**POSSIBLE**
Potential Consequence	**MEDIUM**
Overall Risk	**MODERATE**

Version Date: 18/02/2013
Version Number: 1

Uncertainty
Low

RTIO Acid and Metalliferous Pit Lake Risk Assessment

Preliminary Assessment

A. Physical

	Select Relevant Option Below
Flow mechanism	Sink

	Select Relevant Option Below	**Consequence Score**	**Likelihood Score**
Surface Area of Lake	Ephemeral/Seasonal	0.2	0.2
Depth of lake	Ephemeral/Seasonal	0.2	0.2
Relative Depth	#N/A		
Backfill	Backfill to above pre-mining WT		
Backfill Material	Inert backfill	0.2	0.2
Neutralising Capacity in Backfill	NPR > 3	1	0.2
Time for Pit Lake to Reach Recovery WT	Slow water recovery (100+ years)	5	3
Physical Risk Score	43.1	22.0	21.1
Physical Risk Rank	LOW	**MEDIUM**	**UNLIKELY**

B. Surface Water

		Select Relevant Option Below	**Consequence Score**	**Likelihood Score**
Surface Water Management Hazard	Catchment area above the pit		0.5	3
Sulfur exposure on pit wall above post mining water table (AWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Sulfur exposure on pit wall below post mining water table (BWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Covering pit wall exposure	No cover		0.4	8
Pit wall sulfide stability	Medium stability		0.2	4

Surface water percentage contribution	10%		
Surface Water Risk Score	28.0	8.5	19.5
Surface Water Risk Rank	LOW	**MINOR**	**UNLIKELY**

C. Groundwater Contamination

	Select Relevant Option Below	**Consequence Score**	**Likelihood Score**
Sulfides in Drawdown Cone	<1%	0.1	1
Hydraulic conductivity of sulfidic material in cone of depression	Medium (1-10 m/day)	0.2	24
Groundwater Alkalinity	>300 mg/L CaCO3	0.1	1

Groundwater percentage contribution	90%		
Groundwater Contamination Risk Score	40.5	8.0	32.5
Groundwater Contamination Risk Rank	LOW	**MINOR**	**POSSIBLE**

D. Receptors

		Consequence Score	**Likelihood Score**
Density driven flow	Pit surrounded by moderate conductive material (1-10m/day)	1	0.1
Distance to Perennial Water Bodies	>2000 metres	1	0.05
Distance to Ephemeral Water Bodies	>2000 metres	0.1	0.05
Distance to closest protected / permanently inhabited area	3000 - 10000 metres	2	0.1
Ecosystem receptors affected	Not affected	1	0.05
Alkalinity of receptor	>300 mg/L CaCO3	0.1	0.05
Receptors Risk Score	16.9	14.9	2.0
Receptors Risk Rank	LOW	**MEDIUM**	**RARE**

Environmental, social or heritage concerns that would immediately prevent approval if pit lake forms?	No	

E. Constituents of Concern

Populate the heat map worksheet based on site-specific or analogous data available. Data should be from 2:1 liquid extracts of sulfidic and inert lithologies.

Analyte	**Sulfide Lithologies**			**Inert Lithologies**		
	***n*=**	**# > ADWG**	**% > ADWG**	***n*=**	**# > ADWG**	**% > ADWG**
TDS	*0*	0	0%	*0*	0	0%
SO_4	*0*	0	0%	*0*	0	0%
HCO_3	*0*	0	0%	*0*	0	0%
Al	*28*	14	50%	*28*	6	21%
As	*20*	20	100%	*10*	2	20%
Ba	*20*	2	10%	*28*	3	11%
B	*20*	20	100%	*22*	3	14%
Cd	*20*	20	100%	*10*	2	20%
Cl	*20*	0	0%	*28*	0	0%
Co	*20*	1	5%	*8*	1	13%
Cr	*20*	2	10%	*10*	1	10%
Cu	*20*	0	0%	*17*	0	0%
F	*20*	0	0%	*20*	1	5%
Fe	*20*	12	60%	*8*	5	63%
Hg	*16*	0	0%	*0*	0	0%
Mn	*20*	14	70%	*25*	4	16%
Mo	*20*	1	5%	*22*	0	0%
Ni	*20*	4	20%	*8*	3	38%
Pb	*20*	6	30%	*10*	1	10%
Sb	*20*	20	100%	*11*	6	55%
Se	*20*	20	100%	*8*	3	38%
Zn	*16*	0	0%	*28*	2	7%
NO_3	*0*	0	0%	*0*	0	0%

Overall Likelihood of Acidic Lake Developing

Score	**29.2**
Likelihood of Acidic Lake Developing	**POSSIBLE**
Likely pH range	**pH 4.8-6.3**
Concentrations requiring further investigation	Fe,Sb

Overall Potential Consequence of Pit Lake

Score	**13.4**
Consequence	**MEDIUM**

Assessment Date	Lens EF_no_backfill_based on 492mRL recovery 7/01/2022
Compiled by	Sam Mcharg
Likelihood of AMD Lake Development	POSSIBLE
Potential Consequence	MEDIUM
Overall Risk	MODERATE

Version Date: 18/02/2013
Version Number: 1

Uncertainty
Low

RTIO Acid and Metalliferous Pit Lake Risk Assessment

Preliminary Assessment

A. Physical

	Select Relevant Option Below
Flow mechanism	Sink

	Select Relevant Option Below	Consequence Score	Likelihood Score
Surface Area of Lake	400, 000 - 600, 000 m2	4	3
Depth of lake	60-80m	8	2
Relative Depth	~7-11%		
Backfill	No backfill		
Backfill Material	Inert backfill	0.2	0.5
Neutralising Capacity in Backfill	NPR > 3	1	0.2
Time for Pit Lake to Reach Recovery WT	Slow water recovery (100+ years)	5	3
Physical Risk Score	109.0	60.7	48.3
Physical Risk Rank	CRITICAL	MAJOR	LIKELY

B. Surface Water

		Select Relevant Option Below	Consequence Score	Likelihood Score
Surface Water Management Hazard	Catchment area above the pit		0.5	3
Sulfur exposure on pit wall above post mining water table (AWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Sulfur exposure on pit wall below post mining water table (BWT)	Elevated S (Alunite)	<1%	0.1	0.1
	Category S (Category 2)	<1%	0.1	0.1
	Category SR (Category 3)	<1%	0.1	0.1
Covering pit wall exposure	No cover		0.4	8
Pit wall sulfide stability	Medium stability		0.2	4
Surface water percentage contribution	10%			
Surface Water Risk Score	28.0		8.5	19.5
Surface Water Risk Rank	LOW		MINOR	UNLIKELY

C. Groundwater Contamination

	Select Relevant Option Below	Consequence Score	Likelihood Score
Sulfides in Drawdown Cone	<1%	0.1	1
Hydraulic conductivity of sulfidic material in cone of depression	Medium (1-10 m/day)	0.2	24
Groundwater Alkalinity	>300 mg/L CaCO3	0.1	1
Groundwater percentage contribution	90%		
Groundwater Contamination Risk Score	40.5	8.0	32.5
Groundwater Contamination Risk Rank	LOW	MINOR	POSSIBLE

D. Receptors

		Consequence Score	Likelihood Score
Density driven flow	Pit surrounded by moderate conductive material (1-10m/day)	1	0.1
Distance to Perennial Water Bodies	>2000 metres	1	0.05
Distance to Ephemeral Water Bodies	>2000 metres	0.1	0.05
Distance to closest protected / permanently inhabited area	3000 - 10000 metres	2	0.1
Ecosystem receptors affected	Not affected	1	0.05
Alkalinity of receptor	>300 mg/L CaCO3	0.1	0.05
Receptors Risk Score	16.9	14.9	2.0
Receptors Risk Rank	LOW	MEDIUM	RARE

Environmental, social or heritage concerns that would immediately prevent approval if pit lake forms?	No

E. Constituents of Concern

Populate the heat map worksheet based on site-specific or analogous data available. Data should be from 2:1 liquid extracts of sulfidic and inert lithologies.

Analyte	Sulfide Lithologies			Inert Lithologies		
	n=	# > ADWG	% > ADWG	*n*=	# > ADWG	% > ADWG
TDS	*0*	0	0%	*0*	0	0%
SO_4	*0*	0	0%	*0*	0	0%
HCO_3	*0*	0	0%	*0*	0	0%
Al	*28*	14	50%	*28*	6	21%
As	*20*	20	100%	*10*	2	20%
Ba	*20*	2	10%	*28*	3	11%
B	*20*	20	100%	*22*	3	14%
Cd	*20*	20	100%	*10*	2	20%
Cl	*20*	0	0%	*28*	0	0%
Co	*20*	1	5%	*8*	1	13%
Cr	*20*	2	10%	*10*	1	10%
Cu	*20*	0	0%	*17*	0	0%
F	*20*	0	0%	*20*	1	5%
Fe	*20*	12	60%	*8*	5	63%
Hg	*16*	0	0%	*0*	0	0%
Mn	*20*	14	70%	*25*	4	16%
Mo	*20*	1	5%	*22*	0	0%
Ni	*20*	4	20%	*8*	3	38%
Pb	*20*	6	30%	*10*	1	10%
Sb	*20*	20	100%	*11*	6	55%
Se	*20*	20	100%	*8*	3	38%
Zn	*16*	0	0%	*28*	2	7%
NO_3	*0*	0	0%	*0*	0	0%

Overall Likelihood of Acidic Lake Developing

Score	34.1
Likelihood of Acidic Lake Developing	POSSIBLE
Likely pH range	pH 4.8-6.3
Concentrations requiring further investigation	Fe,Sb

Overall Potential Consequence of Pit Lake

Score	25.0
Consequence	MEDIUM

Appendix 21: Greater Brockman Operation – Closure Surface Water Assessment

RioTinto

Water Resource Evaluation

Greater Brockman Operations

Closure Surface Water Assessment

October 2022



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1. Overview

The operation at Greater Brockman (GBO) consists of two currently operational mine areas, Brockman Syncline 4 (BS4) mine area and Brockman Syncline 2 – Nammuldi Silvergrass (B2NS) mine area. The locations of these mines are illustrated in Figure 1-1. The Brockman Syncline Proposal (BSP) is currently being developed to increase the production at GBO. The BSP involves proposed deposits located across the Boolgeeda Creek, Beasley River and Duck Creek catchments. The indicative layout of the pits is shown in Figure 1-1.

The purpose of this assessment to highlight potential surface water risks associated with closure of the proposed and operational deposits and identify any potential impacts on the hydrologic regime of the creeks and flow paths. This study includes the hydraulic assessment of rare and extreme flood events ranging from 1 in 100 annual exceedance probability (AEP) to 1 in 10,000 AEP. Previous surface water assessment on the catchments of interest was used to inform the findings of this report. These included but are not limited to:

- Brockman Syncline Proposal Hydrology and Hydraulics Study (Rio Tinto, 2022);
- Brockman 4 Syncline — Order of Magnitude Study (Rio Tinto, 2019);
- Caves Creek Baseline Hydrology (HARC, 2019).

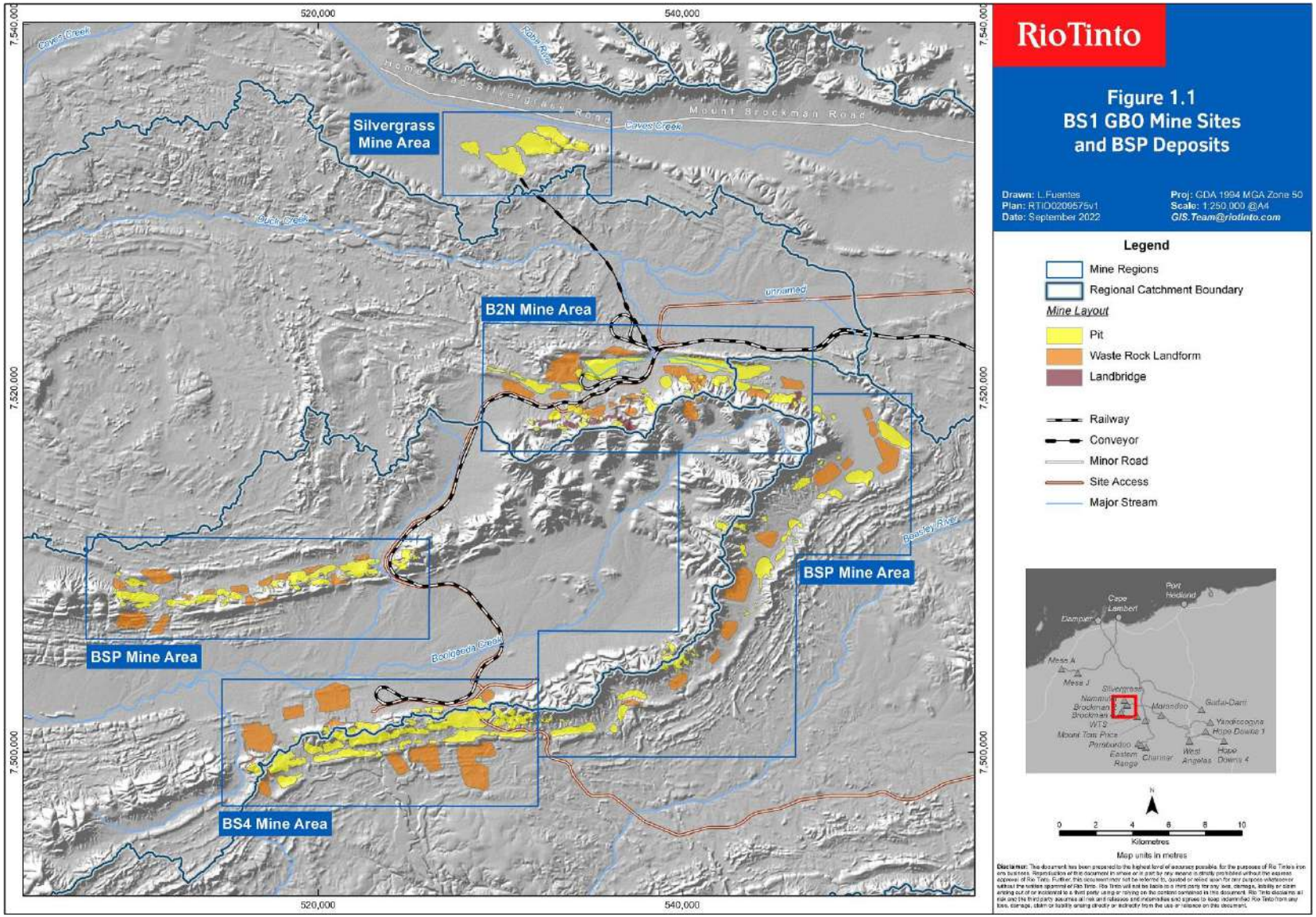


Figure 1-1 BS1 GBO Mine Sites and BSP Deposits

2. Hydrology

Deposits at GBO, operational and proposed, span across three major sub-catchments of the Ashburton River Basin, namely Boolgeeda Creek, Duck Creek, Beasley River and Caves Creek catchment (Figure 2-1).

Silvergrass East (SLVE) is located within the Caves Creek catchment, which covers an area of approximately 1,917 km². The catchment originates to the east of SLVE operations and extends to the west with elevations ranging from 985 mAHD to 480 mAHD. Caves Creek eventually merges into Duck Creek downstream to the west.

B2N is situated within the upper reaches of Duck Creek catchment. The natural catchment flows north before eventually merging with Duck Creek and then west towards the coast. Duck Creek flows in a westward direction, entering the Ashburton River 30 km downstream of Hardey River Junction.

The proposed BS1 Deposits within the BSP and a portion of the BS4 mine area are located within the Boolgeeda Creek catchment. This catchment is approximately 1,600 km^2 in size and drains to the southwest past the BS4 mining area before turning northwest to merge with Duck Creek.

The other portion of the BS4 mine area and some of the remainder of the proposed BSP deposits are located in the Beasley River catchment, a major sub-catchment of the Hardey River catchment. The Beasley River catchment covers an area of approximately 2,032 km^2. The catchment is drained from north to south by the Beasley River, through the Hamersley Ranges and discharges into the Hardey River, approximately 6 km upstream of Cheela Springs.

As for most parts of the Pilbara, streamflow is typically in direct response to rainfall, therefore exhibiting high variability and a similar seasonality to rainfall. The primary runoff generation mechanism is infiltration excess, which is commonly associated with high intensity rainfall and impervious catchments. However, conditions satisfying saturation excess runoff generation can occur during prolonged rainfall influenced by cyclones and tropical depressions. With the low rainfall in the region and general lack of groundwater contribution to surface water flow, extended periods of no flow are the norm, i.e. most water courses are ephemeral (Ruprecht & Ivanescu 2000).

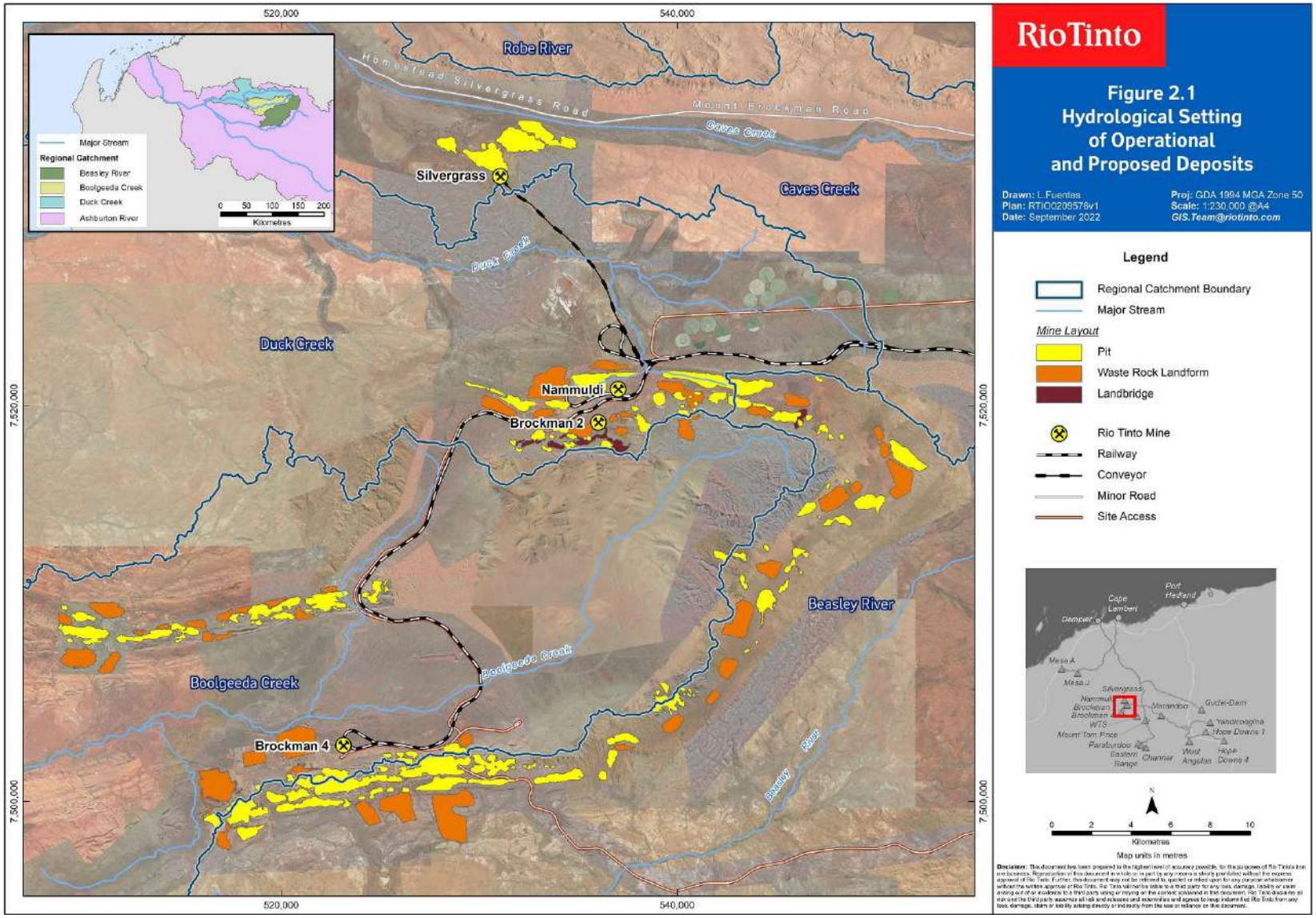


Figure 2-1 Hydrological setting of operational and proposed deposits

3. Closure Strategy

The various sites across GBO are at different stages of its mine life and therefore the closure strategies in some areas are further developed than others. In this assessment, operational pit and waste rock landform designs have been used in instances where final landform is unavailable. In addition, for pits where backfill is proposed, the backfill designs are included where it is available. Once rehabilitation and backfill designs are further developed, flood modelling would be updated to reflect the proposed closure landform.

Abandonment bunds have not been included in this study as these are subject to change. It is expected that surface water reporting to pits would reduce by the abandonment bunds. This study has analysed the maximum impacts scenario with the exception of Pit 1 at SLVE and Lens A at BS2. For the maximum impacts scenario, it is assumed that no tributaries where flow would terminate in pit, will be reinstated. The impact assessment of this proposed strategy is discussed in Section 7.

3.1 BS4 Mine Area

The closure strategy at BS4 is summarised in Figure 3-1 and Table 3-1. In general, all pits that have below water table (BWT) mining will be backfilled to above water table (AWT) level to prevent the formation of pit lakes. For pits that are AWT mining only, no backfill is proposed.

Table 3-1: BS4 Mine closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
BS4 Main			
1	Approved	AWT	No backfill
2	Approved	BWT	Partial backfill to prevent a permanent pit lake
3	Approved	BWT	Partial backfill to prevent a permanent pit lake
4	Approved	BWT	Partial backfill to prevent a permanent pit lake
5	Approved	BWT	Partial backfill to prevent a permanent pit lake
6	Approved	BWT	Partial backfill to prevent a permanent pit lake
7	Approved	BWT	Partial backfill to prevent a permanent pit lake
8	Approved	AWT	No backfill
9	Approved	AWT	No backfill
10	Approved	BWT	Partial backfill to prevent a permanent pit lake
11	Approved	BWT	Partial backfill to prevent a permanent pit lake
12	Approved	BWT	Partial backfill to prevent a permanent pit lake
13	Approved	AWT	No backfill
14	Approved	AWT	No backfill
15	Approved	BWT	Partial backfill to prevent a permanent pit lake
16	Approved	BWT	Partial backfill to prevent a permanent pit lake
17	Approved	BWT	Partial backfill to prevent a permanent pit lake
18	Approved	BWT	Partial backfill to prevent a permanent pit lake
19	Approved	AWT	No backfill

3.2 B2N Mine Area

The closure strategy for pits in the B2N area at the time of writing is summarised in Figure 3-2 and Table 3-2. The waste rock landform designs used in the hydraulic model are a mix of conceptual operational and final rehabilitation designs. These designs are subject to change and hydraulic modelling will be updated to reflect most up to date designs when available.

Most of the mining activities at BS2 is AWT and no backfill is proposed. Pit 4/6 BWT pit will be backfilled to AWT level to prevent formation of pit lake. Similar approach is adopted in BS2 Extension. Pits with BWT mining will be backfilled to AWT level to prevent formation of pit lake while AWT mining pits will not be backfilled. Pit 9c and South E are still in development and their closure strategy have not been formed. In Nammuldi, backfill at LF5 is complete. No backfill is proposed for the other BWT mining pits at Nammuldi. Lens CD, Lens EF and Lens G will form pit lakes post closure while the post closure groundwater level at Lens B is not expected to recover above the pit floor level. Lens A will be converted to a waste fines storage facility. The closure plan for Lens A is backfilling and capping to surface and reinstating the drainage flow path.

Table 3-2: B2N Mine Area closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
BS2			
1	Approved	AWT	No backfill
2	Approved	AWT	No backfill
3	Approved	AWT	No backfill
4/6	Approved	AWT	No backfill
	Approved	BWT	Partial backfill to prevent a permanent pit lake
5	Approved	AWT	No backfill
6X	Approved	AWT	No backfill
7	Approved	AWT	No backfill
BS2-Ext			
8	Approved	BWT	Backfill to AWT (final RL TBD)
9	Approved	AWT	No Backfill
9c	Proposed	Mineral Prospect	
10	Approved	BWT	Partial backfill to prevent a permanent pit lake
11	Approved	BWT	Partial backfill to prevent a permanent pit lake
12	Approved	BWT	Partial backfill to prevent a permanent pit lake
13	Approved	BWT	Partial backfill to prevent a permanent pit lake
14a	Approved	AWT	No Backfill
14b	Approved	AWT	No Backfill
14c	Proposed	AWT	No Backfill
South E	Proposed	Mineral Prospect	
BS2 West			
1a	Proposed	AWT	No Backfill
1d	Proposed	AWT	No Backfill
2b	Proposed	AWT	No Backfill

3a	Proposed	AWT	No Backfill
3b	Proposed	AWT	No Backfill
Nammuldi			
Lens A	Approved	BWT	In pit TSF and backfill/capping to surface
Lens B	Approved	BWT	No Backfill. GW not anticipated to return above pit flood (RPS, 2022)
Lens CD	Approved	BWT	Proposed pit lake (Pit C component)
Lens EF	Approved	BWT	Proposed pit lake
LF5	Approved	AWT	Backfill complete
Lens G	Proposed	BWT	Proposed pit lake

3.3 SLVE Mine Area

The closure strategy at SLVE at the time of writing is illustrated in Figure 3-3 and summarised in Table 3-3. Most pits will be backfilled to above pre-mining groundwater level to prevent the formation of pit lakes at closure. Most of the waste rock landforms will be removed at closure, except for the SLVE DHW waste rock landform.

Table 3-3: SLVE pits closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
SLVE			
Pit 1	Approved	BWT	Backfill to surface within 1:100AEP floodplain; otherwise to prevent pit lake
Pit 2	Approved	BWT	Partial backfill to prevent a permanent pit lake
Pit 3	Approved	BWT	Partial backfill to prevent a permanent pit lake
Pit 5	Approved	BWT	Partial backfill to prevent a permanent pit lake
Pit 7	Approved	AWT	No backfill
Pit 8	Approved	BWT	Partial backfill to prevent a permanent pit lake

3.4 BSP

The proposed closure strategy for each deposit within the BSP is summarised below. Due to the relatively early stage of mine design, the operational pit and waste rock landform designs have been used as the assumed final landform. Once rehabilitation designs are developed, flood modelling will be updated to better reflect the proposed closure landform.

Where the closure strategy of a pit void is to partially backfill to prevent formation of a permanent pit lake, the figures and models in this study have not considered backfill levels of the pits. It will be important to include the backfill levels when the design is further progressed to ensure that overtopping risk is adequately assessed.

The conceptual abandonment bunds developed for the BSP pits have not been used in this assessment as these are subject to change. It is expected that surface water reporting to pits at closure will be reduced by abandonment bunding.

A maximum impact scenario has been assumed for this closure strategy, where no tributaries flowing into pits are re-instated. An alternative closure option under consideration for BS1 includes backfilling

small sections of Pits W1 and E1 to natural surface to re-instate two tributaries flowing back to Boolgeeda Creek. This alternate closure option is detailed further in Section 8.4.1.

3.4.1 BS1

The closure strategy proposed for BS1 is for all BWT pits (W1, W2, E1 and E2) to be partially backfilled to prevent a permanent pit lake forming at closure. The closure strategy assumes that the baseline flow from catchments upstream of BS1 would be terminated in pit and that operational flood protection infrastructure would be removed and rehabilitated at the time of closure. The closure strategy for BS1 is illustrated in Figure 3-4 and summarised in Table 3-4.

Table 3-4: BS1 pits closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
BS1			
E1	Proposed	BWT	Partial backfill to prevent a permanent pit lake
E2	Proposed	BWT	Partial backfill to prevent a permanent pit lake
E3	Proposed	AWT	No backfill
W1	Proposed	BWT	Partial backfill to prevent a permanent pit lake
W2	Proposed	BWT	Partial backfill to prevent a permanent pit lake

3.4.2 Endeavour

The closure strategy for Endeavour is illustrated in Figure 3-5 and summarised in Table 3-5. Endeavour 1, which would have BWT mining, will be partially backfilled to prevent permanent pit lake. The backfill level is not known at this stage and thus have not been included in hydraulic assessment. No backfill is planned for Endeavour 2 where mining is only AWT.

Table 3-5: Endeavour pits closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
Endeavour			
Endeavour 1	Proposed	BWT	Partial backfill to prevent a permanent pit lake
Endeavour 2 (comprised of 2 smaller pits)	Proposed	AWT	No Backfill

3.4.3 BS4 MM and MN

The closure strategy at BS4 MM and MN is summarised in Table 3-6 and illustrated in Figure 3-1 and Figure 3-5. AWT mining has already began at Pit R at BS4 MM. The BWT mining pits at BS4 MM will form part of the BSP. These pits will be backfilled to prevent pit lakes at closure. AWT and BWT mining is proposed for BS4 MN and no backfill is proposed. BWT mining at BS4 MN, Pit M2, N1 and N2 is expected to form pit lakes post closure.

Table 3-6 BS4 MM and MN pits closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
BS4MM			
O1	Proposed	BWT	Partial backfill to prevent a permanent pit lake
O2	Proposed	BWT	Partial backfill to prevent a permanent pit lake
O3	Proposed	BWT	Partial backfill to prevent a permanent pit lake

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
Q	Proposed	BWT	Partial backfill to prevent a permanent pit lake
R	Approved	AWT	No backfill
R	Proposed	BWT	Partial backfill to prevent a permanent pit lake
BS4 MN			
M1	Proposed	AWT	No backfill
M2	Proposed	BWT	Proposed pit lake
N1	Proposed	BWT	Proposed pit lake
N2	Proposed	BWT	Proposed pit lake

3.4.4 BS3 and BS3 Extension

The closure strategy for BS3 and BS3 Extension is summarised in Table 3-7 and illustrated in Figure 3-6. The closure strategy proposes that MM-J, Creekside 2 and two Sandleford pits will be partially backfilled to prevent permanent pit lakes. All other pits will not be backfilled as they are above the water table.

Table 3-7: BS3 and BS3-Ext pits closure strategy

Deposit/Pit	Approved Status	AWT/BWT	Closure Strategy
BS3			
Pit 1	Proposed	AWT	No backfill
Pit 2	Proposed	AWT	No backfill
BS3-Ext			
Diesel	Proposed	BWT	Partial backfill to prevent a permanent pit lake
Sandleford 1	Proposed	AWT	No backfill
Sandleford 2	Proposed	AWT	No backfill
Sandleford 3	Proposed	AWT	No backfill
Monkey 1	Proposed	Mineral Prospect	
Monkey 2	Proposed	Mineral Prospect	
Monkey 3	Proposed	Mineral Prospect	
Creekside 1	Proposed	AWT	No backfill
Creekside 2	Proposed	BWT	Partial backfill to prevent a permanent pit lake
Orbe 1	Proposed	AWT	No backfill
Orbe 2	Proposed	AWT	No backfill
Lauriston	Proposed	AWT	No backfill
Brokenwood	Proposed	AWT	No backfill
MM-J-1	Proposed	BWT	Partial backfill to prevent a permanent pit lake
MM-J-2	Proposed	BWT	Partial backfill to prevent a permanent pit lake
MM-J-3	Proposed	BWT	Partial backfill to prevent a permanent pit lake

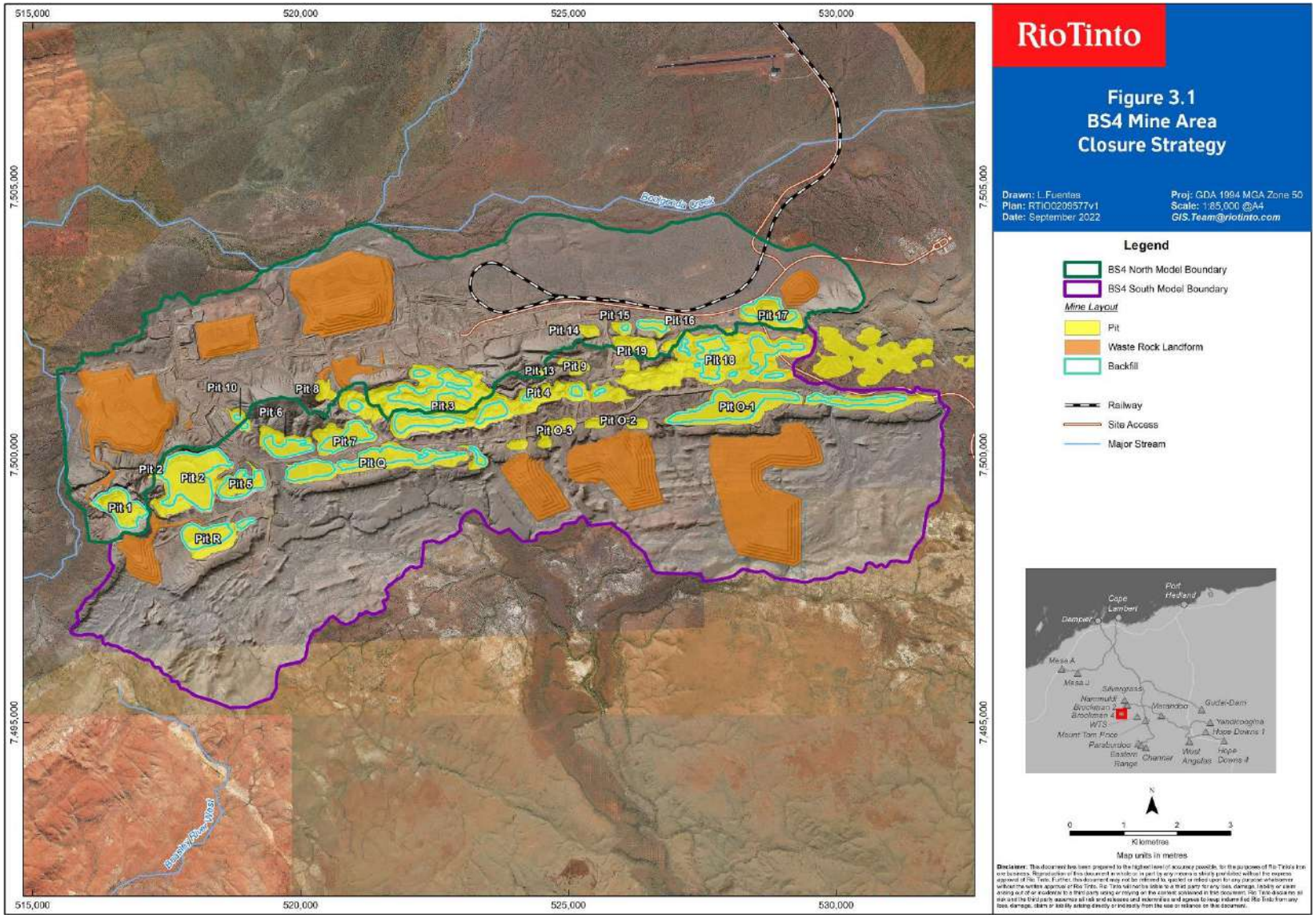


Figure 3-1 BS4 Mine Area Closure Strategy

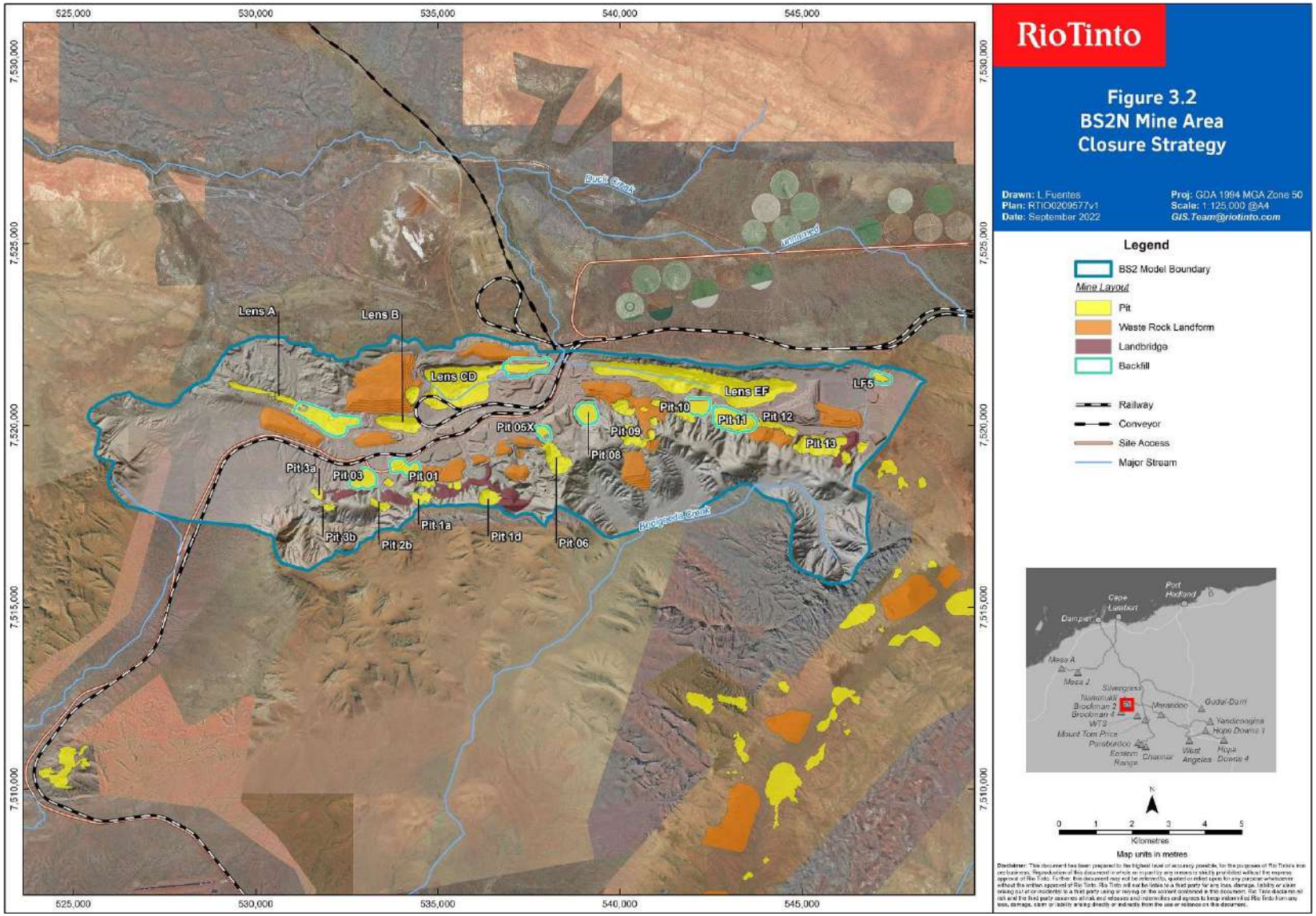


Figure 3-2 B2N Mine Area Closure Strategy

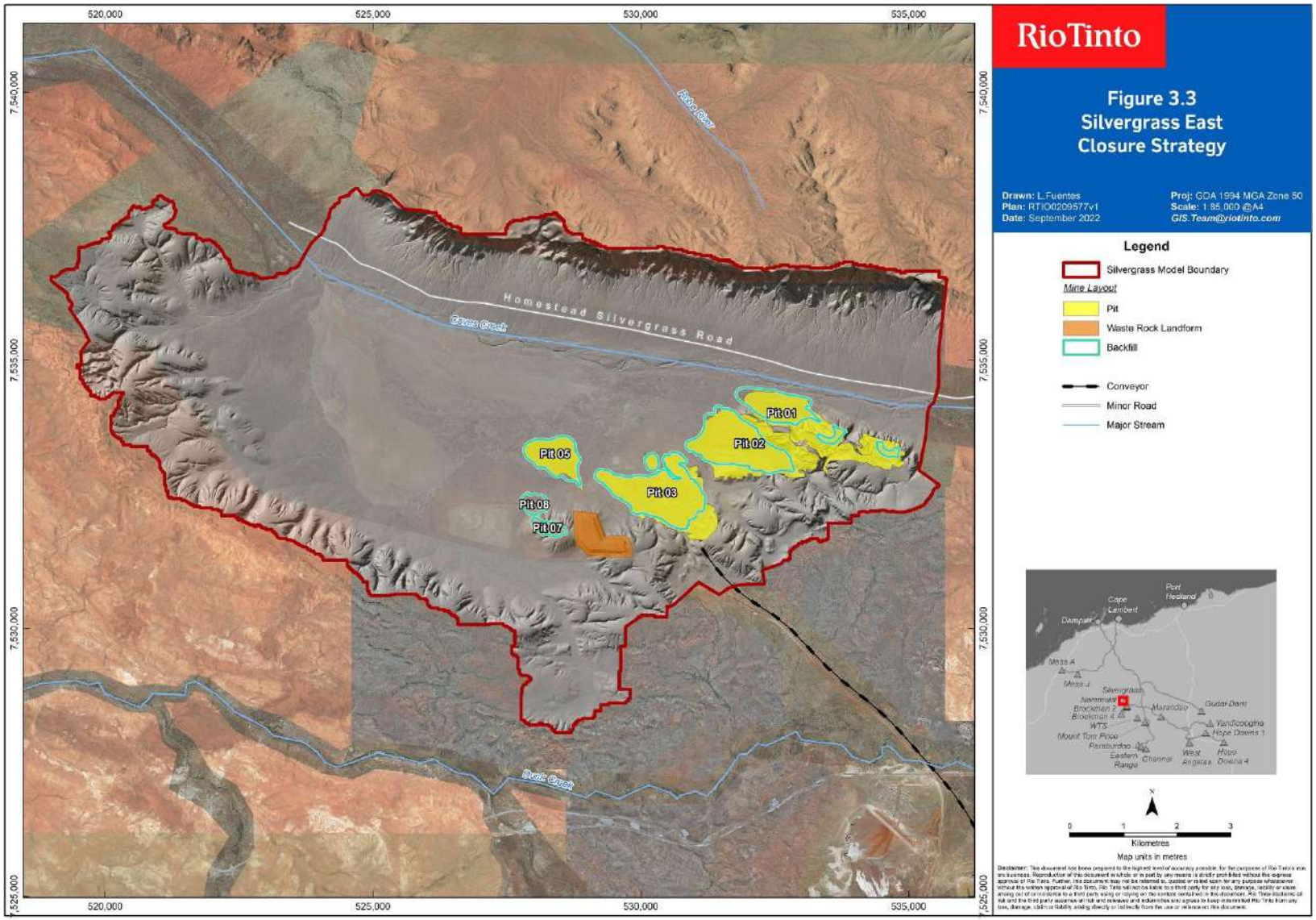


Figure 3-3 Silvergrass East Closure Strategy

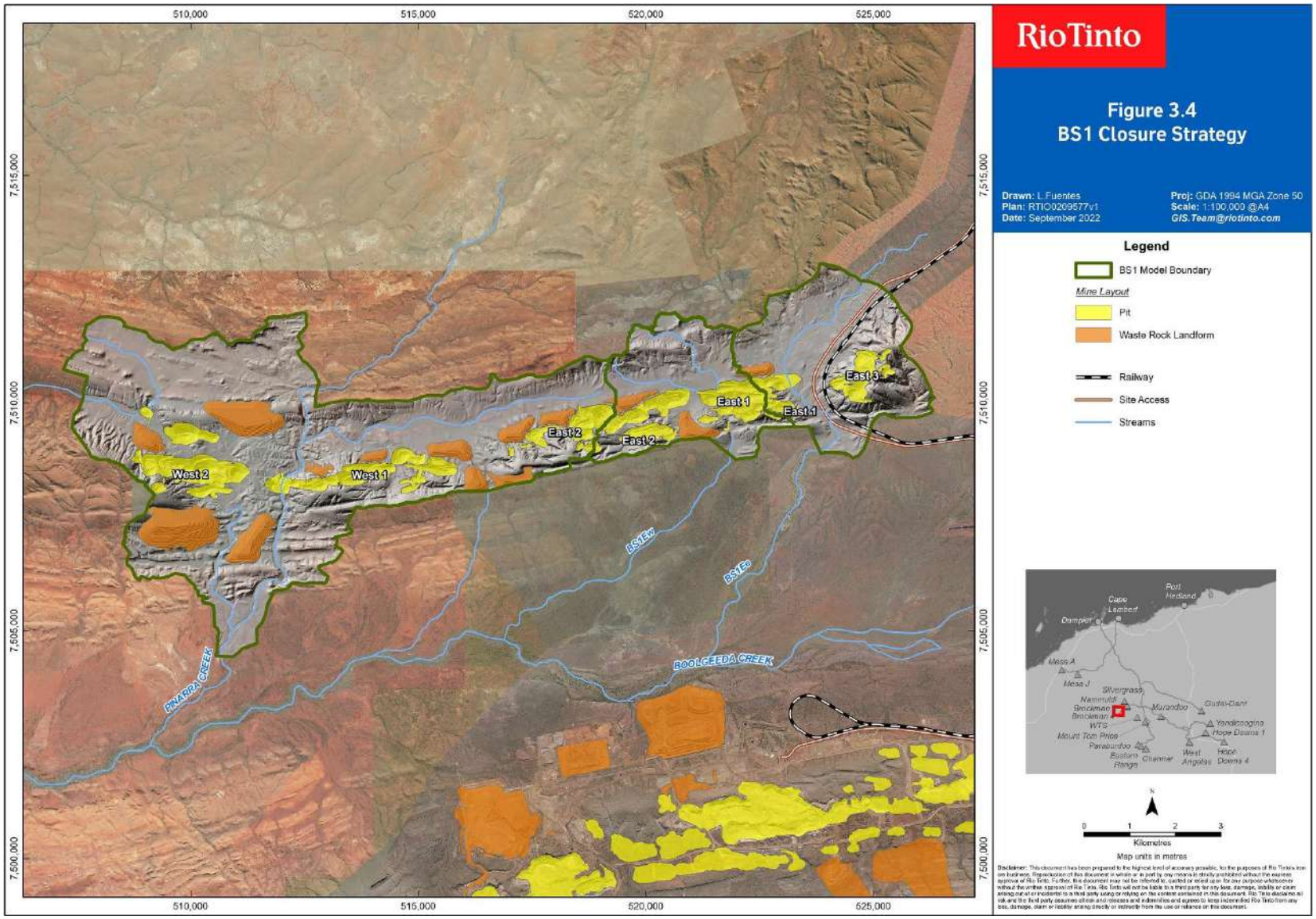


Figure 3-4 BS1 Closure Strategy

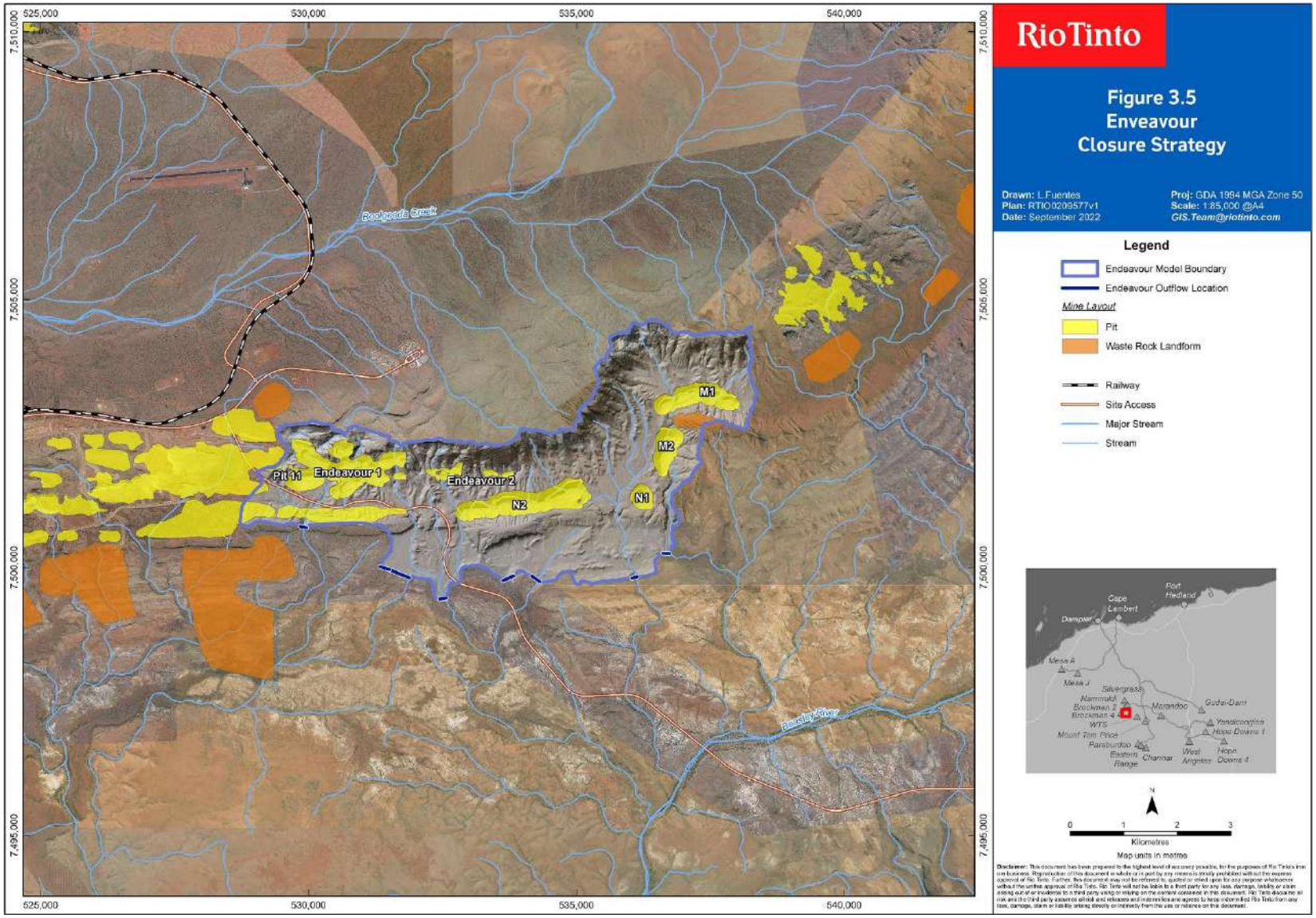


Figure 3-5 Endeavour Closure Strategy

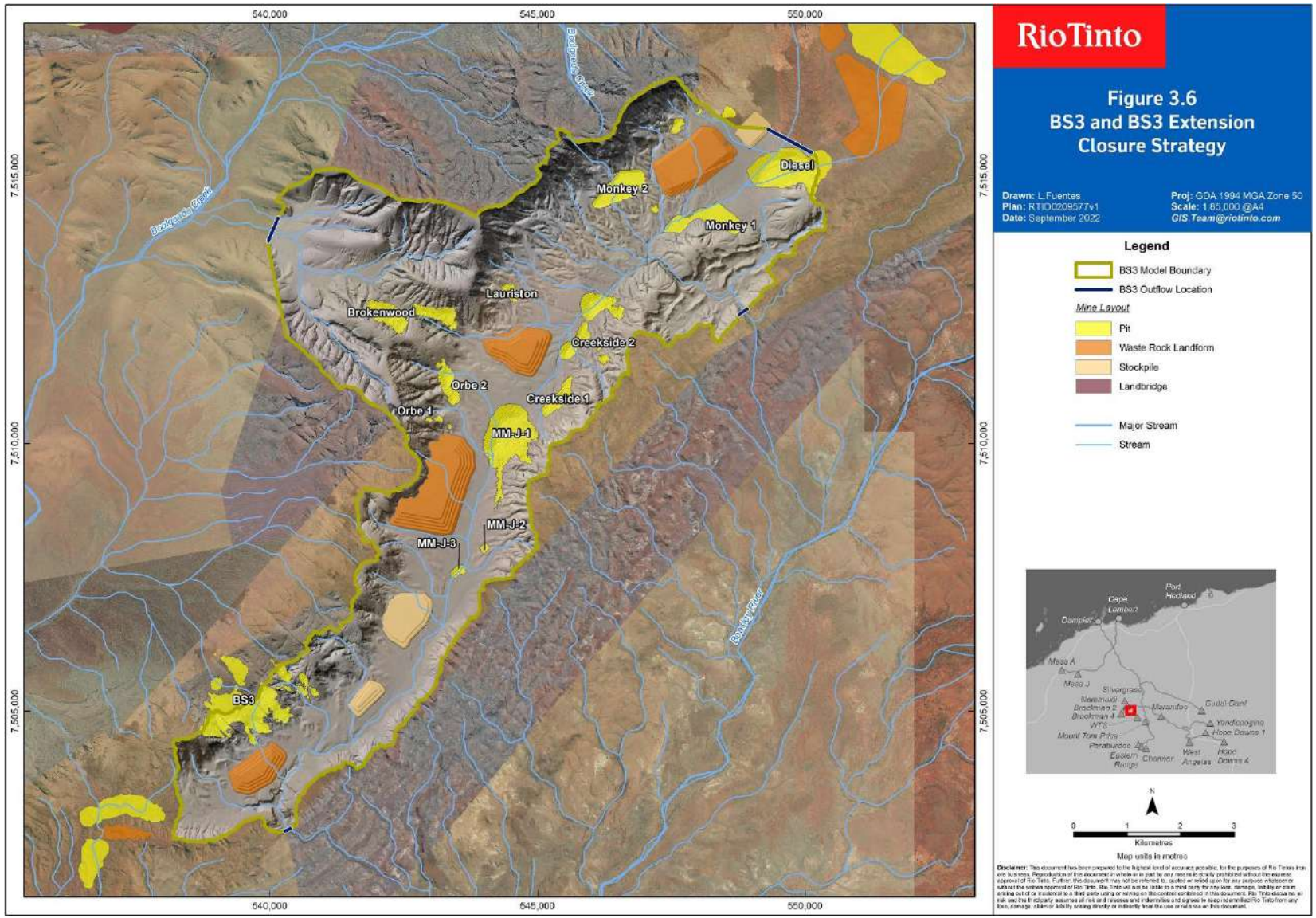


Figure 3-6 BS3 and BS3 Extension Closure Strategy

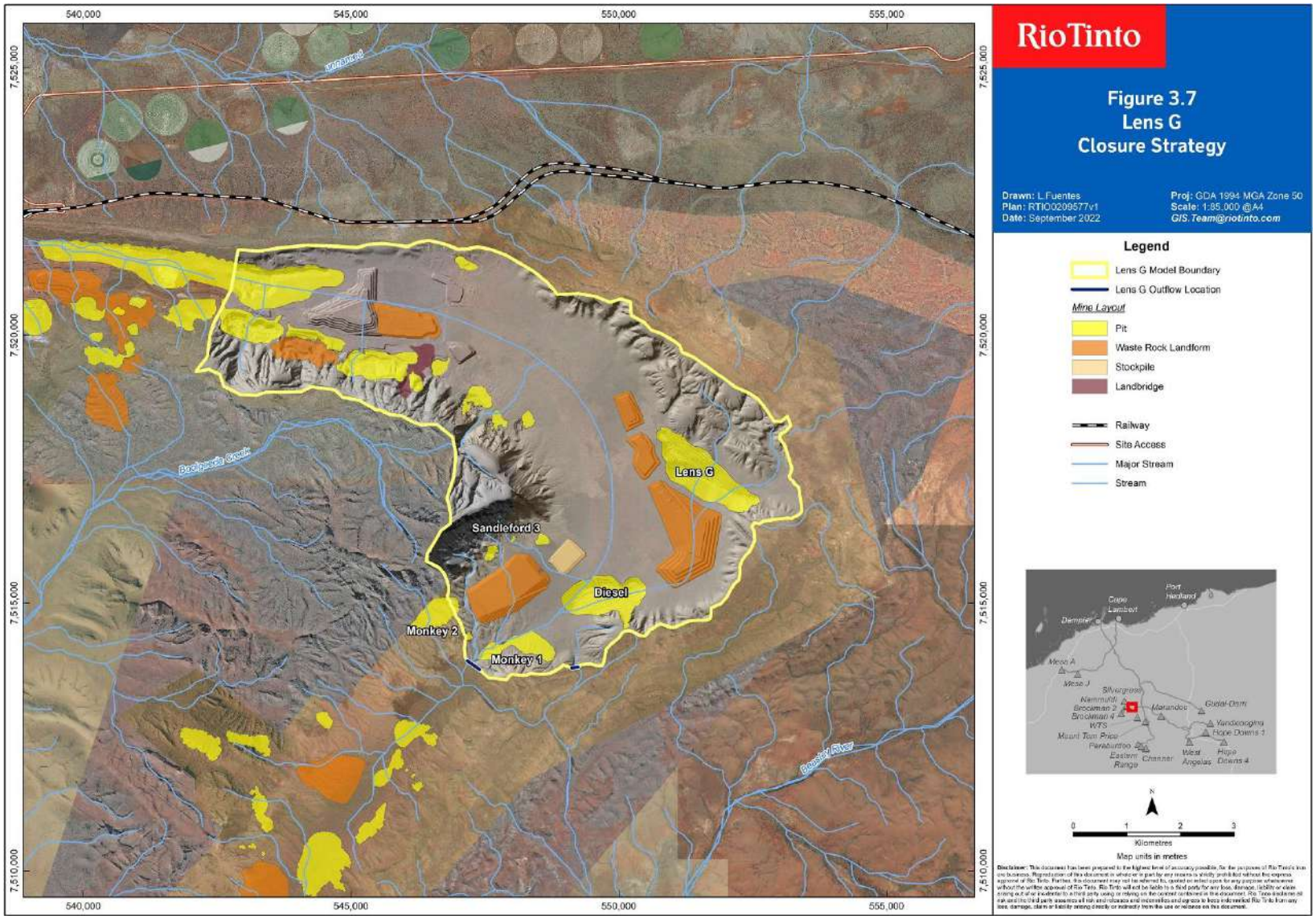


Figure 3-7 Lens G Closure Strategy

4. Hydrological Assessment

4.1 Design Events and Durations

When considering the flood hazard associated with rare to extreme events, it is important to recognise the uncertainty and limitations in estimating flood events with a very low probability of occurrence. As noted in ARR2019 (Ball et al, 2019), the uncertainties involved with the flood estimation process increase with increasing size of the flood. Events of between 1 in 100 AEP and 1 in 1,000 AEP are termed “very rare” but are considered within the range of largest direct observations and the credible limit of extrapolation (limit of plausible extrapolation from other sources of information). Extreme events are in the range between 1 in 10,000 AEP event and the probable maximum flood (PMF) represent the range of floods which borders on the ‘unknowable’, where even a high level of expertise cannot substantially reduce the level of uncertainty (Ball, et al., 2019). Figure 4-1 illustrates the nature of increasing uncertainty with increasing event size.

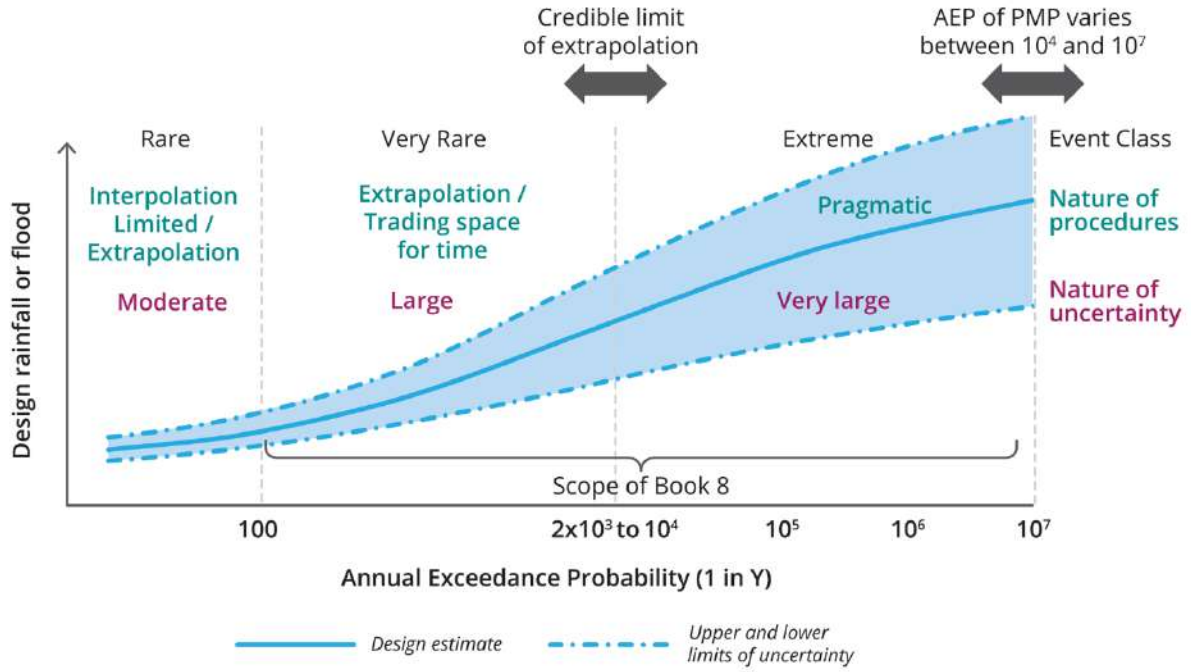


Figure 4-1 Design characteristics of notional event classes (Ball, et al., 2019)

The PMF is a design concept that notionally represents the upper limit on flood magnitude but for which an AEP cannot be readily assigned (Ball, et al., 2019). Although it is possible to produce an estimate of the PMF and simulate the associated flood hydraulics, this needs to be viewed in an appropriate context. There is no precedent for events of this magnitude in a catchment of this size in Australia or globally. The probability of the PMF cannot be reliably estimated as it requires both the probable maximum precipitation (PMP) rainfall and extremely wet antecedent catchment conditions to coincide. Furthermore, it is possible that a catchment may change its behaviour when subjected to extreme rainfalls (Ball, et al., 2019), with geomorphological mechanisms and changes in storage and routing behaviour possible. Extreme floods can be landscape altering even in the natural (undeveloped) environment which can in turn alter the magnitude of the flood flows.

Typically, estimates of the PMF would only be applied in very limited circumstances, for example, in the design of spillways for water or tailings dams which fall into a high-risk category. Application of the PMF is not appropriate for a generalised site-wide floodplain assessment. It may be appropriate to further

refine flood estimates of the PMF in future for application in risk assessments of specific infrastructure approaching closure, however the PMF is not a meaningful or practical design event to consider for site-wide floodplain assessment of operational infrastructure.

Because of the reasons described above, it is suggested that the following events are appropriate to inform closure planning:

- The **1 in 100** AEP flood can be reliably estimated using the methods adopted and is appropriate for use in floodplain assessments for operational infrastructure;
- The **1 in 1,000** AEP flood is a realistic event to use when identifying risks associated with greater than design flood events for operational assets, as it falls within the credible limit of extrapolation, and below the world maximum flood envelope curve; and
- As an extreme case, the **1 in 10,000** AEP flood event may be considered, as this event is at the upper end of the credible limit of extrapolation and is within the envelope curve.

4.2 Design Rainfall Depths, Areal Reduction Factor and Temporal Patterns

Design rainfall depths for the 1 in 100 and 1 in 1,000 AEP events were extracted from the Bureau of Meteorology (BoM's) website at the approximate centroid of each study catchment. For design events rarer than the 1 in 2,000 AEP, design rainfall depths are estimated by interpolating between the design depth of 1 in 2,000 AEP depth and PMP. The interpolation methods are described in ARR 2016, Book 8. Design rainfall depths for each mine area are presented in Appendix A – Design Rainfall Depths .

Design rainfall depths relate to a single point within the catchment of interest and thus are not representative of the entire study catchment. Typically, a larger catchment would have a lower likelihood of experiencing a storm with the same high rainfall intensities across the entire catchment. Areal reduction factor (ARF) represents the ratio between point design rainfall depths and areal average rainfall across the catchment. ARFs are recommended for catchment areas less than 30,000 km², for durations up to and including 168 hours and for annual exceedance probability (AEPs) more frequent than the 1 in 2,000 AEP (Ball, et al., 2019). The recommended ARF values have been applied to the study catchments in this assessment.

Temporal patterns describe how a rainfall event progress in time. Within Australia there are 12 temporal pattern regions; Figure 4-2 depicts these regions and shows that the Pilbara is within the Rangelands West region. For each region, 10 representative point and areal temporal patterns are available for download from the ARR Data Hub. It is recommended that point temporal patterns be used for catchments less than 100 km². All modelled catchments, except for the Boolgeeda Catchment, are less than 100 km² and thus point temporal patterns have been adopted. Areal temporal patterns were adopted for the *Boolgeeda Catchment* model.

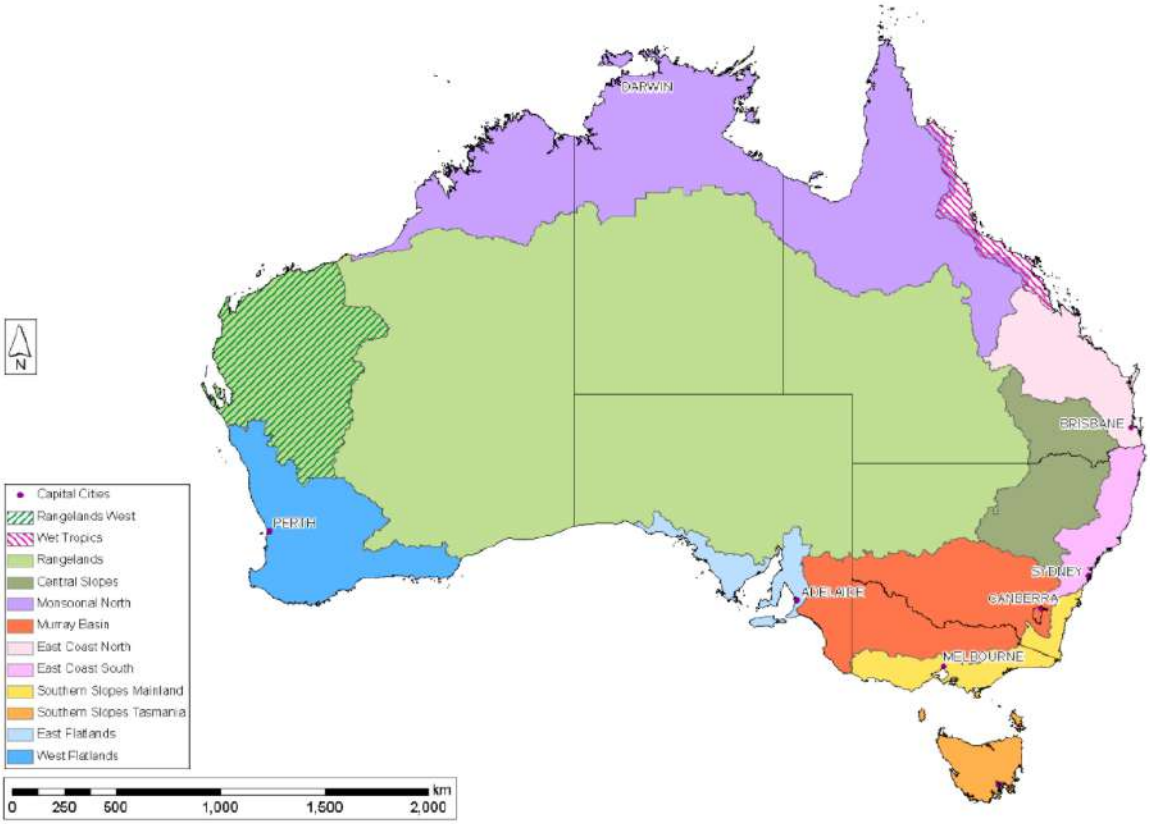


Figure 4-2 Temporal pattern region (Ball, et al., 2019)

4.3 Design Losses

The design losses represent all physical processes that occur after rainfall and before any runoff is generated. These losses include infiltration to the soils, interception by vegetation and retention in surface depressions. The initial loss (IL) – continuing loss (CL) model was adopted for this assessment. The IL is subtracted from the design rainfall depth. After the criteria for the IL is satisfied, CL is applied throughout the rainfall event, as illustrated in Figure 4-3.

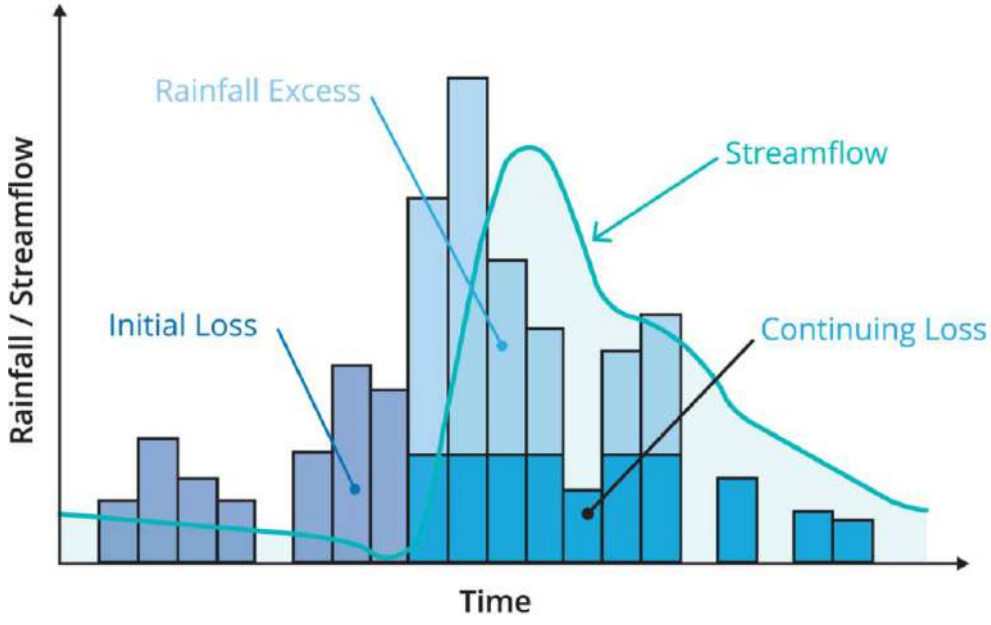


Figure 4-3 IL – CL model (Ball, et al., 2019)

5. Hydraulic Modelling

5.1 BS4 Mine Area

Three TUFLOW hydraulic models were developed to cover the BS4 Mine Area. Two models were created to encompass the BS4 mining area, one model on either side of the divide between the Boolgeeda Creek and Beasley River regional catchments. An additional model covering the entire Boolgeeda catchment was used to capture flows along Boolgeeda Creek, directly north of BS4.

The purpose of the hydraulic modelling is to identify and assess surface water risks at the landforms remaining at closure including expected ponding locations and areas of high velocity. TUFLOW version 2020-10-AA was used in this study.

5.1.1 Model Extent

BS4 South encompasses BS4 operational areas that are within the Beasley River catchment. The model domain is 58 km² and is depicted in Figure 5-1. BS4 North covers BS4 mining operation located in the Boolgeeda Creek catchment. Since most of BS4 operations are situated high up in the catchment, outside of the Boolgeeda Creek floodplain, the flooding characteristics would be very different to that of Boolgeeda Creek with a much larger contributing catchment. Thus, a smaller and higher resolution model was developed to analyse the flooding characteristics of this area. *BS4 North*'s model domain is 38 km² and ends upstream of the main tributary of Boolgeeda Creek as illustrated in Figure 5-1. The third model used in this study is the *Boolgeeda Catchment* model, which was developed as part of the Brockman Syncline Proposal. Details of the model development can be found in Brockman Syncline Proposal – Hydrology and Hydraulics Report (Rio Tinto, 2021). The Boolgeeda Catchment TUFLOW model covers 462 km² with multiple inflow boundaries.

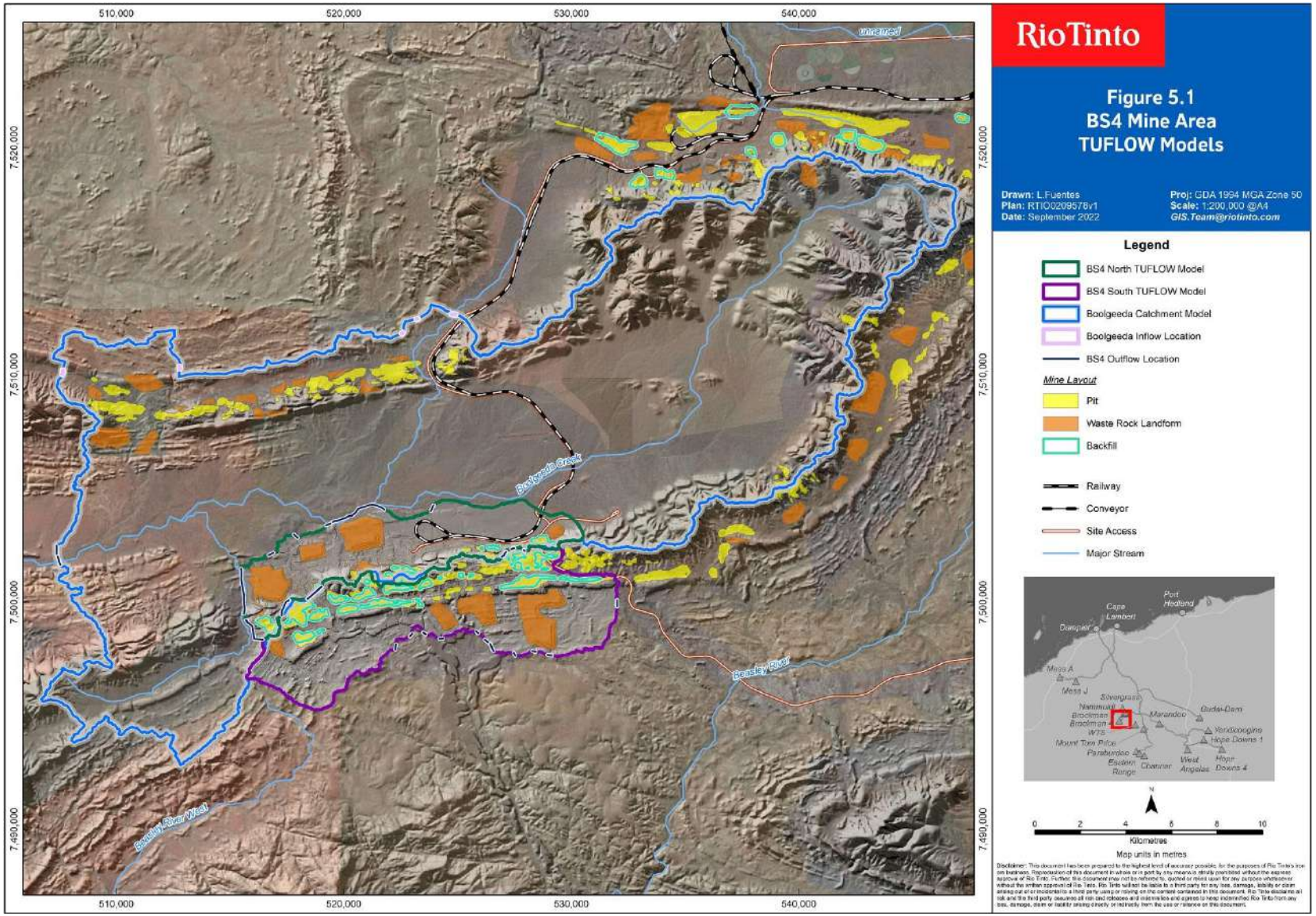


Figure 5-1 BS4 Mine Area TUFLOW models

5.1.2 Boundary Conditions and Manning's 'n'

A rain-in-grid (RoG) approach, where inflow is applied in the form of direct rainfall onto the entire model domain, has been adopted. TUFLOW calculates the excess rainfall, and hence runoff, based on the topographic data, model grid size and surface roughness.

For the BS4 South and BS4 North models, the critical durations of the design events were determined by assessing a range of storm durations using ten ensemble temporal patterns. The duration of storm that produces the largest flood response in terms of flow rate is classified as the critical duration of the catchment. The critical duration for the 1 in 100 and 1 in 1,000 AEP storms is 6 hours, while the critical duration for the 1 in 10,000 AEP is 3 hours.

A different approach was adopted for the Boolgeeda Catchment model. This is documented in *Brockman Syncline Proposal – Hydrology and Hydraulics Report* (Rio Tinto, 2022). The hydrological characterisation of the catchment was derived using RORB (hydrological software that simulates catchment runoff response). The hydrological model determines that the critical durations for the 1 in 100 and 1 in 1,000 AEP storms is 24 hours, while the critical duration for the 1 in 10,000 AEP is 6 hours. The critical storm is applied as RoG over the entire domain of the hydraulic model. In addition to RoG, the *Boolgeeda Catchment* hydraulic model also adopted flow hydrographs from RORB as inflows. This approach reduces model simulation time by reducing the model extent as Boolgeeda Creek has a large contributing catchment. The inflow locations are illustrated in Figure 5-1.

Outflow boundaries are placed downstream of the model extent to allow runoff to flow out of the model domain. A slope is prescribed to each outflow boundary based on topographic data. The boundaries are set at a sufficient distance from any infrastructure to prevent backwater effects.

The roughness of the terrain is represented in the hydraulic model with a roughness coefficient, Manning's 'n'. A uniform value of 0.04 is adopted for this study as it provides a good representation of the floodplain conditions in the study area.

5.1.3 Digital Terrain Model

A Digital Terrain Model (DTM) was created from a combination of high-resolution LiDAR data and coarser regional topographic data. The list of LiDAR datasets used for this study is included in Table 5-1. In areas where LiDAR is unavailable, regional 20 m resolution DTMs were used to produce topographic surfaces that covered each 2D model domain.

Table 5-1: LiDAR dataset used for the development of hydraulic model DTM

LiDAR	Vertical Accuracy (m)	Date
GDA94_MGA_Z50_RTP_Brockman_4_Combined_2104_DEM-GRID_001_Mosaic	0.10	21/04/2021
Brockman201703_5m	0.15	10/03/2017
Brockman 4_2016_09_AAM_10cm_TGP_0.5m	0.10	30/09/2016
Brockman4_201509_5m_MGA50	0.15	06/09/2015
Brockman_Rail_200611_5m_MGA50	0.10	22/11/2006

To simulate the topography at closure, the following alterations were done to the DTM:

- LoM pits and waste rock landforms designs obtained April 2022 were included in the DTM. It is noted that the LoM has not been updated to reflect the design where DP5 was split to avoid

intercepting a tributary to the east of the waste rock landform. This will be modelled during the next iterations once the design is approved;

- The proposed pit backfill levels have been incorporated into the model; and
- There is no operational flood protection in place.

A grid size of 5 m was adopted for the two models encompassing the BS4 mining area as it provides a fine enough resolution while maintaining a reasonable model run time. As the *Boolgeeda Catchment* TUFLOW model domain is an order of magnitude larger, Sub Grid Sampling (SGS) was utilised where a coarser grid can be used for parts of the model while maintaining the storage and conveyance accuracy of a higher resolution digital terrain. A grid size of 20 m was adopted for this model with SGS at 5 m intervals.

5.1.4 Losses

Design losses adopted by the TUFLOW models in this study are summarised in Table 5-2.

Table 5-2: Design losses adopted in BS4 TUFLOW models

Model	IL/CL		
	1 in 100 AEP	1 in 1,000 AEP	1 in 10,000 AEP
BS4 North	59 mm; 8.9 mm/hr		
BS4 South	59 mm; 8.9 mm/hr		
Boolgeeda Catchment [1]	67 mm; 8.9 mm/hr	103.5 mm; 8.9 mm/hr	80.24 mm; 8.9 mm/hr

It is important to note that the available data used to generate the regional design losses are sparse in the Pilbara. Based on available information, it is suggested that the median loss values in the Pilbara are some of the highest in Australia (Ball, et al., 2019). Regional loss values for the catchment of interest extracted from the ARR Data Hub are 59 mm for IL and 8.9 mm/hr for CL. In the absence of data for calibrated catchments, these values were adopted in this study.

5.1.5 BS4 Model Results

The peak flood depth and velocity for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events are presented in Appendix B – BS4 Mine Area Closure Floodplain Mapping. The model results indicate that pits that are not backfilled to surface would intercept natural flow paths causing ponding at the base of the pits which will result in loss of flow to downstream catchments. Any risks identified at BS4 at closure are detailed in Section 6.1.

[1] *Derivation of design losses for the Boolgeeda Catchment model is documented in in Brockman Syncline Proposal – Hydrology and Hydraulics Report* (Rio Tinto, 2022)

5.2 B2N Mine Area

A single TUFLOW hydraulic model was developed encompassing the B2N mining area. The model setup is detailed below.

5.2.1 Model Extent

The model domain includes proposed and existing pits at B2N. The model area, covering an area of 81.9 km², is shown in Figure 5-2**Error! Reference source not found.**. The model domain includes the contributing catchments of the pits assessed.

5.2.2 Boundary Conditions and Manning's 'n'

A RoG approach was adopted for this model. Design rainfall depths are presented in for the model is documented in Appendix A – Design Rainfall Depths. The critical duration was determined by simulating a range of storm durations for each design events assessed. The storm duration that produces the largest flood is considered the critical duration. For B2N, the critical duration for the 1 in 100 and 1 in 1,000 AEP is the 6-hour storm whereas the critical duration for the in 1 in 10,000 AEP event is the 12-hour storm.

Outflow boundaries are placed downstream of the model extent to allow runoff to flow out of the model domain. A slope is prescribed to each outflow boundary based on topographic data. The boundaries are set at a sufficient distance from any infrastructure to prevent backwater effects.

A uniform Manning's 'n' value of 0.04 is adopted for this study as it provides a good representation of the floodplain conditions in the study area.

5.2.3 Digital Terrain Model

The list of LiDAR datasets used to create a DTM for this study is included in Table 5-3. In areas where LiDAR is unavailable, coarse regional elevation data were used to develop a DTM covering the full model domain.

Table 5-3: LiDAR dataset used in the development of the B2N hydraulic model DTM

LiDAR	Vertical Accuracy (m)	Date
BR2_2020_06_Aerometrex_10cm_PE	0.10	15/06/2020
BR_2020_03_AAM_15cm_PE	0.15	10/06/2020
BO_2019_06_Valley_Up_AAM_10cm_PE	0.10	24/06/2019
BR_2017_03_AAM_15cm_PE	0.15	10/03/2017
SI_2012_08_AAM_10cm_PE	0.10	03/08/2012
SI_2008_05_Fugro_15cm_PE	0.15	09/05/2008

To simulate the topography at closure, the following alterations were applied to the DTM:

- Infrastructure intercepting drainage lines were removed; and
- LoM pit designs obtained on 14/04/2021 were included in the DTM for pits that are not backfilled to surface.

The model grid size adopted is 10 m as it provides a fine enough resolution while maintaining a reasonable model run time.

5.2.4 Losses

Regional loss values for the catchment of interest extracted from the ARR Data Hub are 60 mm for IL and 8.3 mm/hr for CL. CL of 8.3 mm/hr is unusually high for the region. In the absence of data to calibrate the model, 6 mm/hr was adopted as a more conservative approach.

5.2.5 B2N Model Results

The hydraulic model results are presented as peak flood depth and velocity maps for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events in Appendix C – B2N Mine Area Closure Floodplain Mapping. The findings from the hydraulic models and surface water risks identified at B2N at closure are detailed in Section 6.2.

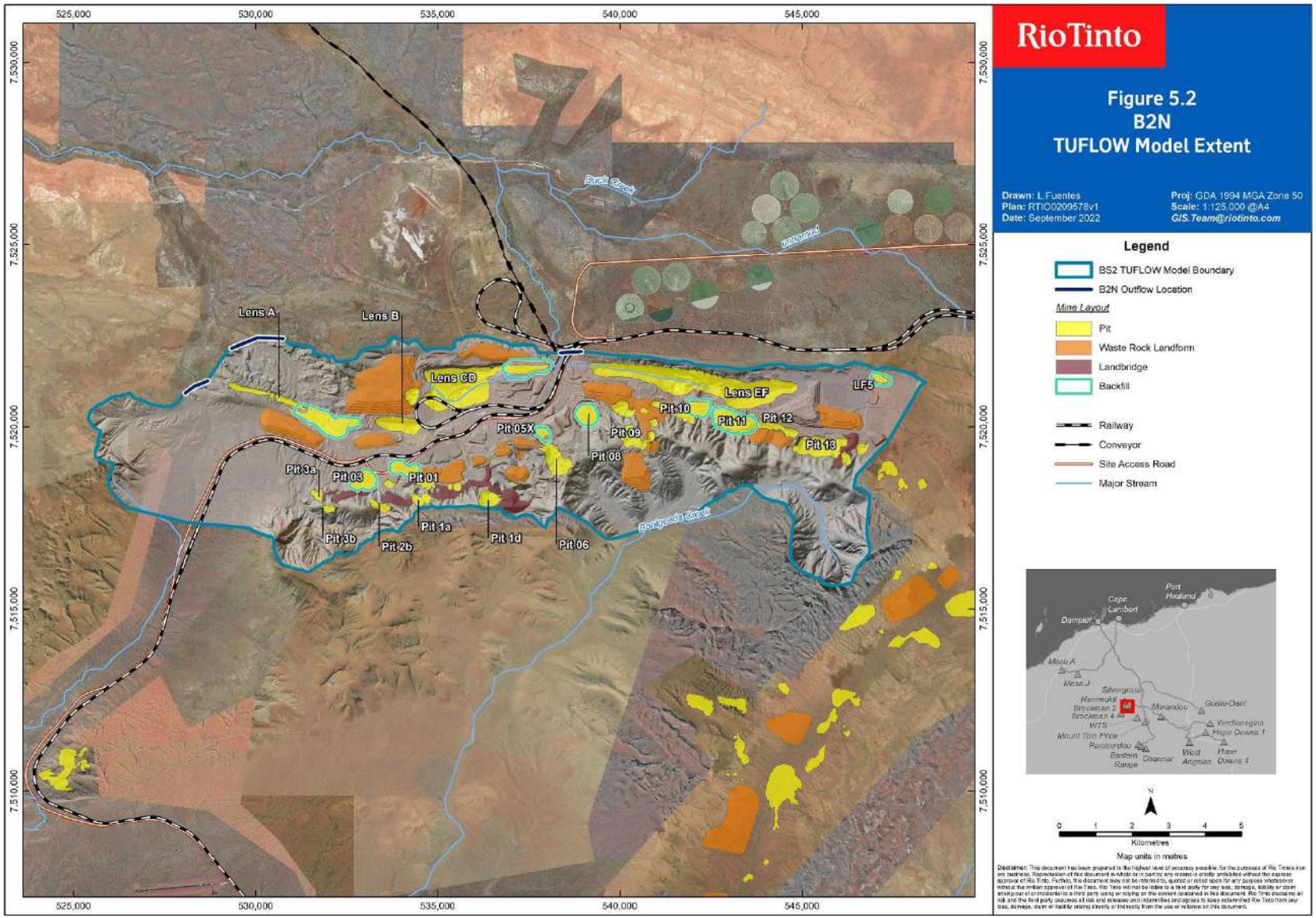


Figure 5-2 B2N TUFLOW model extent

5.3 Silvergrass East

A high resolution TUFLOW hydraulic model was developed as part of the *Caves Creek Baseline Hydrology* (HARC, 2019). The model extent covers SLVE as well as a large portion of Caves Creek downstream of SLVE. The TUFLOW model developed by HARC (2019) was refined and updated to fit the purpose of this study. The details of the TUFLOW model used in this study are described in detail below.

5.3.1 Model Extent

The TUFLOW model domain covers approximately 98 km² including the operations at SLVE as shown in Figure 5-3. To maintain simulation run times to a manageable amount, the upstream catchment of Caves Creek was not included in the hydraulic model development. Section 5.3.2 describes the inflow boundaries included to incorporate streamflow from the upstream catchment to the model domain.

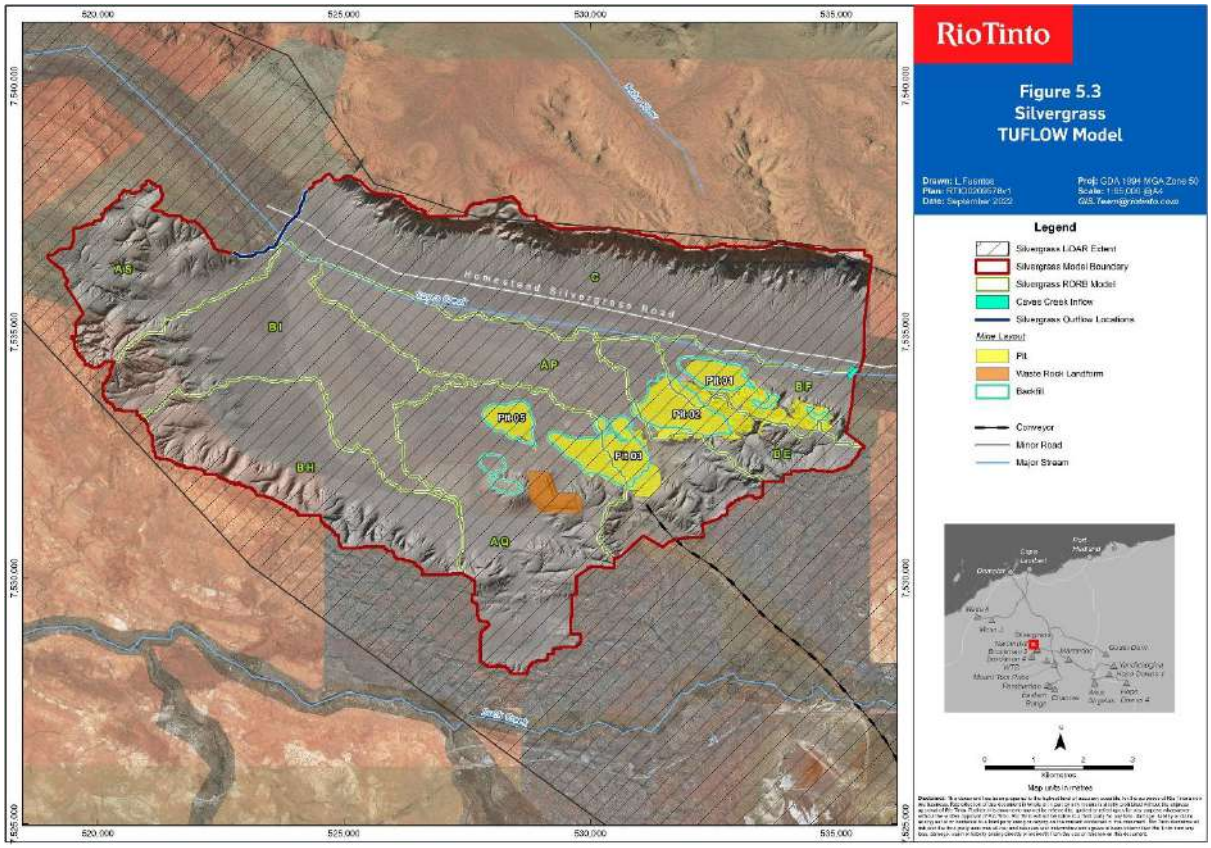


Figure 5-3 SLVE TUFLOW model

5.3.2 Boundary Conditions and Manning's 'n'

In the hydrological study completed by HARC (2019), a combination of hydrological and hydraulic models was used to quantify the streamflow in Caves Creek from the upstream catchment as well as the runoff produced within the TUFLOW model domain. The 2019 study produced inflow hydrographs for a series of design events ranging from 1 in 2 AEP to the probable maximum flood (PMF). The design flows adopted in this assessment are 1 in 100, 1 in 1,000 and 1 in 10,000 AEP.

In this assessment, the model inflows are applied in two ways. The inflow from Caves Creek is applied to the creek's main tributary on the most upstream edge of the TULFOW model domain as shown in Figure 5-3. The Caves Creek inflow hydrographs adopted are shown in Figure 5-4. The runoff from the rest of the catchment covered by the model domain were derived from the RORB model developed in *Caves Creek Baseline Hydrology* (HARC, 2019). The rainfall excess from the RORB model subareas

that coincides with the hydraulic model were applied as inflow hydrographs. This is done by applying water to all active 2D cells.

Outflow boundaries are placed downstream of the model extent to allow runoff to flow out of the model domain. A slope is prescribed at the outflow boundary based on topographic data. The boundaries are set at a sufficient distance from any infrastructure to prevent backwater effects.

A uniform Manning's 'n' roughness value of 0.04 was adopted for this study as it provides a good representation of the floodplain conditions in the study area.

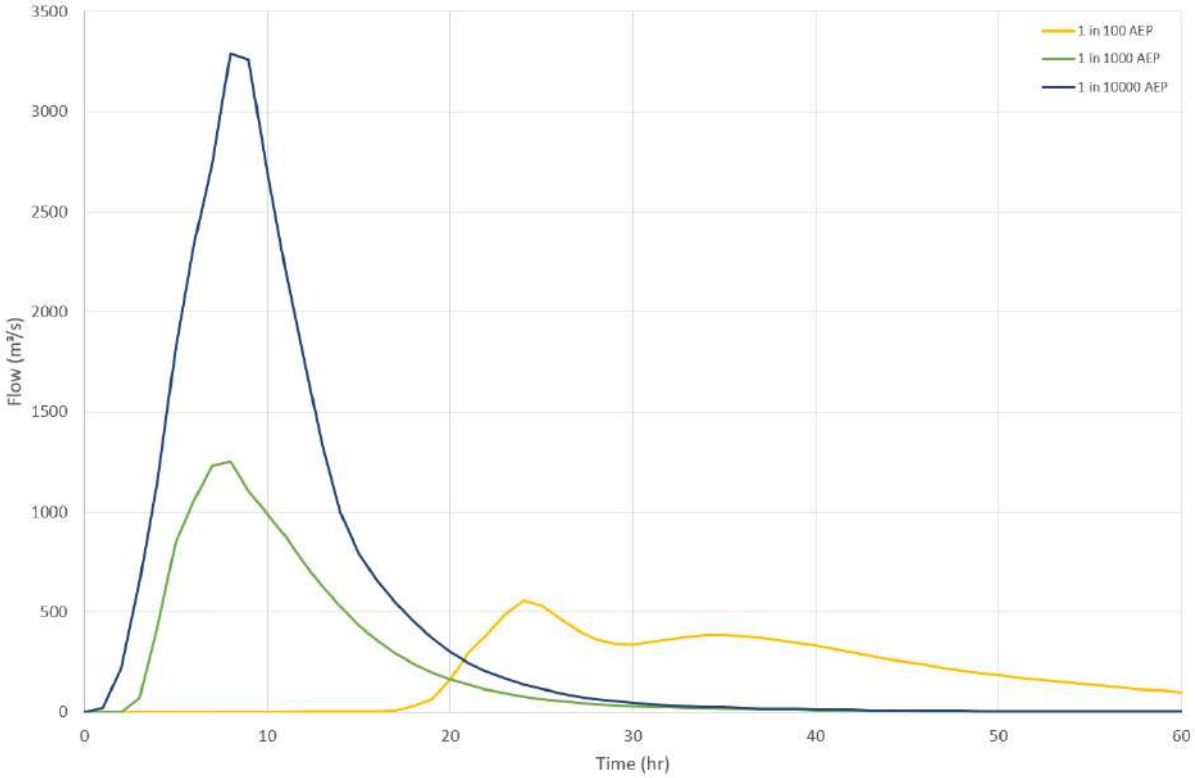


Figure 5-4 Model inflow hydrographs from Caves Creek

5.3.3 Digital Terrain Model

A DTM was created from a combination of high-resolution LiDAR data and coarser regional topographic data. The LiDAR data used in this study, 2008-05_Fugro_15cm, was captured in May 2008 with vertical accuracy of 0.15 m. The extent of this dataset is illustrated in Figure 5-3.

To simulate the topography at closure, the following alterations were applied to the DTM:

- Infrastructure intercepting drainage lines were removed;
- LoM pit designs obtained on 14/04/2021 were included in the DTM; and
- Backfill strategy BWT mining pits assumed backfilled to above groundwater levels.

The model grid size adopted was 10 m as it provided a fine enough resolution while maintaining a reasonable model run time.

5.3.4 SLVE Model Results

The maximum flood depths and peak flood velocities estimated from TUFLOW are presented in Appendix D – Silvergrass Closure Floodplain Mapping. Surface water risks identified at closure are detailed in Section 6.3.

5.4 BSP Closure Models

Six local TUFLOW hydraulic models were developed to encompass the proposed BSP deposits. The models are described below.

5.4.1 Model Extent

The models developed in this study and the corresponding area is summarised in Table 5-4. An overview of the model extents is shown in Figure 5-5.

The approach taken to determine the model grid size was based on a compromise between model run time and adequate resolution to represent key topographic features. A grid size of 5 m was adopted for all models.

5.4.2 Boundary Conditions and Manning's 'n'

A RoG approach was adopted for all models. Outflow boundaries are placed downstream of the model extent to allow runoff to flow out of the model domain. A slope is prescribed to each outflow boundary based on topographic data. The boundaries are set at a sufficient distance from any infrastructure to prevent backwater effects.

Two of the six model domains required inflow boundaries in the form of a flow hydrograph, in addition to direct rainfall. These were BS1WC and BS1Ew, owing to LiDAR constraints. The inflow hydrographs were extracted from the RORB models. Table 5-4 shows the corresponding RORB model where inflow boundaries, design losses and rainfall hyetographs were adopted.

Flow estimates for the 1 in 100 AEP, 1 in 1,000 AEP and 1 in 10,000 AEP events were estimated using the Monte Carlo approach. The development of the RORB models for the 1 in 100 AEP and 1 in 1,000 AEP events is documented in the *Brockman Syncline Proposal – Hydrology and Hydraulics Report* (Rio Tinto, 2022). The RORB model was re-run to simulate the 1 in 10,000 AEP event for this assessment

Table 5-4: TUFLOW models and their corresponding RORB model for inflow boundaries

TUFLOW Model	Area (km²)	RORB Model	QT Inflow	Direct Rainfall
BS1CW	42.2	BS1C, BS1W	✓	✓
BS1Ew	8.7	BS1Ew	✓	✓
BS1Ee	11.5	BS1Ee	X	✓
END-MN	24.0	BSMN, Kurwillinha Pool	X	✓
Lens G	49.4	Lens G (peak flow)	X	✓
BS3EXT	62.4	BS3 CKSD, BS3 MM-J	X	✓

A uniform Manning's 'n' value of 0.04 is adopted for this study as it provides a good representation of the floodplain conditions in the study area.

Model configurations for the six hydraulic models are presented in Appendix E – BSP TUFLOW Model Layouts.

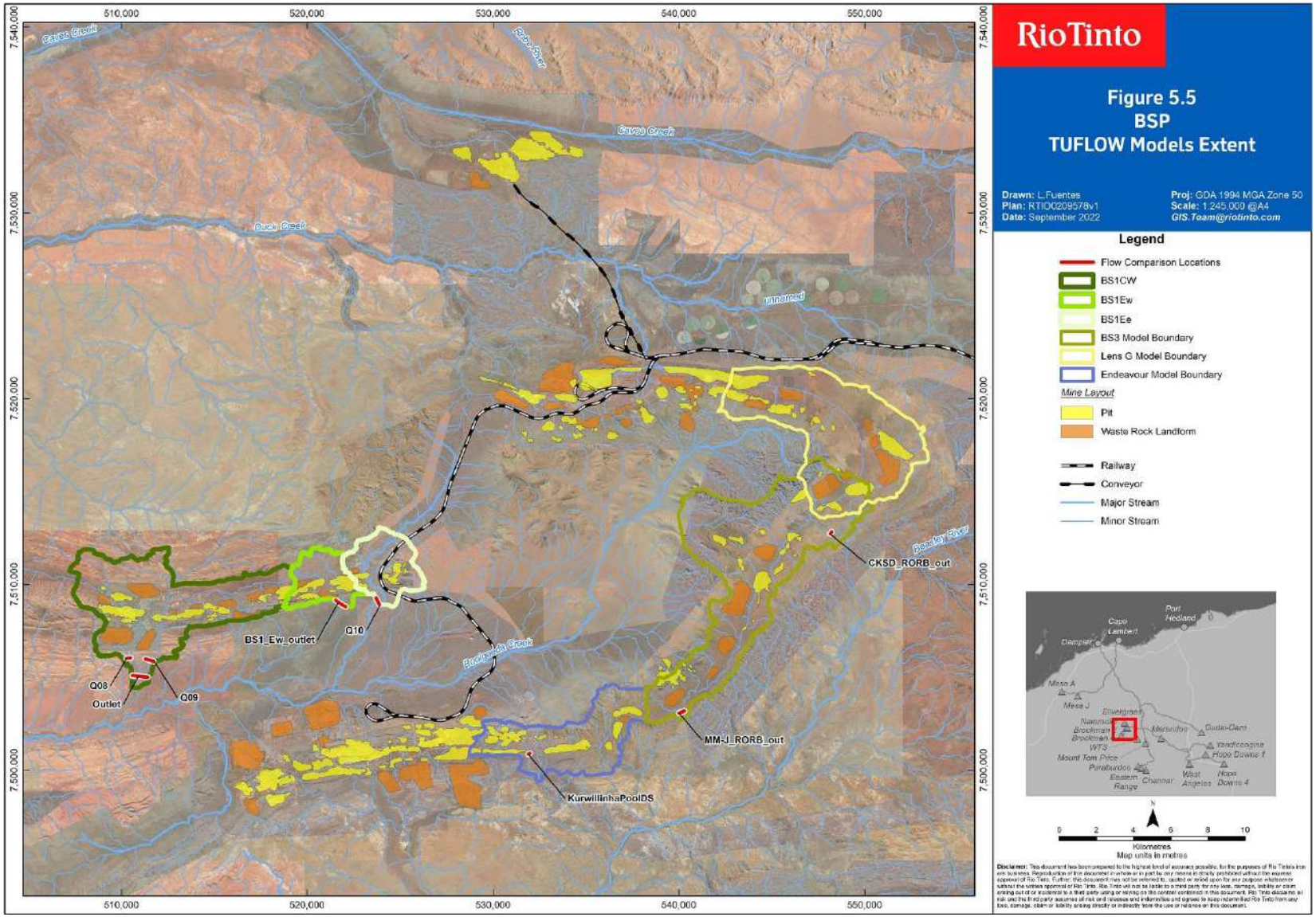


Figure 5-5 BSP TUFLOW models extent

5.4.3 Digital Terrain Model

A DTM was created from a combination of high-resolution LiDAR data and coarser regional topographic data. The list of LiDAR datasets used for this study is included in Table 5-5. These datasets were used to form a baseline topography for TUFLOW model.

Table 5-5: LiDAR dataset used for the development of the BSP hydraulic models

LiDAR	Vertical Accuracy (m)	Date
BR_2006_11_AAM_10cm_PE	0.10	22/11/2006
WTS_2007_08_Fugro_15cm_PE	0.15	17/08/2007
SI_2008_05_Fugro_15cm_PE	0.15	09/05/2008
WP_2011_12_Fugro_13cm_PE	0.13	30/12/2011
SI_2012_08_AAM_10cm_PE	0.10	03/08/2012
BR_2013_08_AAM_10cm_PE	0.10	28/08/2013
BR4_2015_09_AAM_15cm_PE	0.15	06/09/2015
BR4_2016_09_AAM_10cm_PE	0.10	30/09/2016
BR1_2016_12_AAM_10cm_PE	0.10	24/12/2016
BR_2017_03_AAM_15cm_PE	0.15	10/03/2017
BO_2019_06_Valley_Up_AAM_10cm_PE	0.10	24/06/2019
BR1_2019_06_AAM_10cm_PE	0.10	24/06/2019
BO_2019_06_Valley_Down_AAM_10cm_PE	0.10	25/06/2019
CC_2020_02_Aerometrex_10CM_1_PE	0.10	20/01/2020
BR2_2020_06_Aerometrex_10cm_PE	0.10	15/06/2020

The closure strategy discussed in Section 3.4 was incorporated into the model's DTM using the life of mine (LoM) design.

5.4.4 Losses

The design losses, temporal patterns and model parameters are summarised in Table 5-6. The setup and development of the hydrological model is documented in the *Brockman Syncline Proposal – Hydrology and Hydraulics Report* (Rio Tinto, 2022).

Table 5-6: RORB catchment parameters and peak flow estimates

Catchment	Critical Duration Event Parameters	Design Event (AEP)		
		1 in 100	1 in 1,000	1 in 10,000
BS1 W	Duration (hours)	6	2	2
	Temporal Pattern	30	4	6
	IL (mm)	50.0	40.0	15.0
	CL (mm/h)	9.4	9.4	9.4
	Peak Discharge (m³/s)	**130**	**250**	**665**
BS1 C	Duration (hours)	6	2	2
	Temporal Pattern	30	9	8
	IL (mm)	53.0	40.0	34.8
	CL (mm/h)	9.7	9.7	9.7
	Peak Discharge (m³/s)	**186**	**344**	**999**
BS1 Ee	Duration (hours)	6	2	2
	Temporal Pattern	30	4	8
	IL (mm)	60.0	40.0	46.0
	CL (mm/h)	9.7	9.7	9.7
	Peak Discharge (m³/s)	**210**	**426**	**1187**
BS1 Ew	Duration (hours)	6	1.5	1
	Temporal Pattern	21	5	9
	IL (mm)	9.4	20.0	56.1
	CL (mm/h)	8.9	8.9	8.9
	Peak Discharge (m³/s)	**61**	**116**	**261**
Lens G	Duration (hours)	6	1	1.5
	Temporal Pattern	30	10	7
	IL (mm)	60.0	30.0	31.72
	CL (mm/h)	6.7	6.7	6.7
	Peak Discharge (m³/s)	**14**	**31**	**707**
BS3 CKSD	Duration (hours)	6	1.5	1
	Temporal Pattern	30	6	7
	IL (mm)	61.0	30.0	40.87
	CL (mm/h)	6.7	6.7	6.7
	Peak Discharge (m³/s)	**146**	**239**	**572**
BS3 MM-J	Duration (hours)	6	3	2
	Temporal Pattern	30	5	8
	IL (mm)	48.2	30.0	41.48
	CL (mm/h)	6.7	6.7	6.7
	Peak Discharge (m³/s)	**108**	**187**	**435**
MM-M	Duration (hours)	6	1	0.5
	Temporal Pattern	23	10	30
	IL (mm)	61.0	30.0	50.63
	CL (mm/h)	6.7	6.7	6.7
	Peak Discharge (m³/s)	**36**	**79**	**137**

Catchment	Critical Duration Event Parameters	Design Event (AEP)		
		1 in 100	1 in 1,000	1 in 10,000
Kurwillinha Pool	Duration (hours)	0.75	0.75	1
	Temporal Pattern	30	28	26
	IL (mm)	35.0	39.5	16.77
	CL (mm/h)	6.7	6.7	6.7
	Peak Discharge (m^3/s)	**10**	**22**	**30**

5.4.5 BSP Model Results

The TUFLOW model estimates the maximum flood depth and velocity for each simulation. The results for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events for each model area are presented in Appendix G – BSP Closure Floodplain Mapping. A summary of the surface water risks for each catchment is provided in Section 6.4.

6. Risk Assessment

6.1 BS4

The BS4 flood maps (Appendix B – BS4 Mine Area Closure Floodplain Mapping) show that ponding occurs around waste rock landforms that intersect flow paths. This issue is the most apparent at DP5, DP8 and DP9. For example, DP9 waste rock landform intersects multiple tributaries causing ponding depths up to 6 m to the east of the waste rock landform in a 1 in 1,000 AEP event. Extensive ponding is also expected on the western side of the waste rock landform. DP8 intercepts some low lying areas on the northern side which resulted in ponding depth greater than 5 m in the 1 in 10,000 AEP event.

The hydraulic model also indicates that DP5 waste rock landform intersects a tributary at the north-eastern toe of the waste rock landform with ponding depths of up to 4 m expected in a 1 in 10,000 AEP event. As stated in Section 5.1.3, the design of DP5 has been updated. The updated design would see that the waste rock landform was split to avoid damming the tributary to the north-east. The position of the waste rock landform was also adjusted to be out of the 1 in 100 AEP floodplain. It is expected that the next iteration of modelling will include the updated design.

DP4 is adjacent to Boolgeeda Creek. The hydraulic modelling results shows that the northern toe of DP4 would intersect the floodplain.

The peak velocity maps show that flow velocities within the majority of the study area are less than 1 m/s and thus scour risk is relatively low. Flood velocities on the northern toe of DP4, caused by flows from Boolgeeda Creek, are estimated to be up to 3 m/s in a 1 in 10,000 AEP event, with depths up to 3 m (Figure 6-1 and Figure 6-2). Scour protection is recommended for areas around the waste rock landforms where high velocity (> 2 m/s) is predicted. It is estimated that velocities would also exceed 3 m/s along the western edge and south-east corner of DP9 in the 1 in 10,000 AEP event (Figure 6-3).

Where surface flows from minor tributaries flow into the pits, high velocities over the crest of the pits may also create a scour risk. The peak velocity maps show that there is a risk at Pits 3, 4, 6, 17, R, O2 and Q (See Appendix C velocity maps). It is recommended that pit crests that are likely to experience high velocity inflow should be protected with suitable erosion resistant material to prevent head cutting at closure.

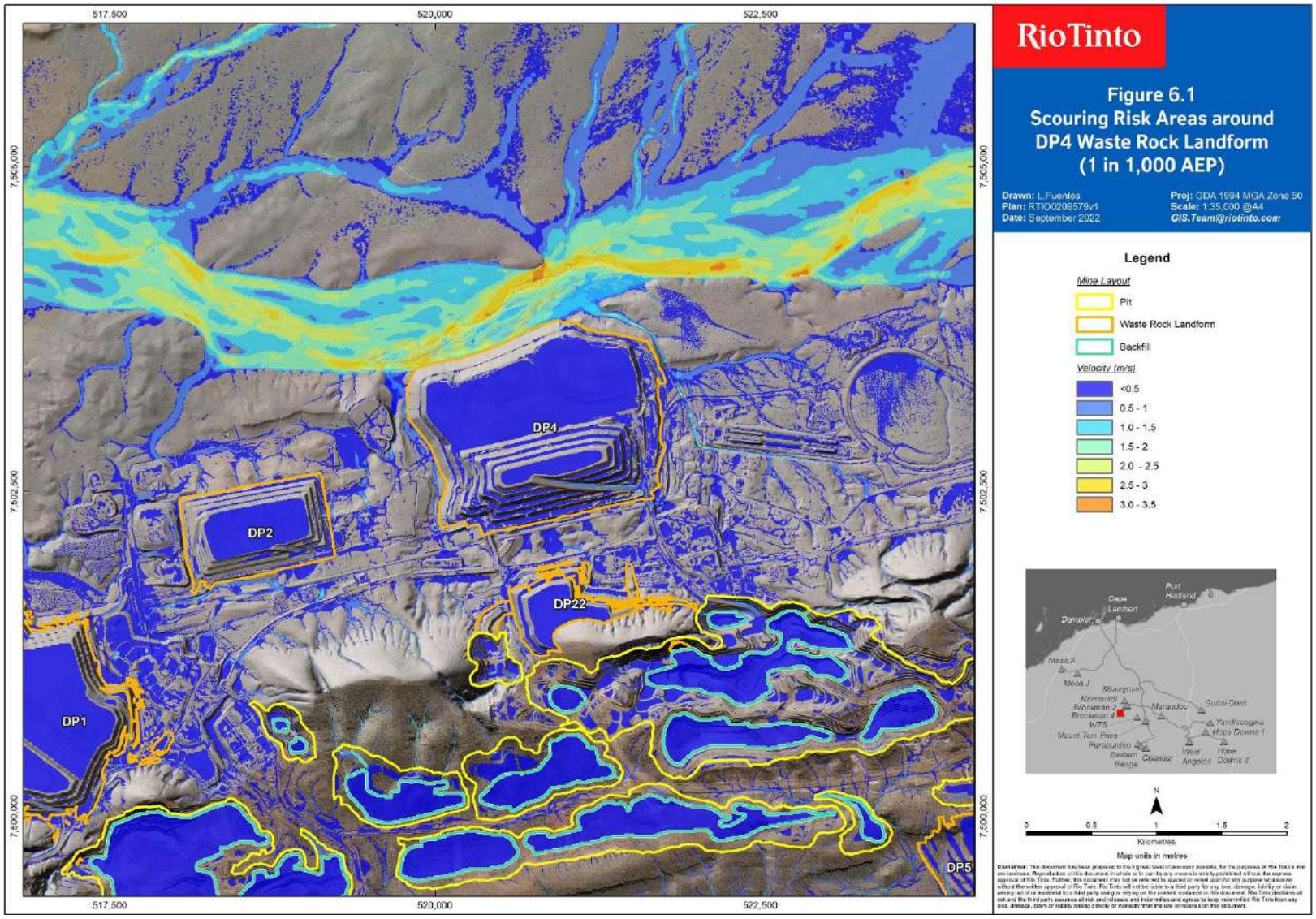


Figure 6-1 Scouring risk areas around DP4 waste rock landform (1 in 1,000 AEP)

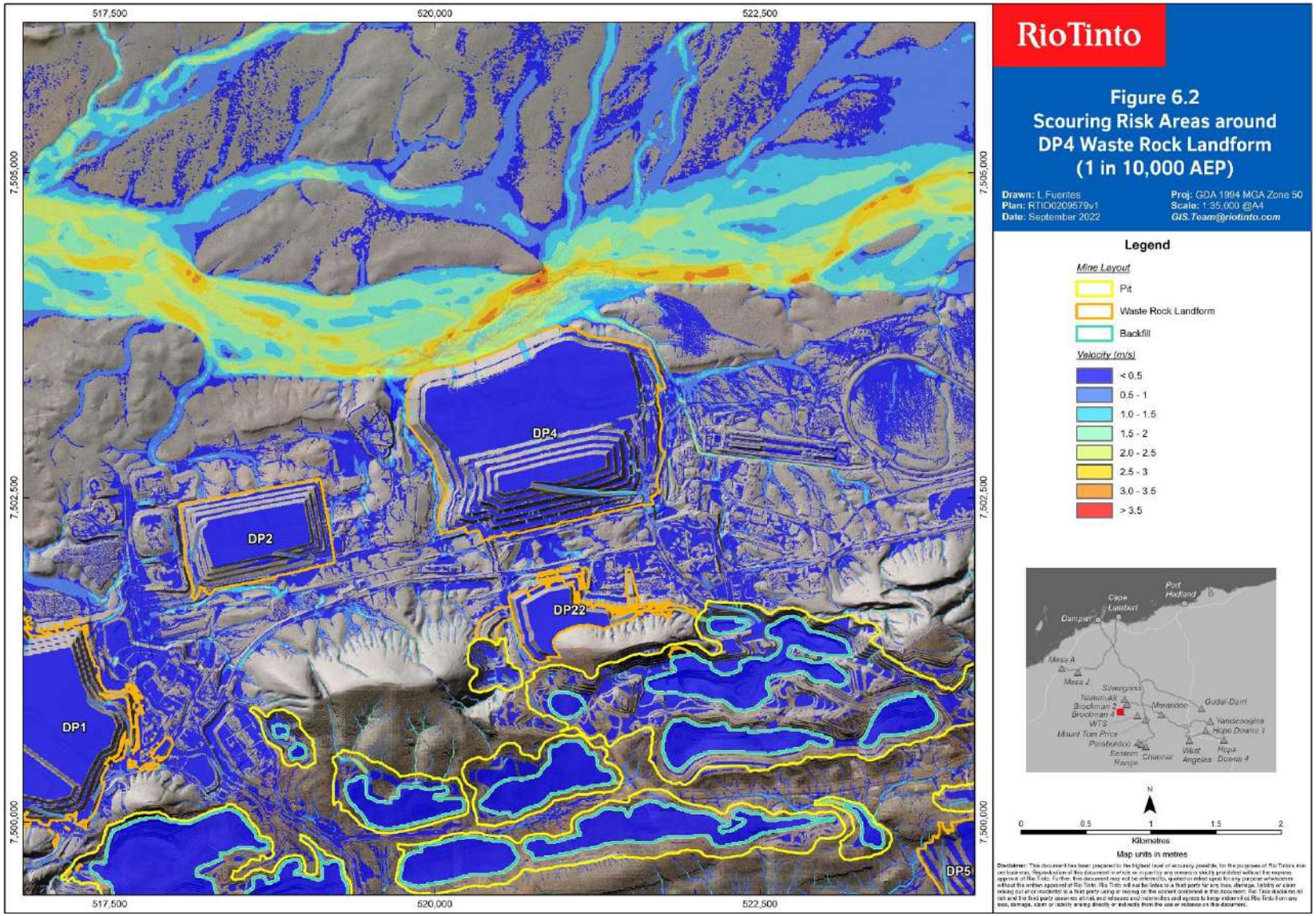


Figure 6-2 Scouring risk areas around DP4 waste rock landform (1 in 10,000 AEP)

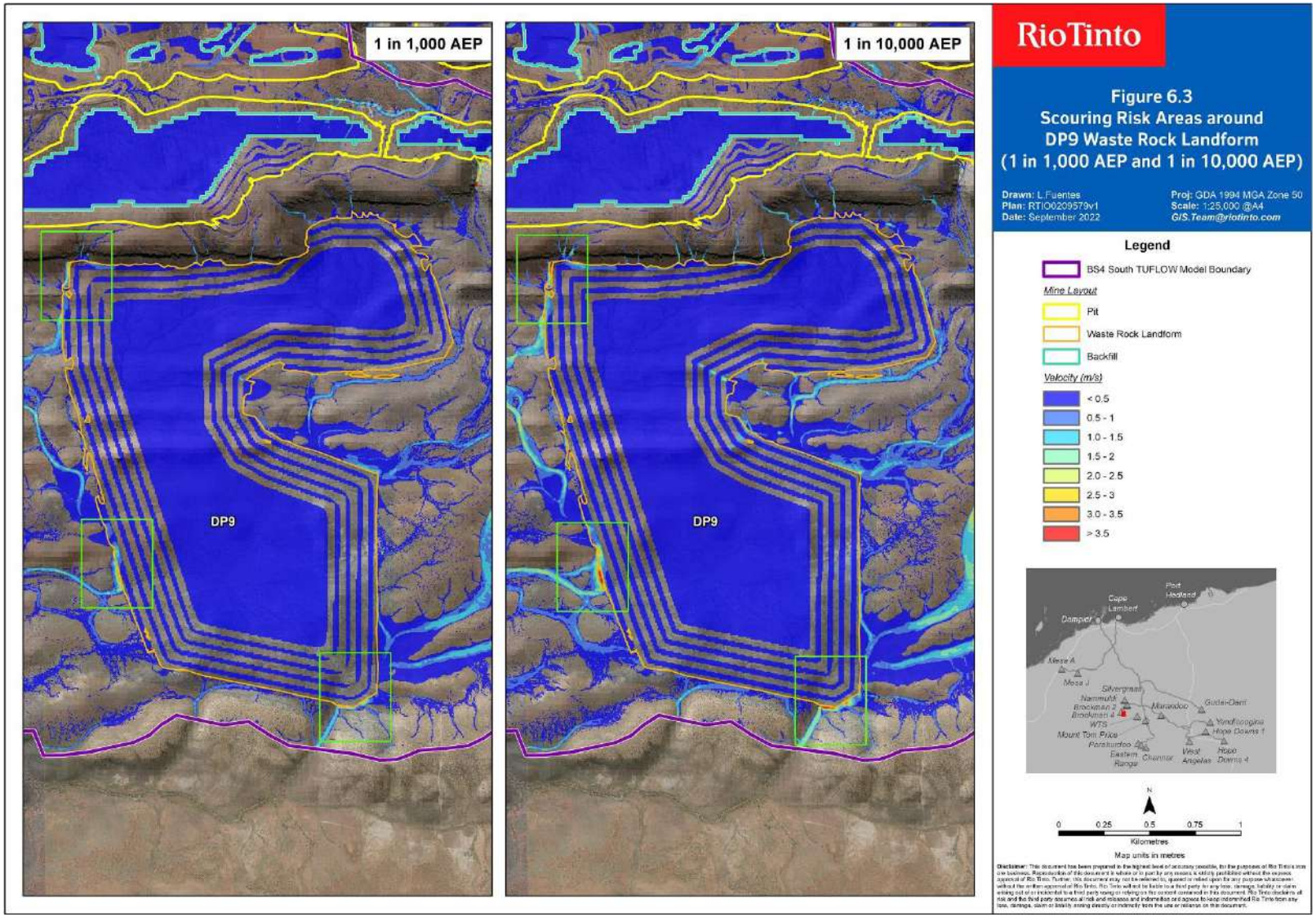


Figure 6-3 Scouring risk areas around DP9 waste rock landform during 1 in 1,000 AEP (left) and 1 in 10,000 AEP (right)

6.2 B2N

The B2N model results (Appendix C – B2N Mine Area Closure Floodplain Mapping) indicate that pits that are not backfilled to surface would intercept natural flow paths causing ponding at the base of the pits, resulting in loss of flow to downstream catchments. No ponding is expected at Lens A since it will be backfilled to reinstate its natural flow lines. The reinstated flow path would convey significant flow in the extreme events, which may erode the capping material used. The design of the flow path would play a significant role in the flow velocity and scour risk. The current hydraulic model indicates that this drainage line would experience peak velocity over 3 m/s in the 1 in 10,000 AEP flood event. This is indicative of the actual peak flow velocity post closure as the reinstated flow path is likely to be different from the pre-development flow path.

The flood maps also show that ponding occurs around waste rock landforms that intersect with flow paths. For example, Lens A waste rock landform intersects a tributary causing ponding to the south of the waste rock landform, which then flows around the waste rock landform towards the north as illustrated in Figure 6-4.

The peak velocity maps show that flow velocities within the majority of the study area are less than 1 m/s. The flow velocities at certain sections around the toe of waste rock landforms at Lens A and Lens B are greater than 2 m/s as shown in Figure 6-4**Error! Reference source not found.**. **Error! Reference source not found.**The high velocity would increase the risk of scouring around the toe of the waste rock landforms.

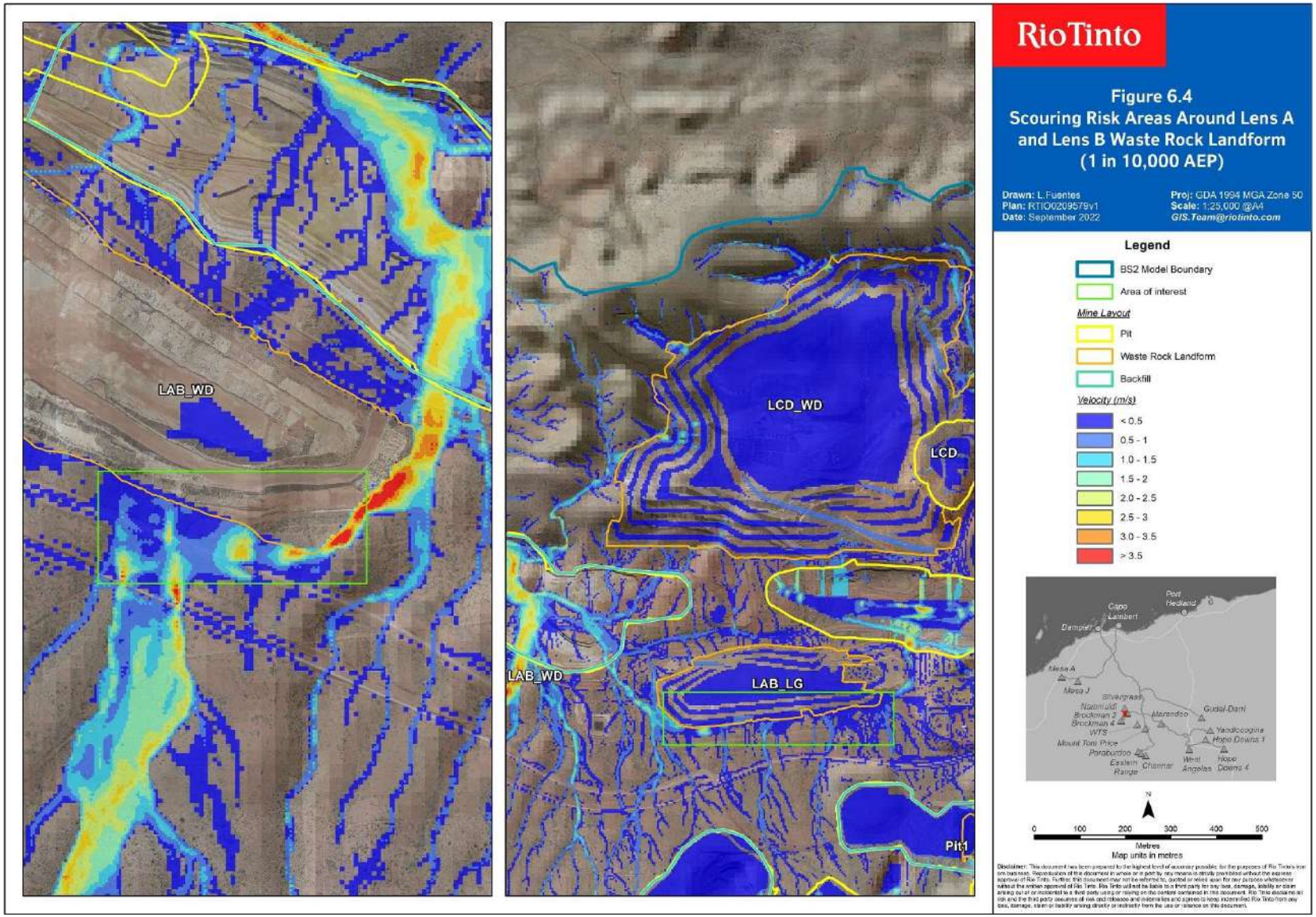


Figure 6-4 Scouring risk areas around Lens A and Lens B waste rock landform

6.3 Silvergrass East

The Silvergrass model results (Appendix D – Silvergrass Closure Floodplain Mapping) show that the proposed backfill of Pit 1 (to 560 mAHD) adjacent to Caves Creek is above the flood level for the 1 in 100 AEP event, i.e. no flood water captured in the pit. However, ponding is expected on the eastern side of Pit 1 caused by incident rainfall. For events rarer than the 1 in 100 AEP, flooding of Pit 1 from Caves Creek is expected as flood levels in Caves Creek exceed the backfilled level.

Pit 5 is not within the 1 in 100 AEP floodplain and minor ponding is expected for Pit 5 for the 1 in 100 AEP event. As the flood extent increase for the rarer events, Pit 5 would be inundated, having 1.6 m and 2.8 m of ponding depths for the 1 in 1,000 and 1 in 10,000 AEP events respectively.

Pit 2 and Pit 3 are situated away from the Caves Creek floodplain. These pits capture runoff from small contributing catchments as well as incidental rainfall. The maximum ponding depths within these pits increase with increase in rarity of the design rainfall events. Rainfall excess intercepted by Pit 2 and Pit 3 will not overtop the backfilled pits for all design events assessed in this study.

The risk of scouring and erosion increases as flow velocity increases. In general, the areas disturbed by mining activities at SLVE have relatively low risk of scouring based on the current closure plan and LoM design. An area where high velocity flow (>2.5 m/s) is predicted is over the crest of Pit 2 on the eastern side for the very rare events (1 in 1,000 and 1 in 10,000 AEP). The flow velocity for the proposed backfilled areas is low and thus risk of scouring is expected to be low.

6.4 BSP Deposits

6.4.1 BS1

6.4.1.1 BS1 West 1

The most western part of the W1 pit intercepts an unnamed major tributary with a catchment area of approximately 55 km². For events more frequent than the 1 in 10,000 AEP, flow would terminate at the pit. It is expected that this section of the pit would overtop during a 1 in 10,000 AEP rainfall event (Figure 6-5). It is important to note that this assessment has not considered backfill levels. Therefore, pit West 1 could overtop at a more frequent event than currently estimated.

Risk of head cutting is high due to large modelled flow over the pit crest during extreme rainfall events. Figure 6-5 shows flow over pit W1 would exceed 3.5 m/s for the 1 in 10,000 AEP event, which presents a long-term scour risk if mitigation strategies are not in place at the time of closure.

6.4.1.2 BS1 West 2

Both pits W2a and W2b are situated at topographic low points and would intercept tributaries to the north and west of the pits with contributing catchments of 3.7 km² and 30.6 km² respectively. The hydraulic model results indicate that pit W2b would overtop[2] for events 1 in 1,000 AEP and rarer (Figure 6-5). Since the model have not considered backfill in this assessment, it is possible that overtopping could occur in events more frequent than the 1 in 1,000 AEP storm.

6.4.1.3 BS1 East

The majority of BS1 E1 and E2 pits are located away from the floodplain. Ponding in the pits is mostly caused by incidental rainfall. The eastern section of pit E1 would intercept a major tributary with contributing catchment of approximately 58.3 km². The peak flow of the creek intercepted for the 1 in 10,000 AEP event is estimated to be over 1200 m³/s and the estimated volume of runoff that will be

[2] The overtopping discussed in this study are caused by design event based floods. This study has not considered the overtopping risks based on long term pit lake water balance.

captured is approximately 2050 m³. Velocity over pit crest will be high as illustrated in Figure 6-6. Although overtopping is not predicted in this assessment, future modelling should consider the proposed backfill levels to assess risk of pit E1 overtopping.

Towards the west, Pit E1 and E2 will act as terminal sinks to tributaries to the north. Pit crests are likely to experience high velocity inflows which present a long-term scour risk (Figure 6-6).

6.4.1.4 Waste Rock Landforms

Flow velocities around the toe of waste rock landforms DP08 (Figure 6-5) and DP01 (Figure 6-6) during a 1 in 10,000 AEP event are greater than 2 m/s. The high velocity would increase the risk of scouring around the waste rock landform.

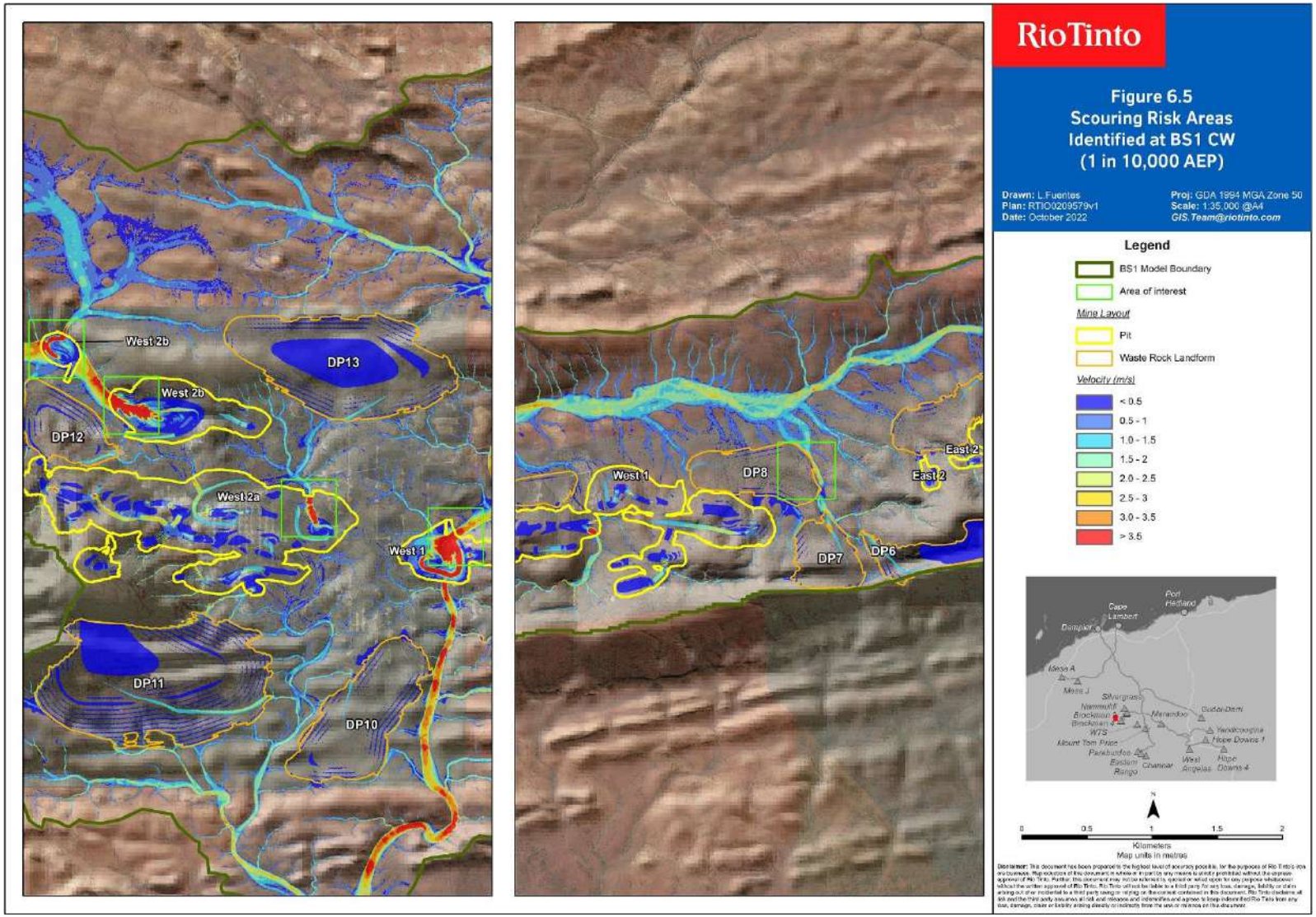


Figure 6-5 Scouring risk areas identified at BS1 CW (1 in 10,000 AEP)

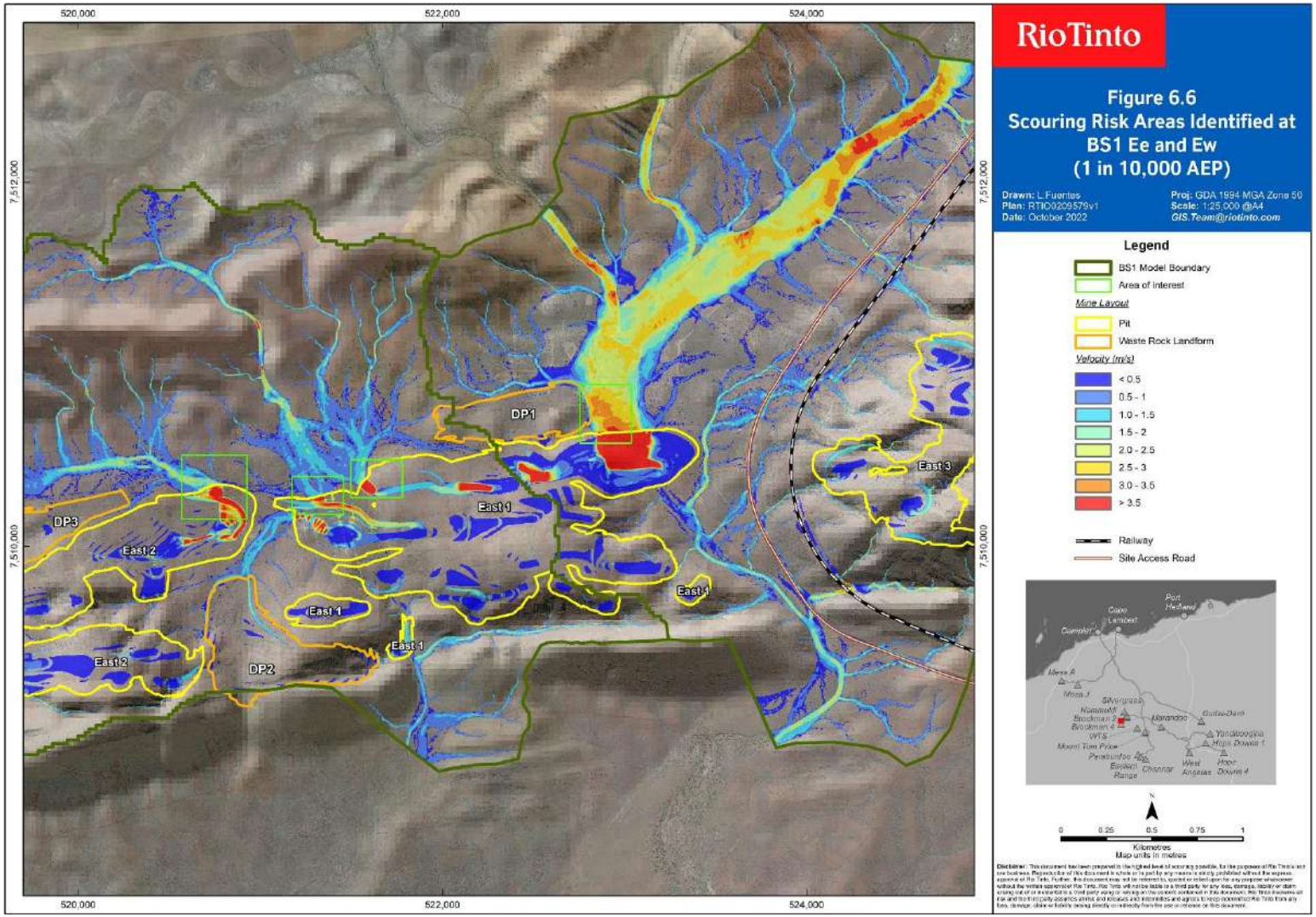


Figure 6-6 Scouring risk areas identified at BS1 Ee and Ew (1 in 10,000 AEP)

6.4.2 END-MN

Pits M1, M2 and N2 will act as terminal sinks to minor tributaries to the north. Where surface flows enter the pit, high velocities may create a long-term scour risk (Figure 6-7).

Endeavour 1 and 2 Pits and N1 Pit are situated high up the catchment, intercepting only a small catchment area. The pits will largely only capture runoff from incidental rainfall. Therefore, the risk of scouring is estimated to be low for these pits.

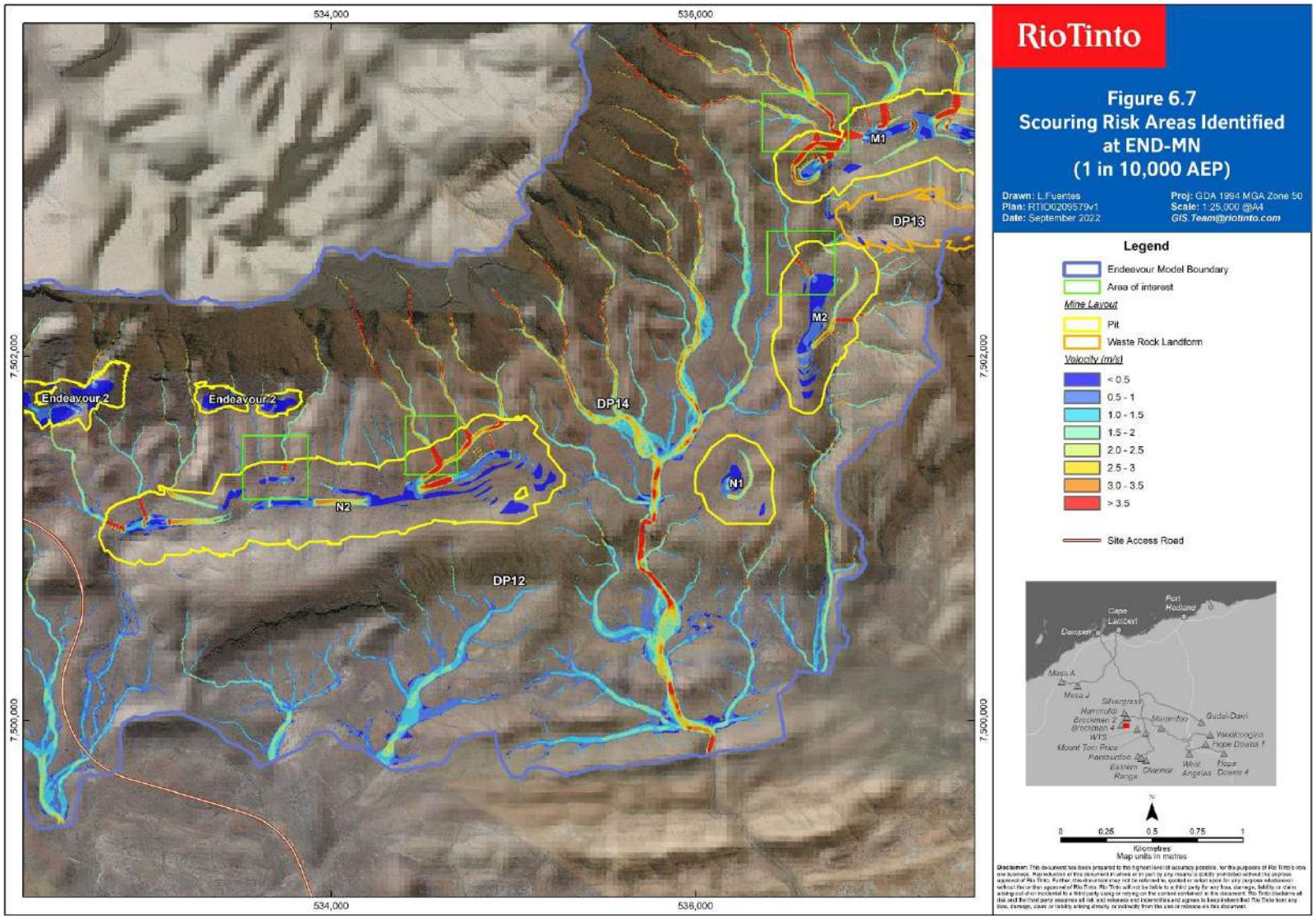


Figure 6-7 Scouring risk areas identified at END-MN (1 in 10,000 AEP)

6.4.3 BS3 and BS3 Extension

Deposit BS3 and the southern part of BS3 Extension are located upstream of Plunge Pool, a culturally significant and sensitive site. The Plunge Pool catchment consists of a steep upper catchment that flow in a south-west direction. Catchment flow is concentrated to one main creek line prior to entering Plunge Pool. Figure 6-8 shows the natural drainage flow path of Plunge Pool and where the proposed pits and waste rock landform intersect with the natural tributaries.

Pit BS3 is located at the top of the catchment where risk of scouring to the pit is low and ponding in the pit is caused by incidental rainfall. Waste rock landform BS3 DP1 intercepts runoff on the north-west causing ponding at the toe of the waste rock landform. Flows from larger events, such as the 1 in 10,000 AEP will be directed around the south-western toe of the waste rock landform. Modelled flow velocities around the toe of the waste rock landform during a 1 in 10,000 AEP event are greater than 2 m/s (Figure 6-9). The high velocity would increase the risk of scouring around the waste rock landform.

Pit MM-J3 which is part of the BS3 Extension deposits, is located in one of the drainage lines upstream of Plunge Pool. The hydraulic model results shows that the pit does not overtop up to the 1 in 10,000 AEP in this assessment. However, the ponding depth in the pit is very close to the pit's crest elevation and if backfill is considered, overtopping will most definitely occur during the 1 in 10,000 AEP event and possibly during the less rare events. In addition to overtopping risk, the flow over MM-J3's pit crest is estimated to be over 3.5 m/s for all design events assessed in this study which would be considered high risk for head cutting.

Pit MM-J1 is expected to intercept a portion of catchment flow from the north-west. Overtopping is not expected up to the 1 in 10,000 AEP event based on currently available information. The pit design used in this assessment is preliminary and lacking in details of the benches proposed. Future assessments are recommended as the pit development and backfill details are further developed.

Figure 6-9 shows that high velocity flow (> 2 m/s) is estimated to flow around the north-east toe of MM-J DP1 in the 1 in 10,000 AEP rainfall event. This presents a risk of scouring around the toe of the waste rock landform during extreme rainfall events. In addition, ponding depth of over 5 m at the northern side of Diesel WD1 would be expected for the 1 in 10,000 AEP rainfall event.

Other pits that are part of the BS3 Extension but are not within the Plunge Pool catchment are Lauriston, Creekside, Monkey, Sandleford and Diesel. These pits are situated north of the Plunge Pool catchment. Most of these pits have low surface water risks as they are not intercepting large catchments with high velocity flows. The exception to this would be Creekside 2 pits where high velocity flows over pits crest are estimated as shown in Figure 6-10.

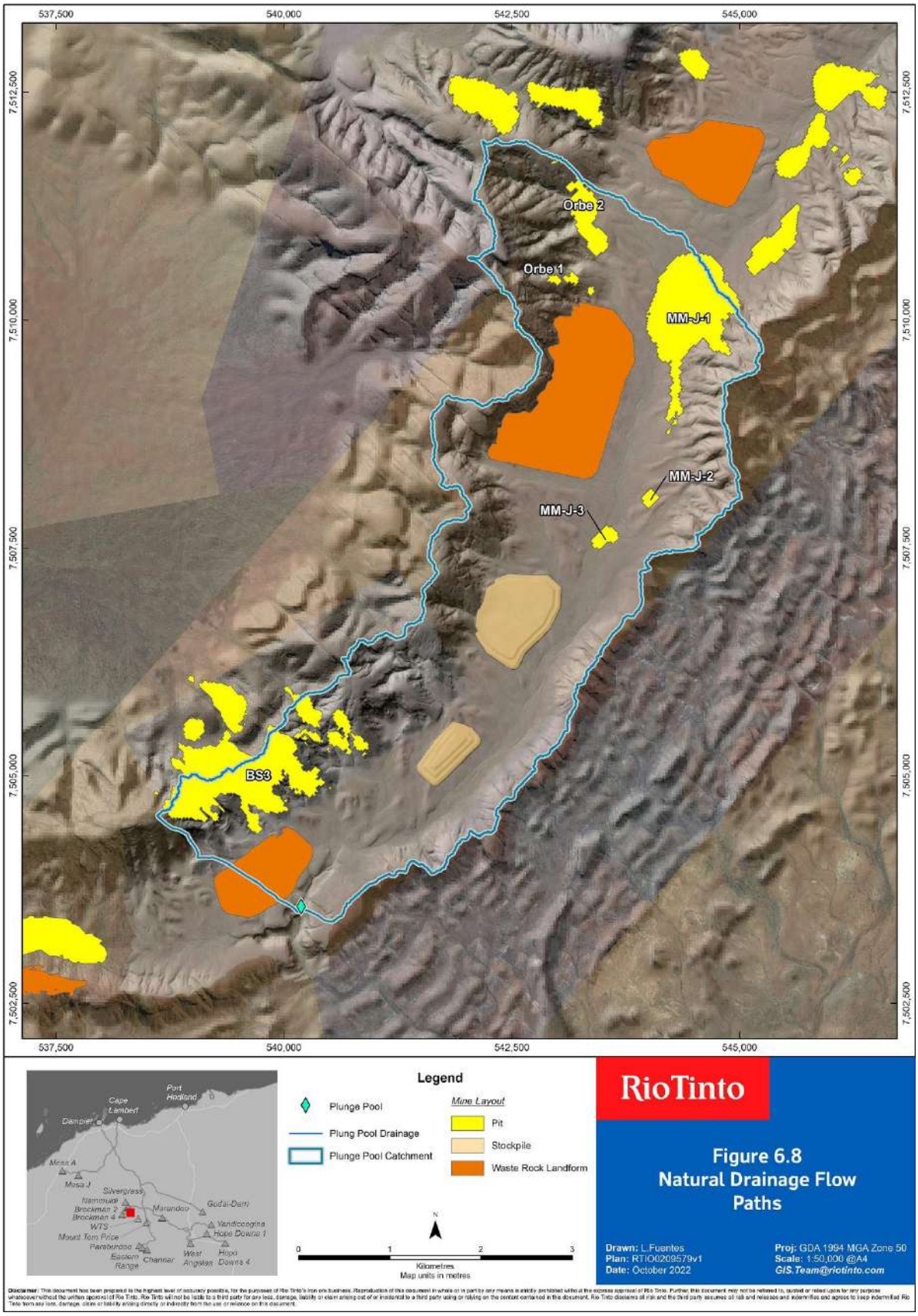


Figure 6-8 Natural drainage flow paths in the Plunge Pool catchment

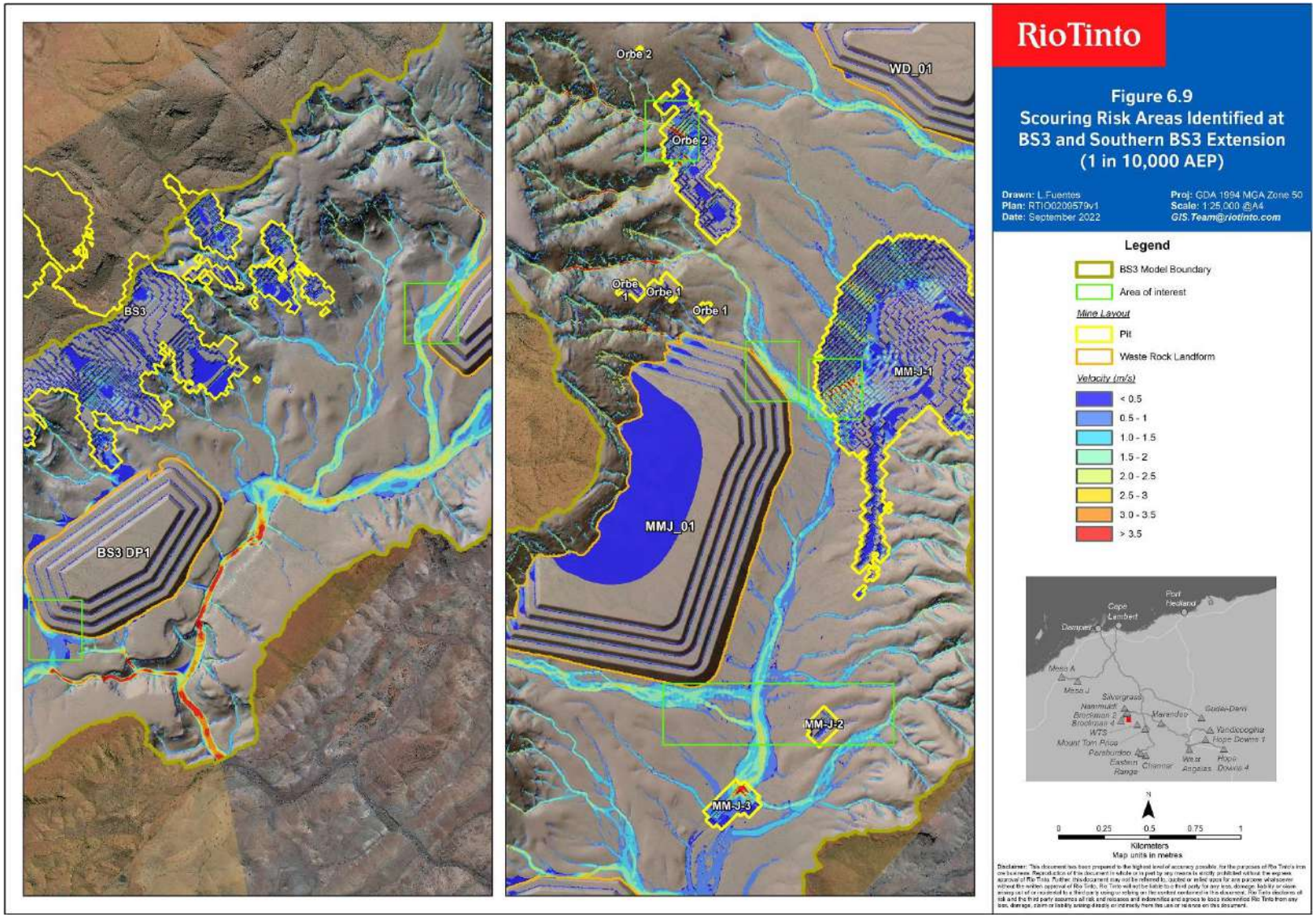


Figure 6-9 Scouring risk areas identified at BS3 and southern BS3 Extension (1 in 10,000 AEP)

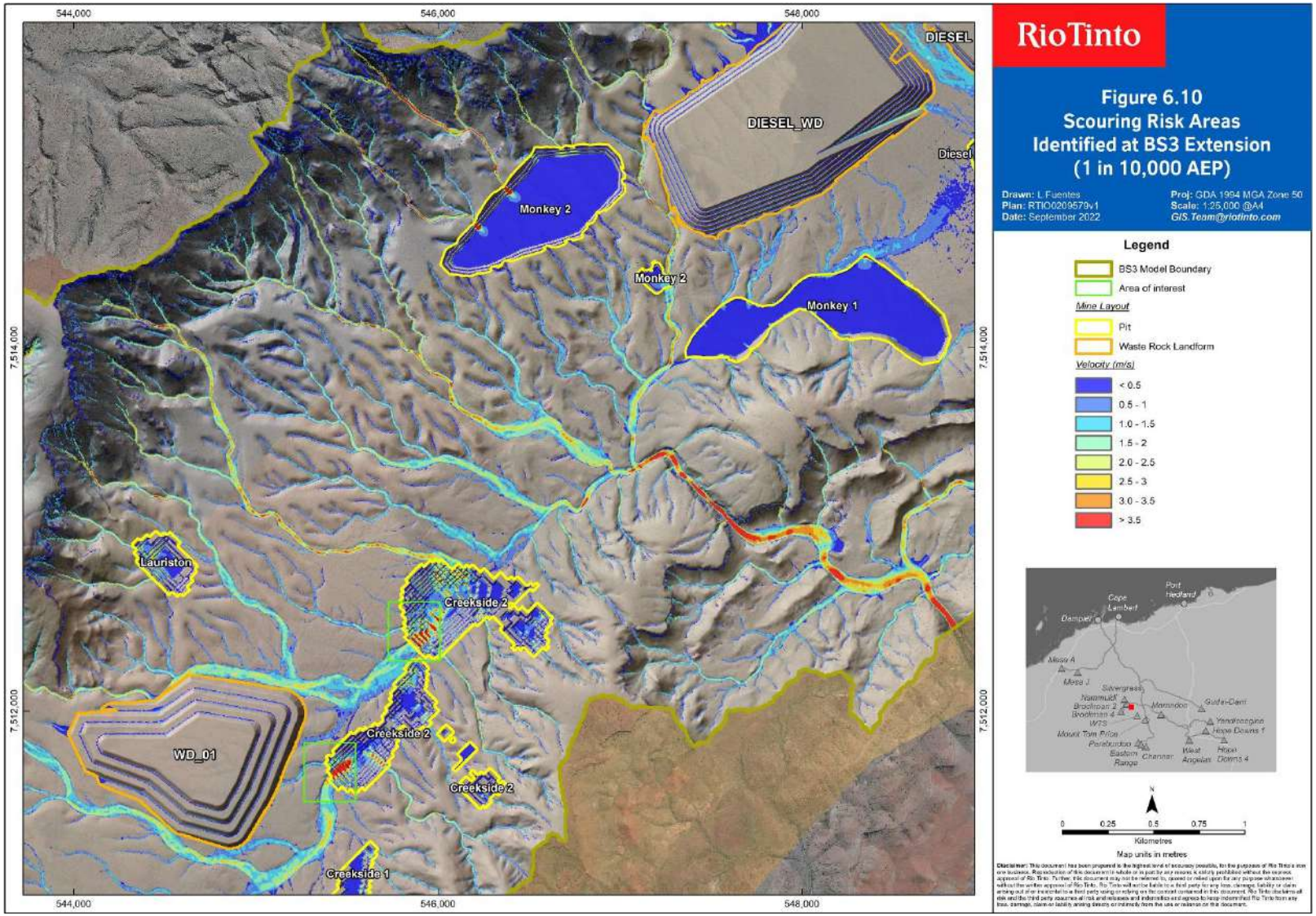


Figure 6-10 Scouring risk areas identified at BS3 Extension (1 in 10,000 AEP)

6.4.4 Lens G

Lens G is located in an internally draining basin that is approximately 44 km². The catchment has steep embankments and fans out onto a flat valley in the centre. Lens G would intercept 4 km² of catchment, which could increase the risk of head cutting where flow over pit crest as illustrated in Figure 6-11.

Ponding will occur on the eastern toe of WD1, WD2 and WD3. For the rarer rainfall events (1 in 1,000 AEP and above), the floodplain will encroach Lens G Waste Rock Landform 1, 2 and 3 (Figure 6-11). However, depths are expected to be less than 0.5 m and velocities less than 1 m/s, so there is a relatively low risk of scouring. Additional investigation is needed to determine if the low level of ponding depth would cause instability to the structure of the waste rock landforms.

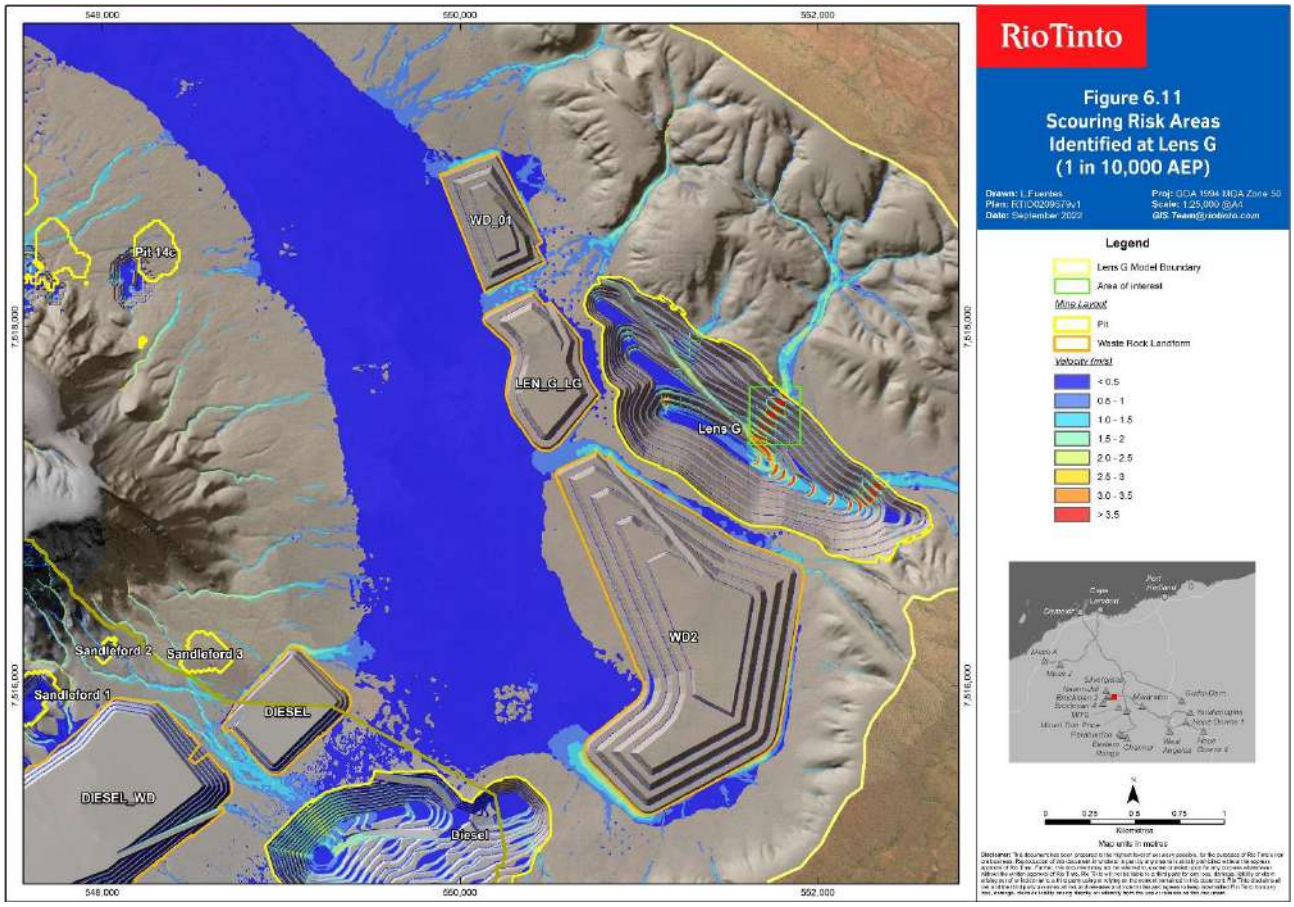


Figure 6-11 Scouring risk areas identified at Lens G (1 in 10,000 AEP)

6.4.5 BS2ED South

Three deposits have been classified as part of BS2ED South (Figure 6-12). The deposits to the west are considered to be mineral prospect at this stage and thus the design available are too conceptual to perform any meaningful analysis. Pit 14 are a cluster of pits which are also part of BS2ED South. They are located further to the east and it is within the same internally draining catchment as Lens G. Figure 6-11 shows that Pit 14 are located outside of the 1 in 10,000 AEP floodplain where risk of scouring and flooding is low.

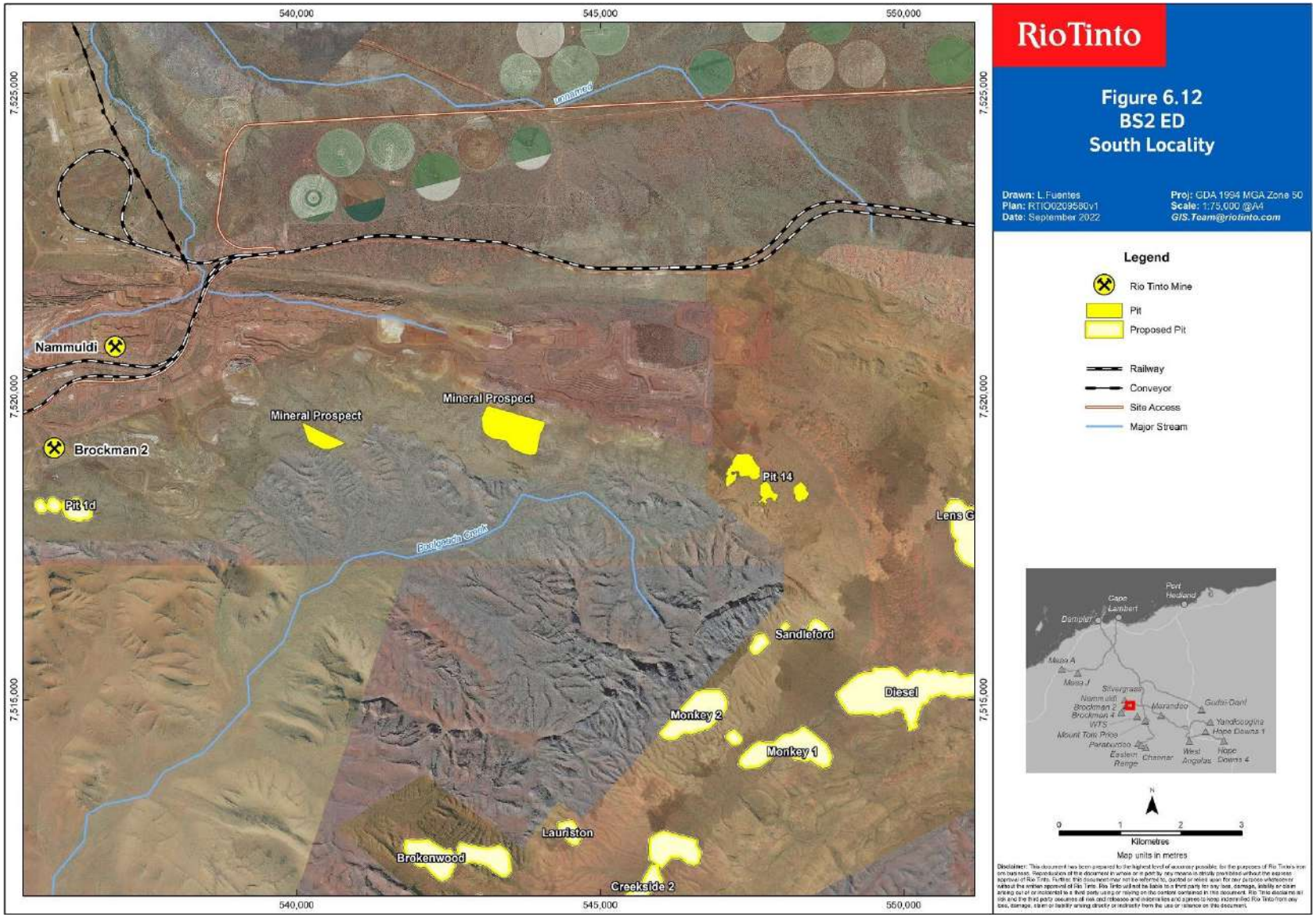


Figure 6-12 BS2ED South Locality

7. Potential Impacts

7.1 Boolgeeda Creek

The BSP could potentially remove 55 km² of catchment area from the Boolgeeda Creek catchment. This is equivalent to approximately 3.3% of the regional catchment. The mean annual runoff at various locations along Boolgeeda Creek was estimated using the assumption that the average runoff depth is 0.2 mm/d (~7.3 mm per annum) (Zhang, et al., 2013). This assessment is summarised in Table 7-1 and it shows the potential maximum impact conditions[3] at the respective locations shown in Figure 7-1.

The largest impact is expected to be at confluence Location 6 (Figure 7-1) which is downstream of BS1W and BS1C catchment. Mean annual runoff could be reduced by up to 9.7% from development of BSP. Cumulatively, reduction of 18.5% is predicted for the Boolgeeda Creek catchment at confluence Location 6. The reduction in runoff estimated at Location 7 and 8 is due to FMG's Eliwana operations (MS1109). Further downstream along the catchment, as the incremental catchment area increases more than the potential impacted areas, the cumulative impact is expected to reduce.

Table 7-1: Estimated potential reduction in mean annual runoff for locations on Boolgeeda Creek at confluences with current and proposed disturbed catchment

Confluence Location	Mean Annual Runoff (ML) (Pre-mining)	Mean Annual Runoff (ML) (MS1109)	% Reduction (Incremental)	% Reduction (Cumulative)	Mean Annual Runoff (ML) (MS1109+Brockman Syncline Proposal)	% Reduction (Incremental)	% Reduction (Cumulative)
1	343	343	0.0%	0.0%	335	2.5%	2.5%
2	944	944	0.0%	0.0%	926	1.9%	1.9%
3	2,300	2,298	0.1%	0.1%	2,132	7.2%	7.3%
4	2,662	2,659	0.1%	0.1%	2,415	9.2%	9.3%
5	3,129	3,057	2.3%	2.3%	2,809	7.9%	10.2%
6	4,124	3,765	8.7%	8.7%	3,363	9.7%	18.5%
7	5,219	4,653	10.8%	10.8%	4,251	7.7%	18.5%
8	10,901	9,924	9.0%	9.0%	9,522	3.7%	12.6%
9	12,112	11,135	8.1%	8.1%	10,733	3.3%	11.4%

[3] Potential maximum impacts conditions assumes that catchment flows are terminated at pits and no overtopping would occur for all rainfall events.

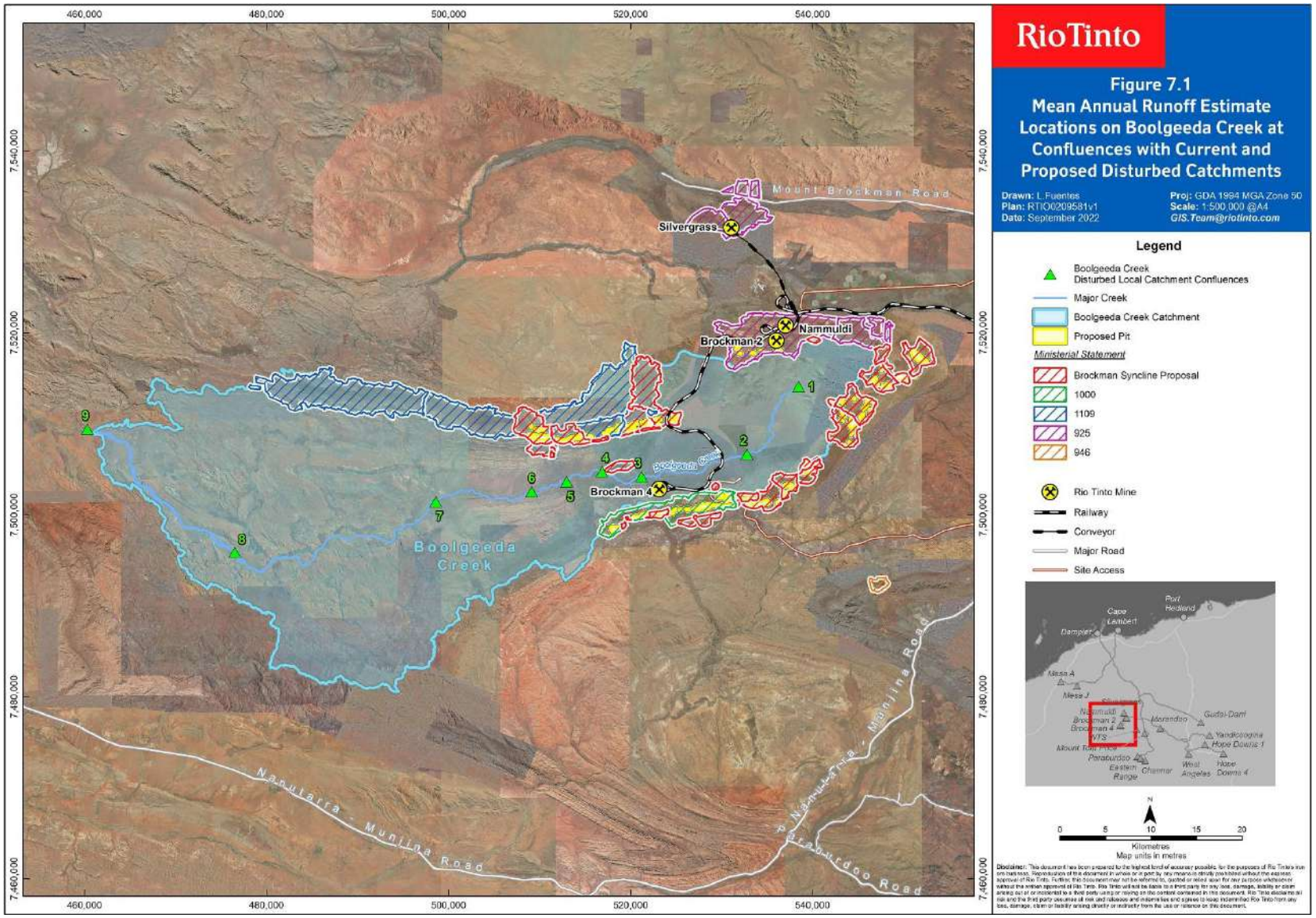


Figure 7-1 Mean annual runoff estimate locations on Boolgeeda Creek at confluences with current and proposed disturbed catchments

7.2 Beasley River

BSP could potentially remove approximately 63 km² of Beasley River's catchment, which equates to 3.1% of the regional catchment. The same approach used in Section 7.1 for Boolgeeda Creek has been adopted for Beasley River. A 43 km² internally draining basin is present in the Beasley River catchment. This basin does not contribute flow to the Beasley River. A reduction in catchment area of this basin is does not affect flow presented in Table 7-2.

Table 7-2: Estimated maximum potential reduction in mean annual runoff for locations on Beasley River at confluences with current and proposed disturbed catchments

Confluence Location	Mean Annual Runoff (ML) (Pre-mining)	Mean Annual Runoff (ML) (MS1000+MS946)	% Reduction	Mean Annual Runoff (ML) (MS1000 + MS946+MBrockman Syncline Proposal)	% Reduction (Incremental)	% Reduction (Cumulative)
1	1,209	1,209	0.0%	1,084	10.3%	10.3%
2	3,338	3,321	0.5%	3,098	6.7%	7.2%
3	3,917	3,899	0.4%	3,642	6.6%	7.0%
4	4,027	4,009	0.4%	3,687	8.0%	8.4%
5	4,203	4,185	0.4%	3,857	7.8%	8.2%
6	6,534	6,310	3.4%	5,942	5.8%	9.1%
7	12,408	12,185	1.8%	11,817	3.0%	4.8%
8	14,720	14,496	1.5%	14,128	2.5%	4.0%

Table 7-2 shows that the greatest reduction of 10.3% in flow, is predicted at confluence Location 1 (Figure 7-2), which is downstream of part of BS3 Extension deposit to the north. From confluence Location 2 to 6, mean annual runoff is expected to reduce ranging from 8% to 5.8%. This is largely caused by the BS3, Marra Mamba and Endeavour deposits. Cumulative impacts from this point onwards are reduced as incremental catchment area increases over the potential impacted areas.

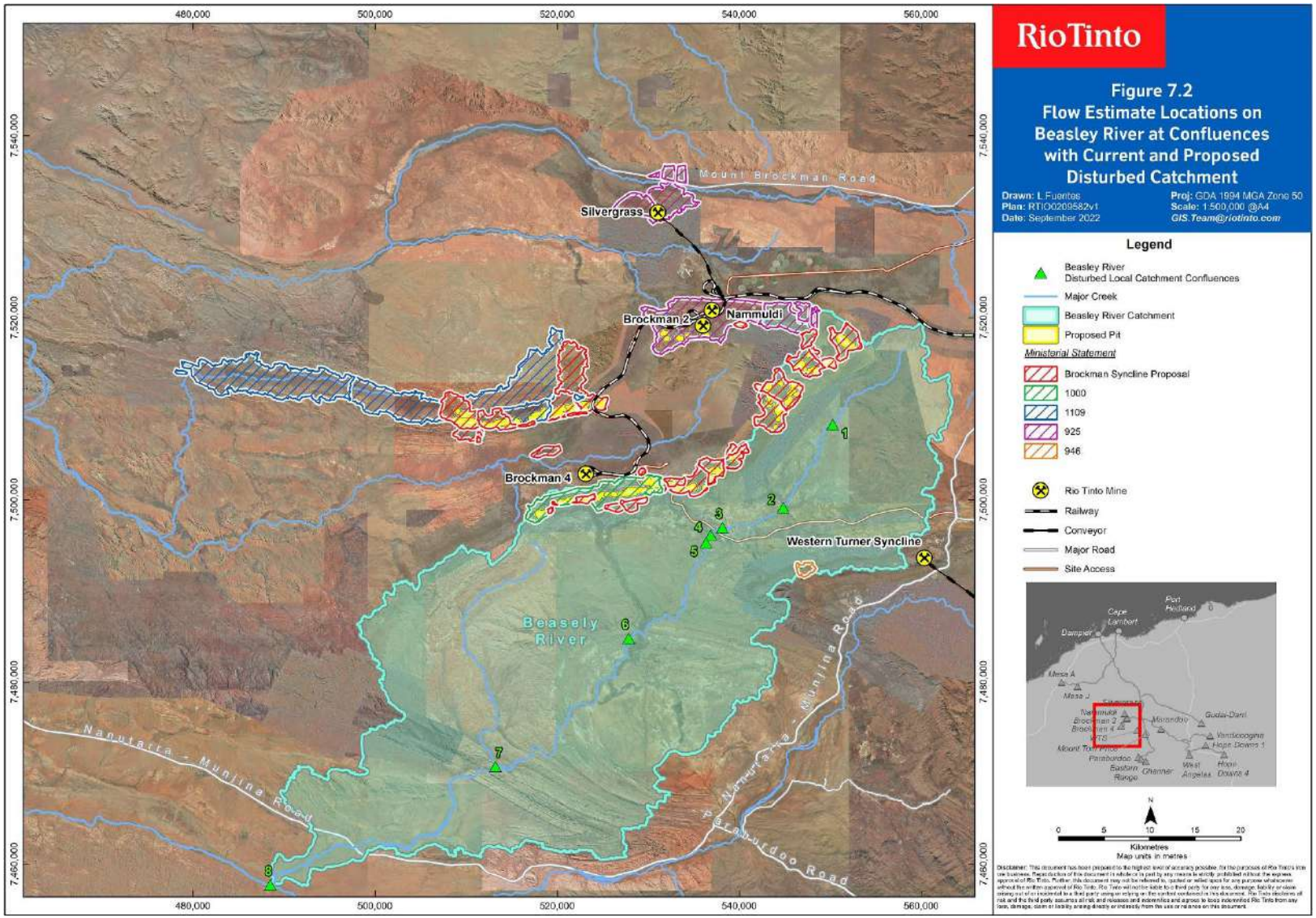


Figure 7-2 Flow estimate locations on Beasley River at confluences with current and proposed disturbed catchment

7.3 Caves Creek

SLVE could potentially remove approximately 13 km² of Caves Creek catchment, which equates to 0.4% of the regional catchment. An impact assessment was also conducted to assess the potential impact on mining activities on the Caves Creek flows.

A location downstream of SLVE (purple line shown in Figure 7-3) was used to compare flow hydrographs between baseline and post closure scenarios for all design events assessed in this study. Pre- and post-development hydrographs for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events at this location are presented in Figure 7-4. Slight attenuation and hence reduction of the flood peak is predicted, while the receding limbs of the hydrographs remain the same between baseline and closure scenarios. Peak flows for each event are summarised in Table 7-3. The comparisons indicated that the reduction in peak flow caused by mining activities is minimal.

Table 7-3 Peak flow estimated downstream of SLVE

Design Event	Baseline Peak Flow (m³/s)	Closure Peak Flow (m³/s)	Difference (m³/s)	Difference (%)
1 in 100 AEP	597.0	578.1	18.9	3.2
1 in 1,000 AEP	1363.9	1298.6	65.3	4.8
1 in 10,000 AEP	3474.7	3428.9	45.8	1.3

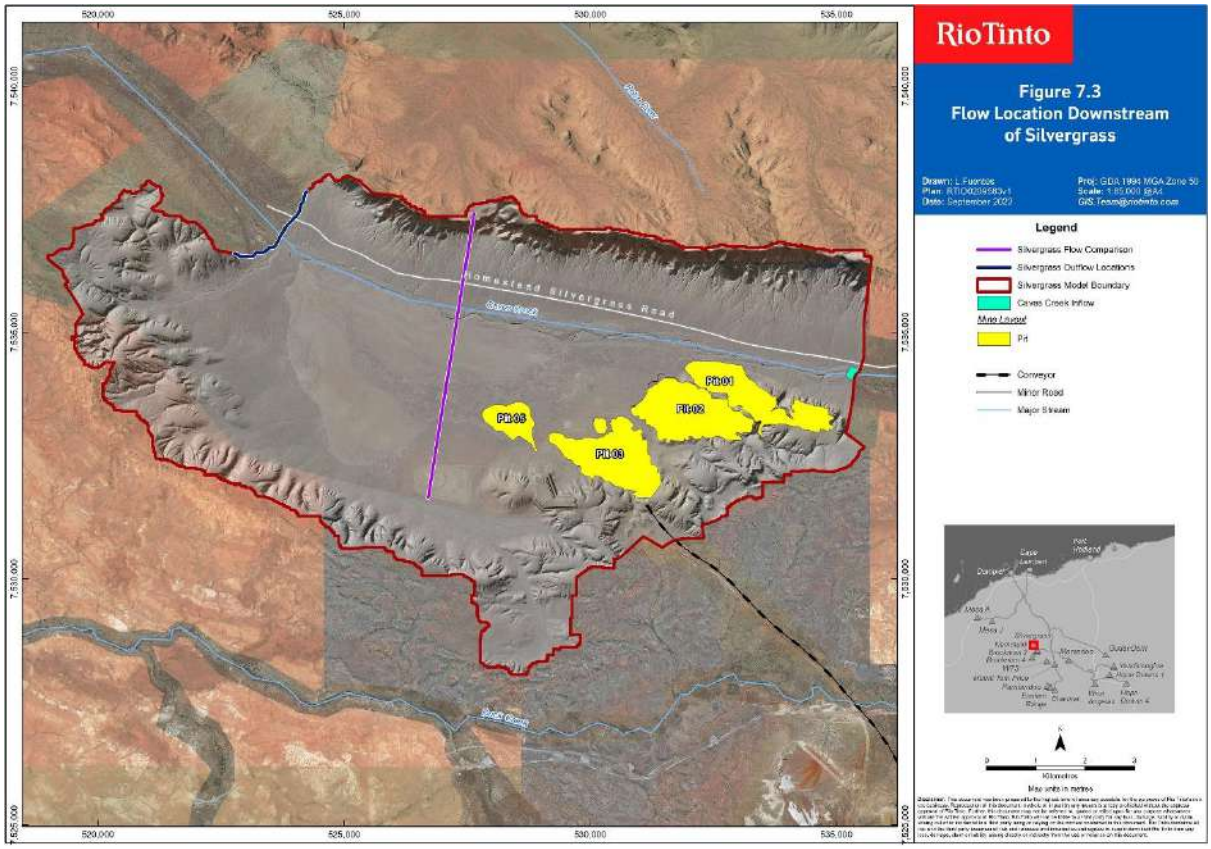


Figure 7-3 Flow location downstream of SLVE

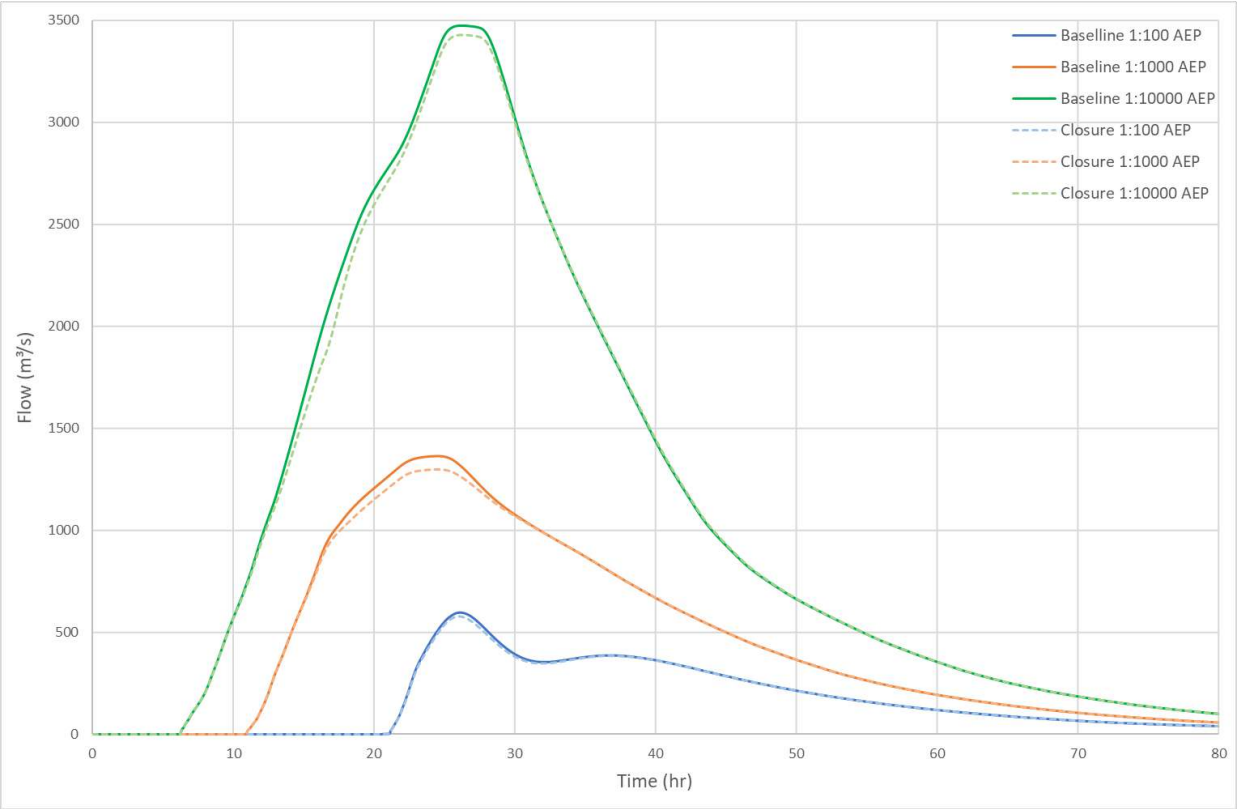


Figure 7-4 Flow hydrographs downstream of SLVE

8. Post Closure Management

8.1 BS4

The overall surface water risk for BS4 at closure is relatively low. It is recommended that areas around waste rock landforms where high velocities are expected should be armoured with erosion resistant materials.

Detailed closure landform designs are yet to be developed. As part of future closure planning, Rio Tinto plans to design, upgrade and/or construct landforms which will improve landform stability over closure time frames. In addition, impact assessments to downstream catchments should be included as part of closure planning when final landforms become available.

8.2 B2N

The overall surface water risk for B2N at closure is relatively low. It is recommended that areas around waste rock landforms where high velocities are expected should be armoured with erosion resistant materials. In particular, the eastern toe of Lens A waste rock landform is expected to experience high velocity flow which would require scour protection. In addition, the design to reinstate the flow path through Lens A should also take into account the risk of erosion and flow reducing engineering control should be considered.

Detailed closure landform designs are yet to be developed. But as part of future closure planning, Rio Tinto plans to design, upgrade and/or construct landforms which will improve landform stability over closure time frames. In addition, impact assessments to downstream catchments should be included as part of closure planning when final landforms become available.

8.3 Silvergrass East

The overall surface water risk for SLVE at closure is low. It is recommended that pit crests that are likely to experience high velocity (>2.5 m/s) inflow as identified in this assessment should be assessed by geotechnical engineers to determine the risk of head cutting. Head cutting is a type of erosion where a drainage line expands upstream as unstable material is eroded away over time. In the event that head cutting is likely, the pit edge should be protected with suitable erosion resistant material to prevent head cutting at closure.

Detailed closure landform designs are yet to be developed. As part of future closure planning, Rio Tinto plans to design, upgrade and/or construct landforms which will improve landform stability over closure timeframes. In addition, impact assessments to downstream catchments should be included as part of closure planning when final landforms become available.

8.4 BSP Deposits

This assessment has considered rare to extreme rainfall events for catchments where the BSP deposits are located. The model results indicate that pits that are not backfilled to surface would intercept natural flow paths causing ponding at the base of the pits which will result in loss of flow to downstream catchments (Section 7.1).

BS1 West 1 and West 2b pits are identified to be at risk of overtopping during extreme rainfall events. It is understood that overtopping from pits would be an unacceptable outcome. As discussed in Section 6.4.1, the overtopping risk discussed in this report is caused by event based flood events. This study have not considered overtopping risk based on long term pit lake water balance.

Strategic placement of abandonment bunds could reduce inflows and hence reduce the risk of pits overtopping. Abandonment bund strategy requires further development and it is important to note that abandonment bunds are not typically engineered to withstand extreme flood events. Alternatively, backfilling to surface could be considered as an alternative surface water management strategy for pits at risk of overtopping under extreme events.

It is recommended that areas around waste rock landforms where high velocities are expected should be armoured with erosion resistant materials. Similarly, it is recommended that pit crests that are likely to experience high velocity inflow as identified in this assessment should be protected with suitable erosion resistant material to prevent head cutting at closure.

Detailed closure landform designs are yet to be developed. But as part of future closure planning, Rio Tinto plans to design, upgrade and/or construct landforms which will improve landform stability over closure time frames. In addition, it is important to note that this study have not considered backfill levels for the proposed pits as outlined in the closure strategy in Section 3.4. It will be important to include the backfill levels when the design is further progressed to ensure that overtopping risk is adequately assessed.

8.4.1 Alternative Closure Option at BS1

The closure scenario presented in Section 6.4.1 has assumed that no drainage lines will be re-instated to return flows back to Boolgeeda Creek, reflecting a base case scenario caused by the operations at BS1. An alternative closure option that is under consideration is to backfill sections of BS1 Pits W1 and E1 back to natural surface to re-instate the BS1C and BS1Ee tributaries flowing back to Boolgeeda Creek. The proposed areas of backfill are shown in green in Figure 8-1 (referred to as Rehabbed Area).

This pit rehabilitation closure scenario was also modelled in TUFLOW for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events. The model configuration is presented in Appendix E – BSP TUFLOW Model Layouts. To simulate the topography at closure, the DTM was altered in parts of Pit W1 and E1 to

simulate the backfilling of the pits. This backfill area is indicative only and will be refined as closure landform is further developed.

The maximum flood depth and velocity results for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events are presented in Appendix H – BS1 Alternative Closure Scenario Floodplain Mapping. Flow hydrographs downstream of the impacted catchments (BS1CW and BS1Ee) were also compared for this rehabilitation scenario. Flow hydrographs for the 1 in 100, 1 in 1,000 and 1 in 10,000 AEP events are presented in Figure 8-2 and Figure 8-3 and the results are summarised in Table 8-1.

The comparison indicates that by rehabilitating Pit W1 and E1 to re-instate the tributaries to Boolgeeda Creek, the peak flows at the BSCW confluence are expected to decrease by 50% as opposed to 65% for the original closure scenario for the 1 in 10,000 AEP event. Peak flows at BS1Ee would be expected to be the same as pre-development flows in comparison to the original closure scenario which predicted a 92% reduction in peak flow for the 1 in 10,000 AEP event (Table 8-1).

It is important to note that this assessment have not considered the impacts from FMG's Eliwana operations which is located upstream of the BS1C tributaries. If upstream flows are terminated on FMG's tenure, backfilling BS1C tributary would have less of a difference.

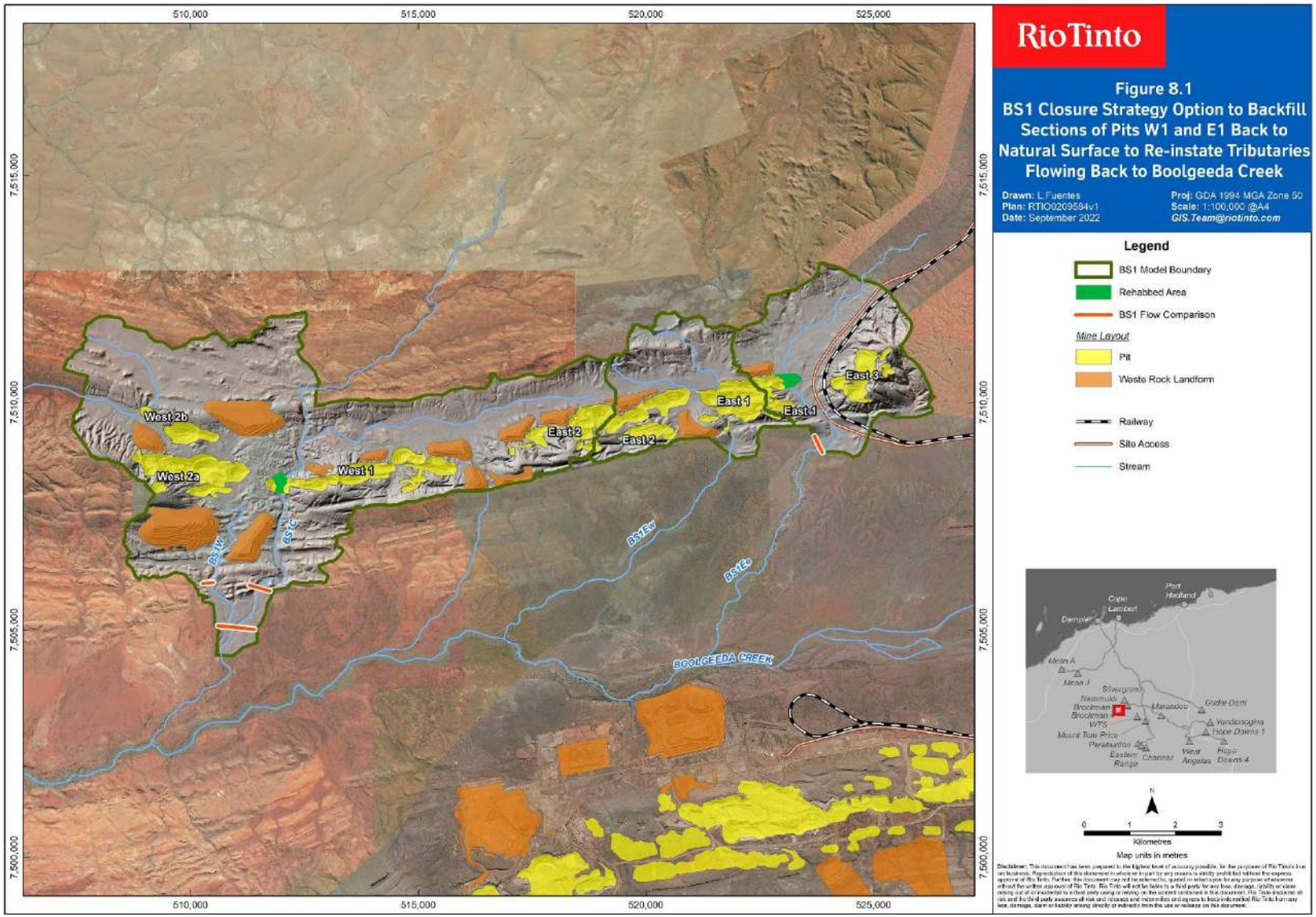


Figure 8-1 BS1 Closure Strategy Option to backfill sections of Pits W1 and E1 back to natural surface to re-instate tributaries flowing back to Boolgeeda Creek

Table 8-1: Peak flow comparisons between baseline, closure and alternative closure scenarios

Location			BS1C	BS1CW Confluence	BS1Ee
1 in 100 AEP	Baseline Scenario	Flow (m^3/s)	208	323	236
	Closure Scenario	Flow (m^3/s)	35	68	20
		Reduction (%)	-83%	-79%	-92%
	Alternative Closure Scenario	Flow (m^3/s)	180	195	236
		Reduction (%)	-14%	-40%	0%
1 in 1000 AEP	Baseline Scenario	Flow (m^3/s)	408	724	510
	Closure Scenario	Flow (m^3/s)	66	136	41
		Reduction (%)	-84%	-81%	-92%
	Alternative Closure Scenario	Flow (m^3/s)	347	408	511
		Reduction (%)	-15%	-44%	0%
1 in 10,000 AEP	Baseline Scenario	Flow (m^3/s)	934	1581	1258
	Closure Scenario	Flow (m^3/s)	548	548	103
		Reduction (%)	-41%	-65%	-92%
	Alternative Closure Scenario	Flow (m^3/s)	826	797	1243
		Reduction (%)	-12%	-50%	-1%

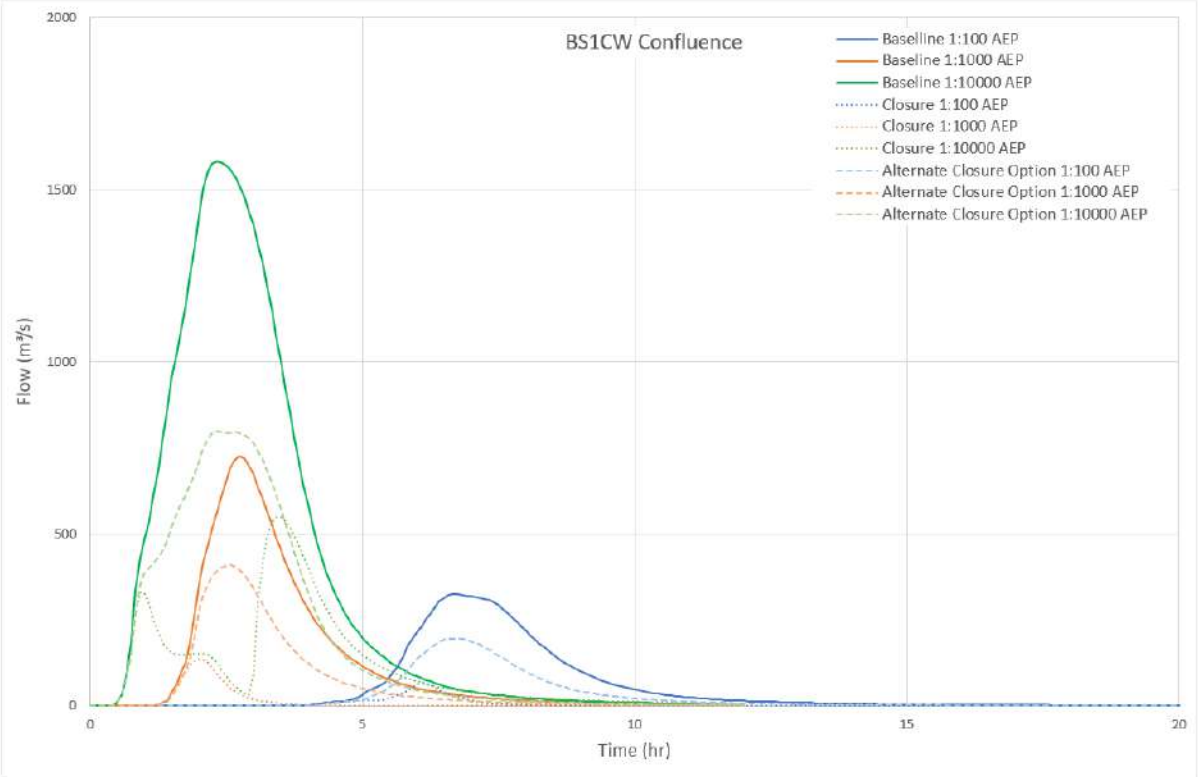


Figure 8-2 Flow hydrographs at BS1CW confluence for the 1 in 10, 1 in 100 and 1 in 10,000 AEP events

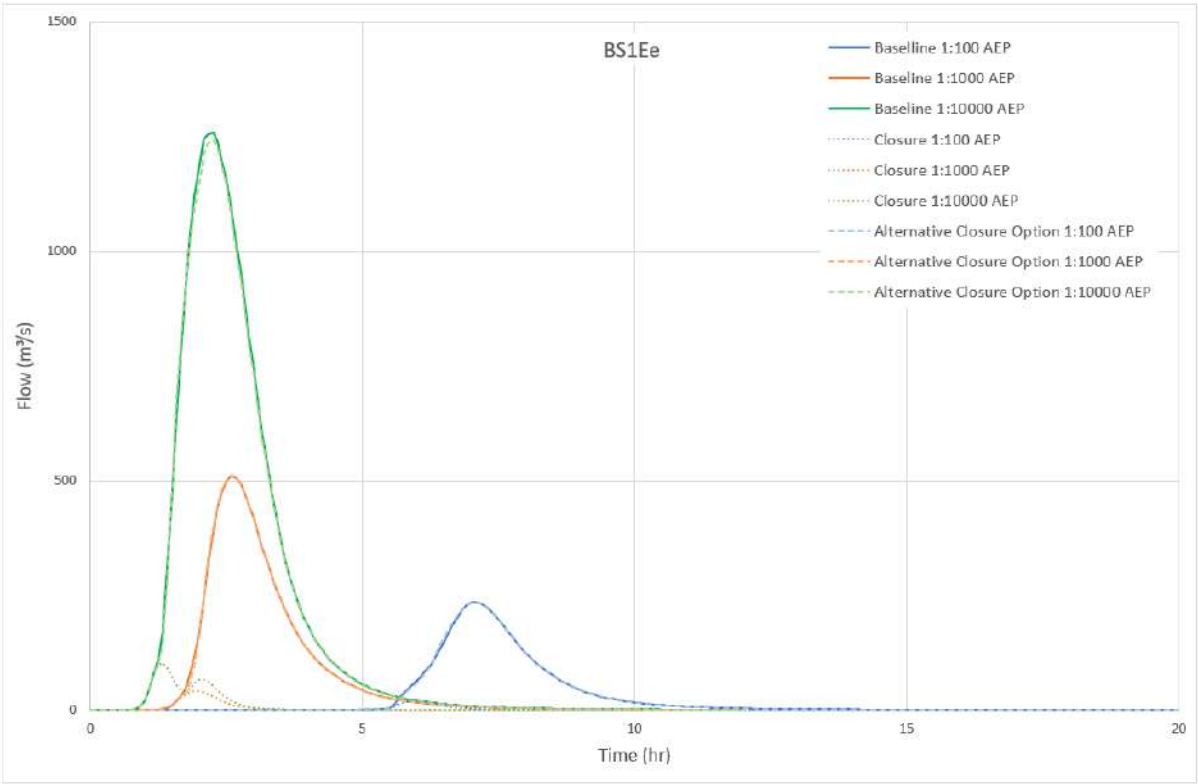


Figure 8-3 Flow hydrographs at BS1Ee downstream for the 1 in 10, 1 in 100 and 1 in 10,000 AEP events

9. References

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10. Appendices

10.1 Appendix A – Design Rainfall Depths

Table 10-1: Design rainfall depths (mm) for BS4 North and South Models and Boolgeeda Catchment Model

Duration	BS4 North and South			Boolgeeda Creek		
	1 in X AEP			1 in X AEP		
Hours	100	1,000	10,000	100	1,000	10,000
1	64	100	151	64	100	150
1.5	73	114	173	73	114	171
2	81	125	191	81	125	189
3	93	144	220	93	144	220
6	121	187	288	122	189	290
9	143	220	340	145	224	344
12	160	247	383	163	252	390
18	187	288	449	191	296	461
24	205	318	498	211	328	514
36	228	363	579	237	376	601
48	242	385	616	251	399	640
72	255	402	644	265	418	673
96	260	409	653	271	425	682
120	264	413	657	274	429	688

Table 10-2: Design rainfall depths (mm) for B2N Model Area (Centroid at -22.4308, 117.3284)

Duration	Design Rainfall Depth (mm) for Annual Exceedance Probability (AEP)		
	1 in X AEP		
Hours	100	1000	10,000
1	63	97	146
1.5	71	111	168
2	79	122	184
3	91	142	215
6	124	191	292
9	150	232	356
12	172	266	410
18	206	320	497
24	232	360	563
36	265	423	673
48	285	453	723
72	304	477	758
96	311	486	769
120	314	491	776

Table 10-3: Design rainfall depths (mm) for BS1 Models (BSP Deposits)

Duration		BS1 W			BS1 C			BS1 Ew			BS1 Ee		
		1 in X AEP			1 in X AEP			1 in X AEP			1 in X AEP		
Hours	Mins	100	1,000	10,000	100	1,000	10,000	100	1,000	10,000	100	1,000	10,000
1	60	66.5	103	155	65.4	102	152	64.4	100	152	64.1	99.7	149
1.5	90	75.7	117	175	74.5	116	174	73.3	114	173	73.1	114	172
2	120	83.3	129	191	82	127	192	80.7	125	191	80.5	125	190
3	180	96	148	218	94.6	147	223	93.3	145	222	93.1	144	219
4.5	270	112	173	280	111	171	295	109	169	294	109	169	291
6	360	126	194	398	124	192	396	123	190	350	123	191	348
9	540	148	228	519	147	227	518	146	226	397	147	227	396
12	720	167	257	608	166	256	608	165	255	469	166	257	470
18	1080	195	301	650	194	300	647	194	300	522	196	303	526
24	1440	216	334	684	215	333	677	215	333	610	217	337	619
30	1800	231	363	695	230	362	688	230	363	652	233	369	661
36	2160	242	384	702	241	382	692	241	384	683	245	390	693

Table 10-4: Design rainfall depths (mm) for BSP Models – BS3 and Lens G

Duration		BS3-MM-J			BS3Ext-CKSD			Lens G		
		1 in X AEP			1 in X AEP			1 in X AEP		
Hours	Mins	100	1,000	10,000	100	1,000	10,000	100	1,000	10,000
1	60	60.9	94.7	144	60.9	94.7	144	61.7	95.9	146
1.5	90	69.4	108	165	69.4	108	165	70.4	109	165
2	120	76.7	119	181	76.7	119	181	77.7	121	183
3	180	89.5	139	214	89.5	139	214	90.5	140	216
4.5	270	107	165	293	107	165	293	108	167	296
6	360	122	189	-	122	189	359	123	190	-
9	540	149	231	415	149	231	415	149	231	418
12	720	172	266	-	172	266	506	171	265	-
18	1080	208	323	574	208	323	574	206	319	574
24	1440	235	365	688	235	365	688	232	360	689
30	1800	256	406	741	256	406	741	251	398	740
36	2160	271	433	778	271	433	778	266	423	776
48	2880	292	465	790	292	465	790	285	453	787
72	4320	312	490	794	312	490	794	303	476	792

Table 10-5: Design rainfall depths (mm) for BSP Models – MM-M and Kurwillinah Pool

Duration		MM-M			Kurwillinah Pool		
		1 in X AEP			1 in X AEP		
Hours	Mins	100	1,000	10,000	100	1,000	10,000
0.5	30	49.1	76.3	115	49.1	76	115
1	60	62.4	97.1	147	62.3	97	147
1.5	90	71.2	111	169	71.0	110	168
2	120	78.4	122	186	78.2	121	186
3	180	90.8	141	218	90.6	141	216
4.5	270	106	165	289	120	186	289
6	360	120	185	344	144	222	346
9	540	142	220	389	163	251	393
12	720	161	248	459	192	297	465
18	1080	189	292	511	213	330	519
24	1440	208	323	594	240	382	609
30	1800	223	353	633	256	407	651
36	2160	234	372	659	271	427	682
48	2880	248	394	668	277	434	690
72	4320	261	412	672	281	439	696

10.2 Appendix B – BS4 Mine Area Closure Floodplain Mapping

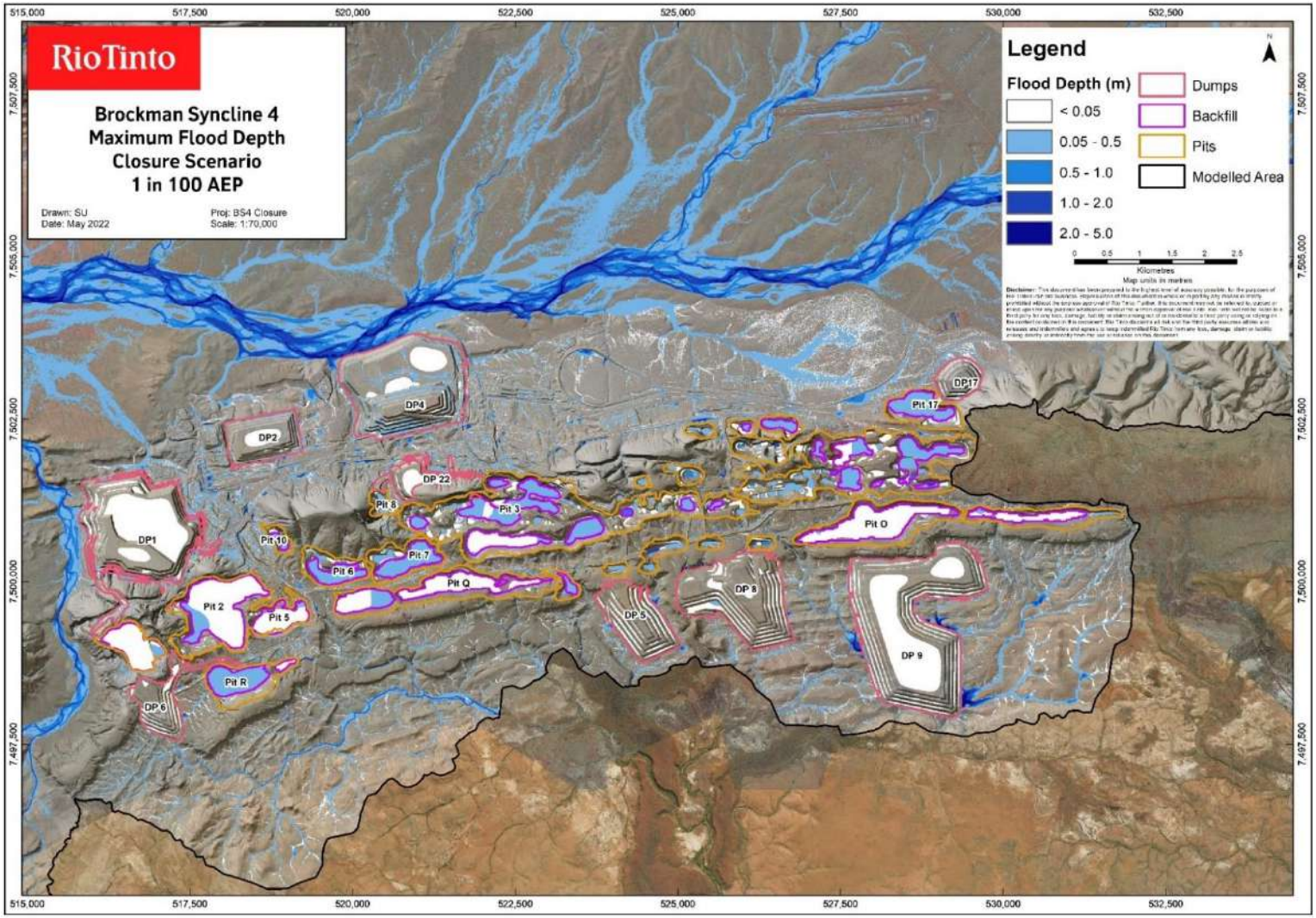


Figure 10-1 1 in 100 AEP peak flood depth for BS4

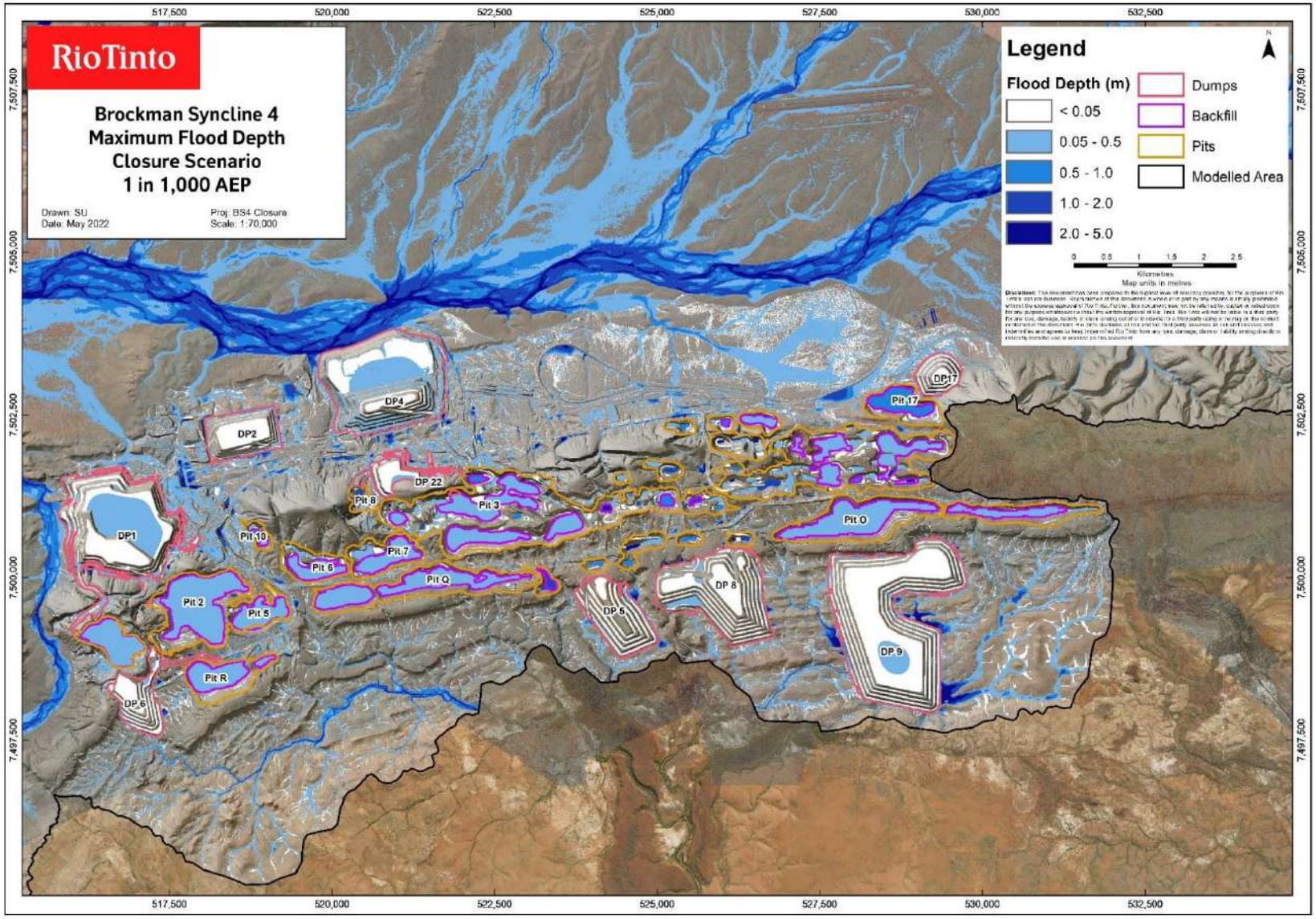


Figure 10-2 1 in 1,000 AEP peak flood depth for BS4

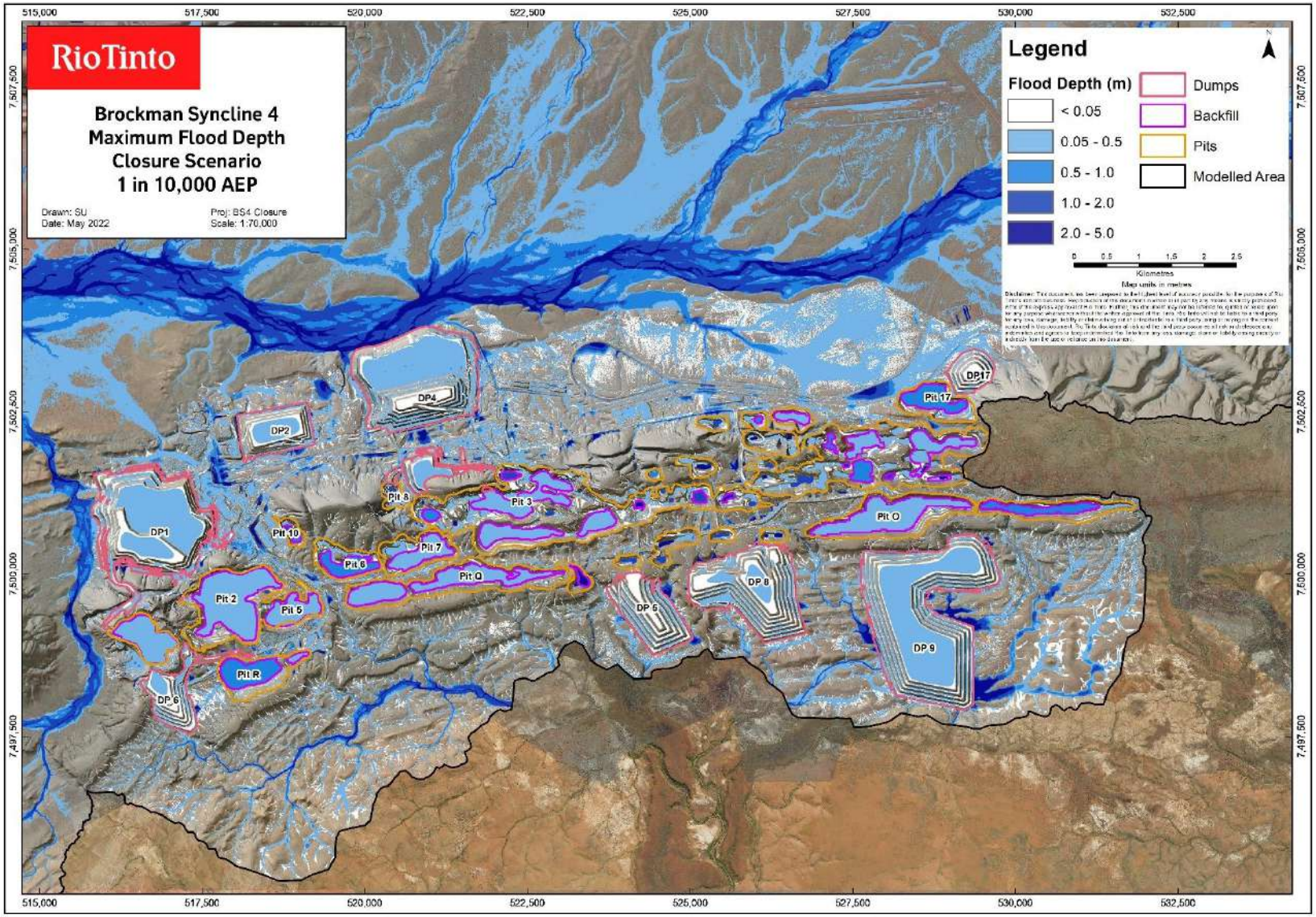


Figure 10-3 1 in 10,000 AEP peak flood depth for BS4

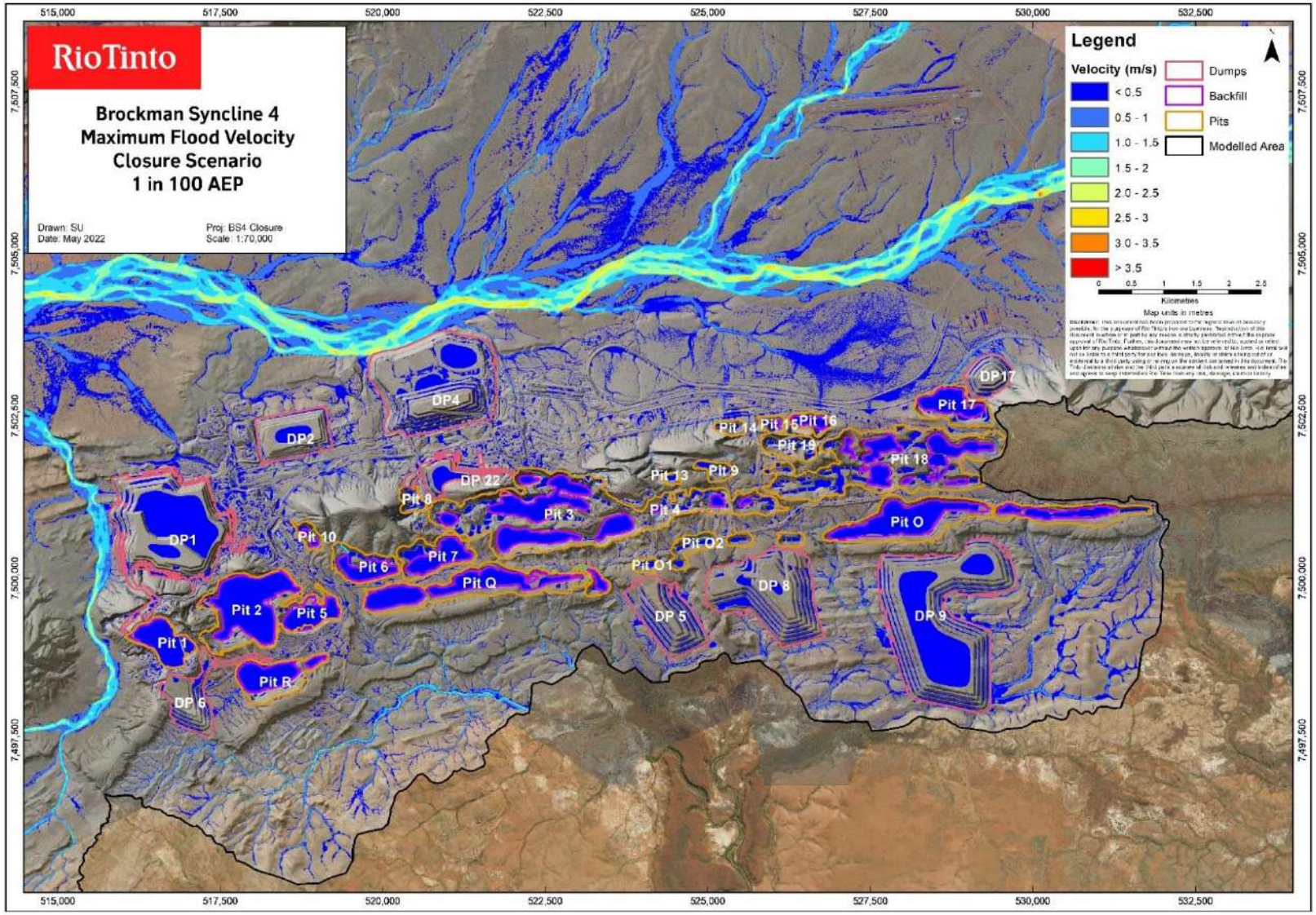


Figure 10-4 1 in 100 AEP peak flood velocity for BS4

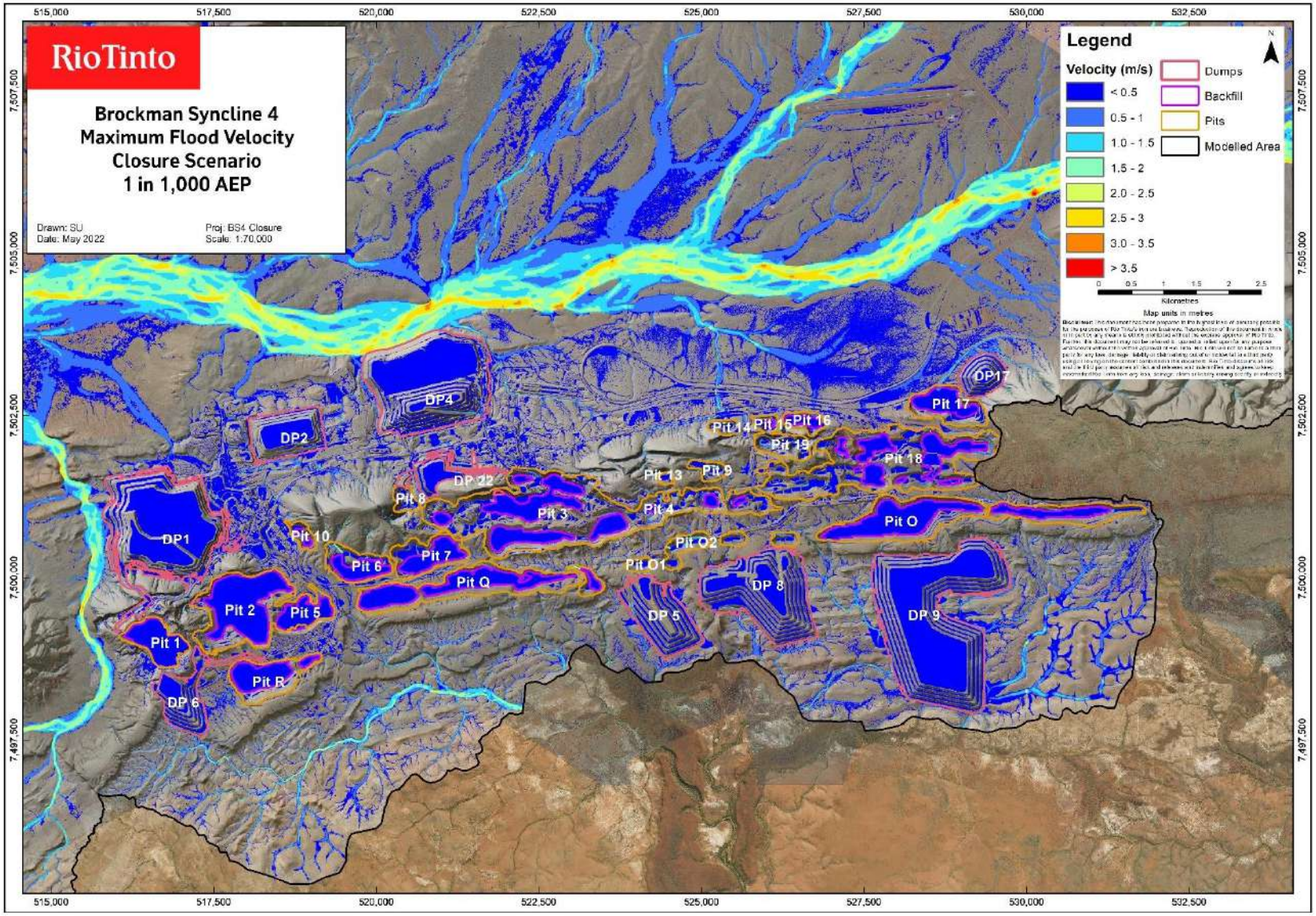


Figure 10-5 1 in 1,000 AEP peak flood velocity for BS4

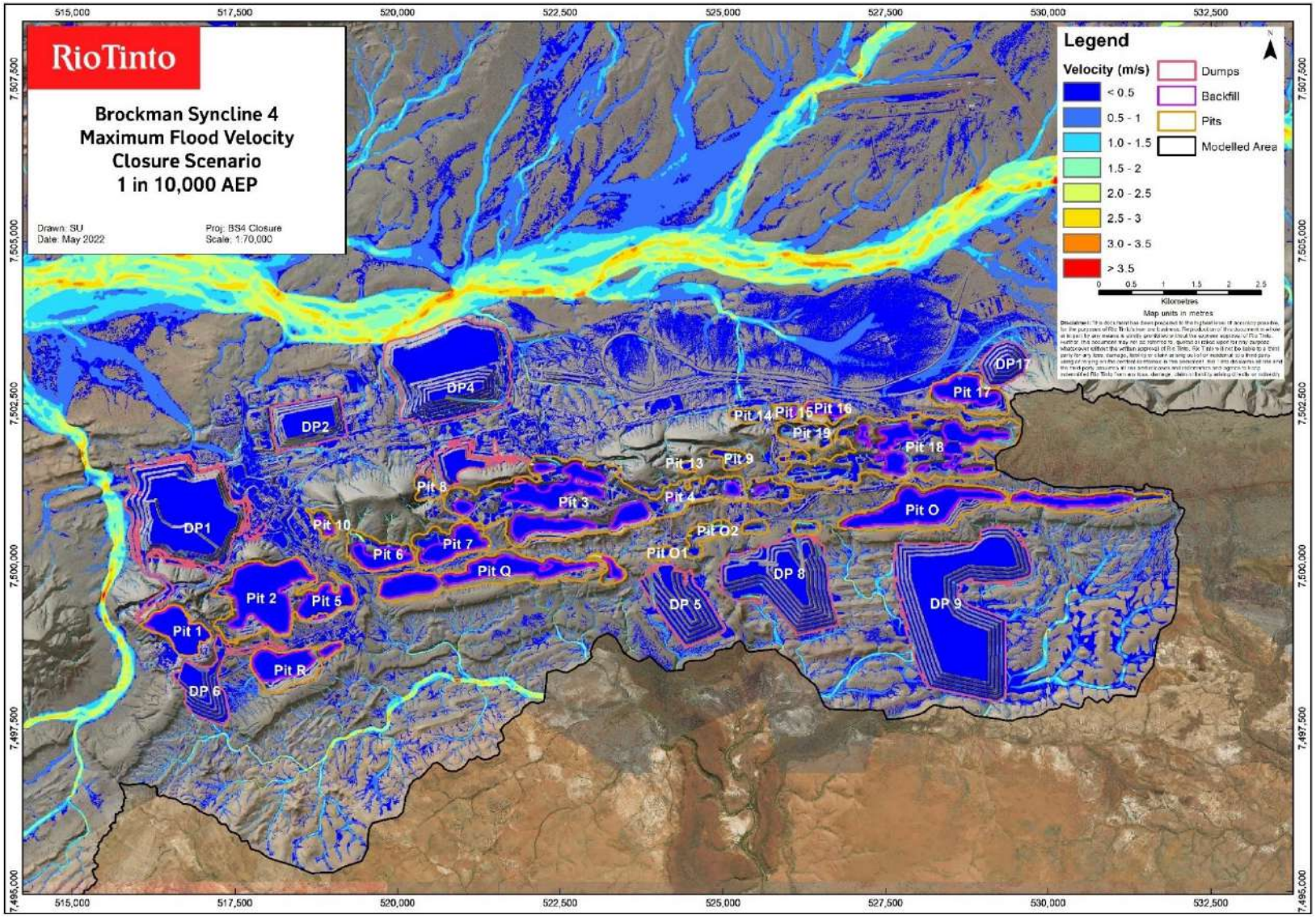


Figure 10-6 1 in 10,000 AEP peak flood velocity for BS4

10.3 Appendix C – B2N Mine Area Closure Floodplain Mapping

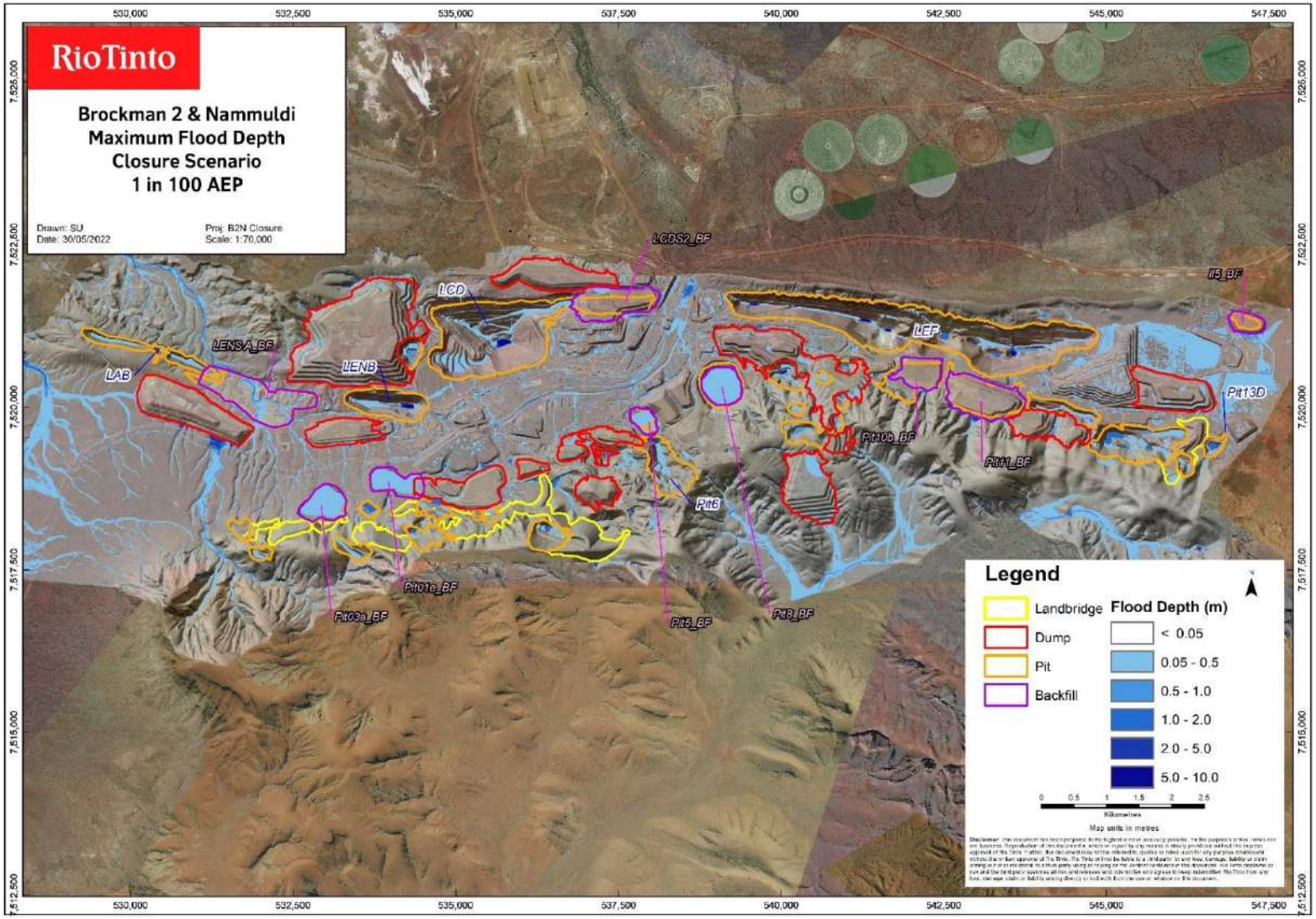


Figure 10-7 1 in 100 AEP peak flood depth for B2N

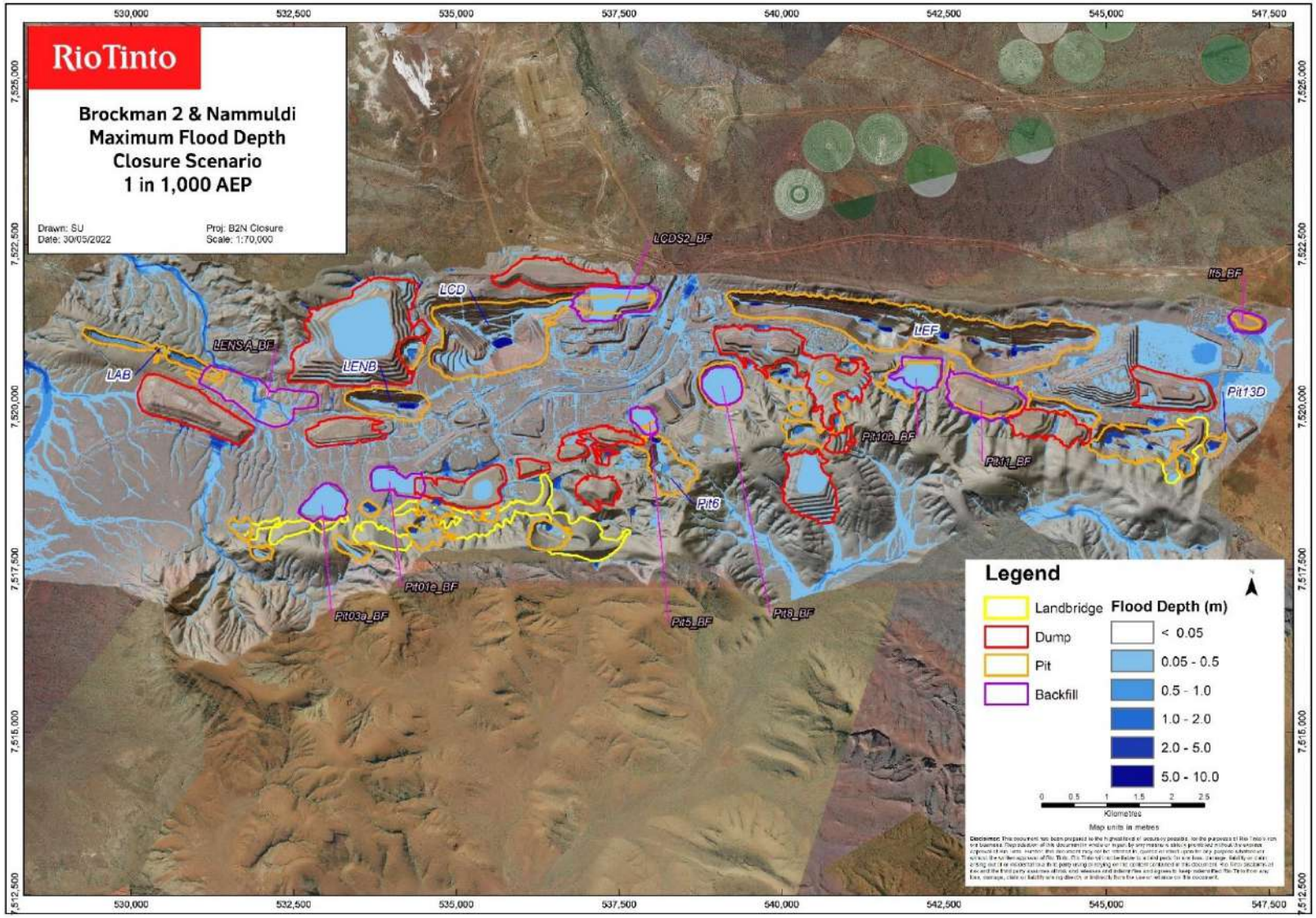


Figure 10-8 1 in 1,000 AEP peak flood depth for B2N

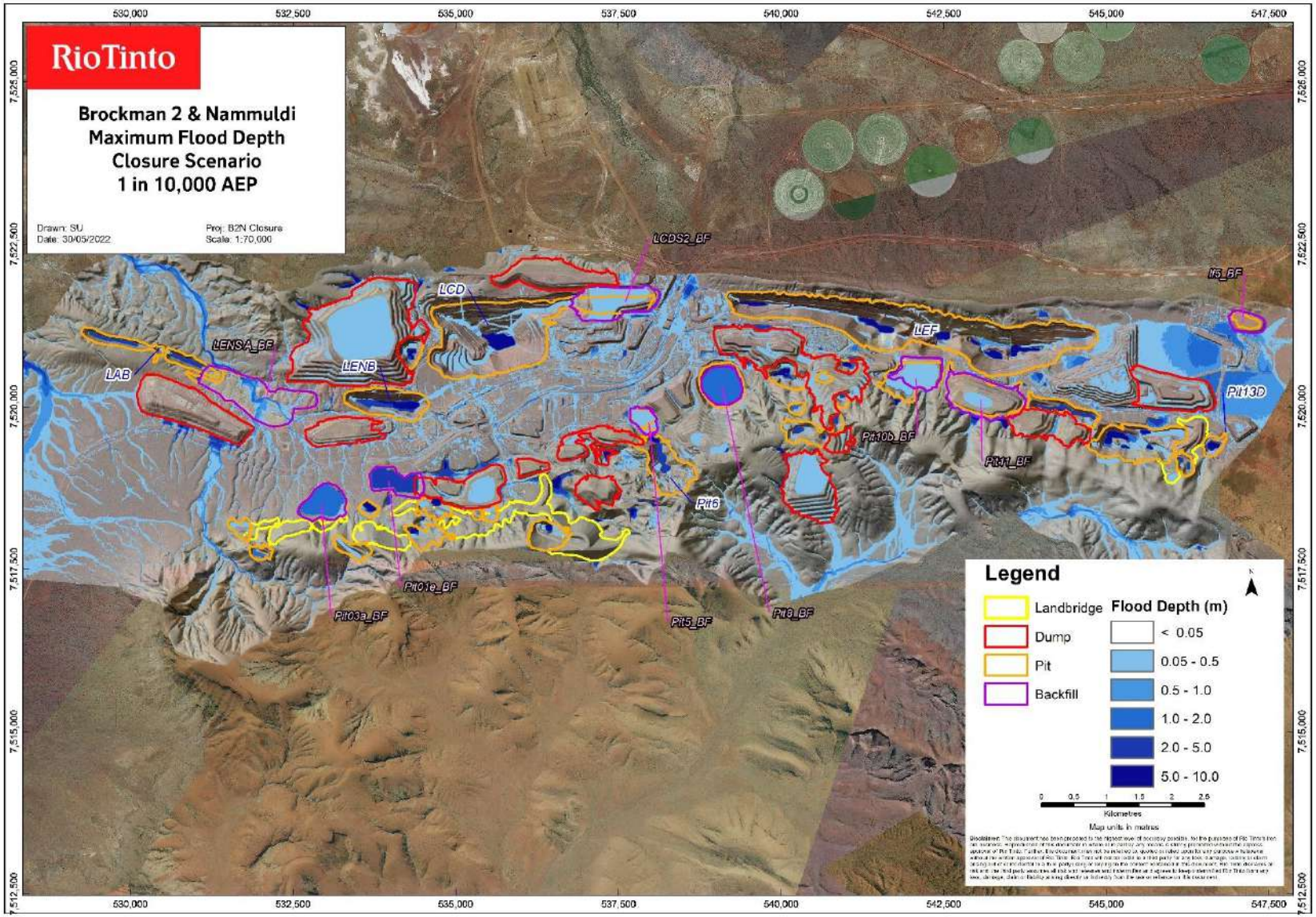


Figure 10-9 1 in 10,000 AEP peak flood depth for B2N

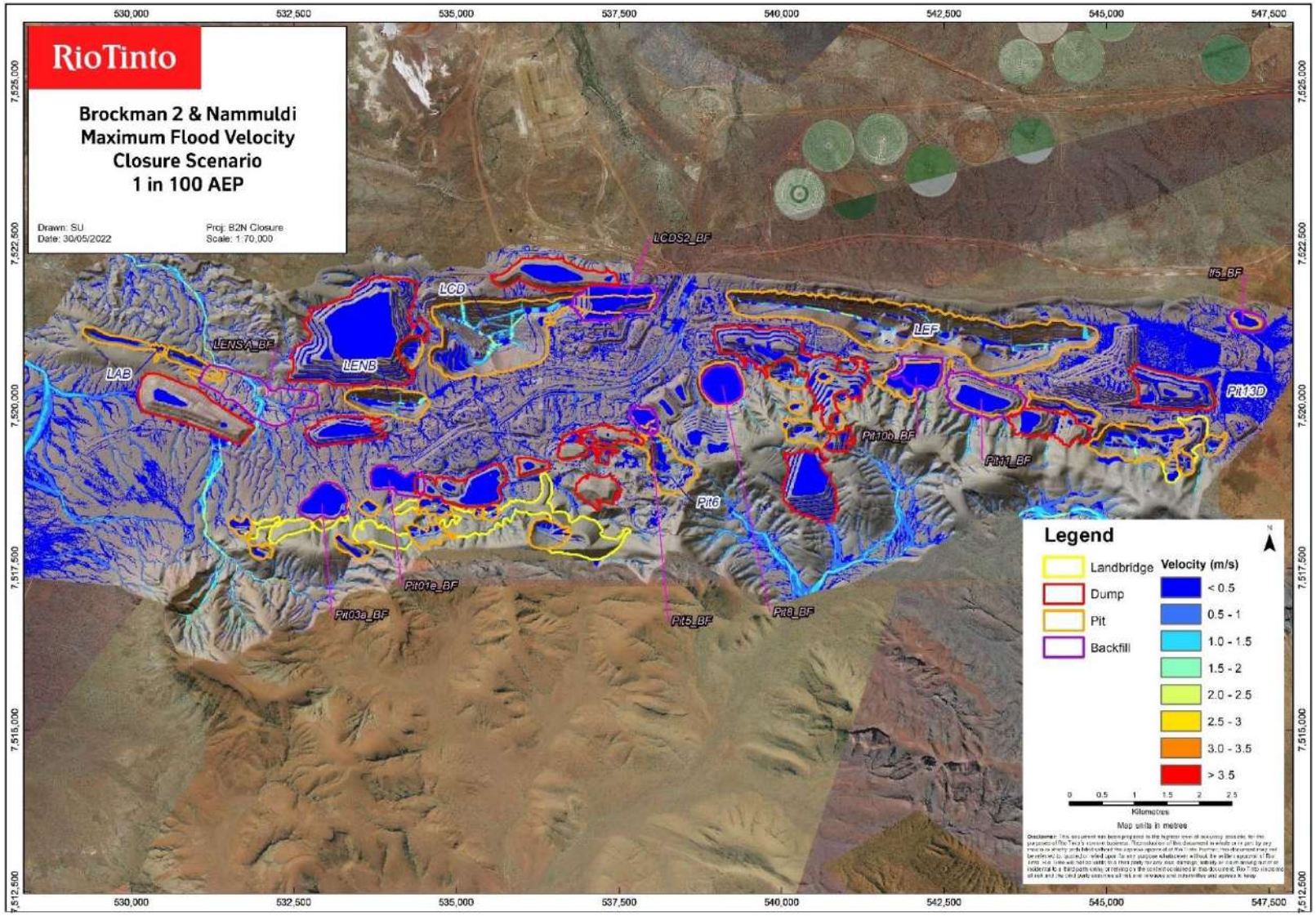


Figure 10-10 1 in 100 AEP peak flood velocity for B2N

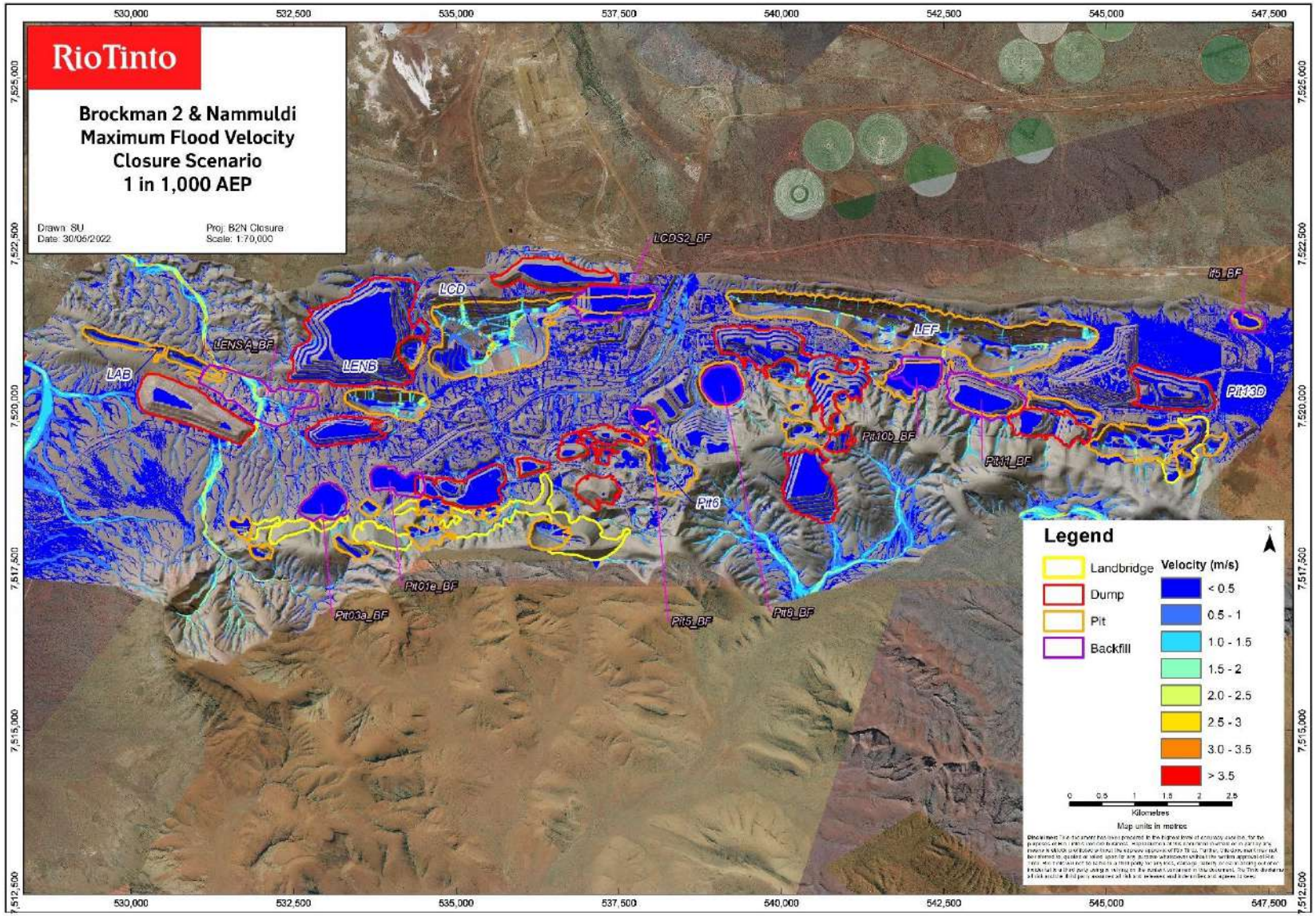


Figure 10-11 1 in 1,000 AEP peak flood velocity for B2N

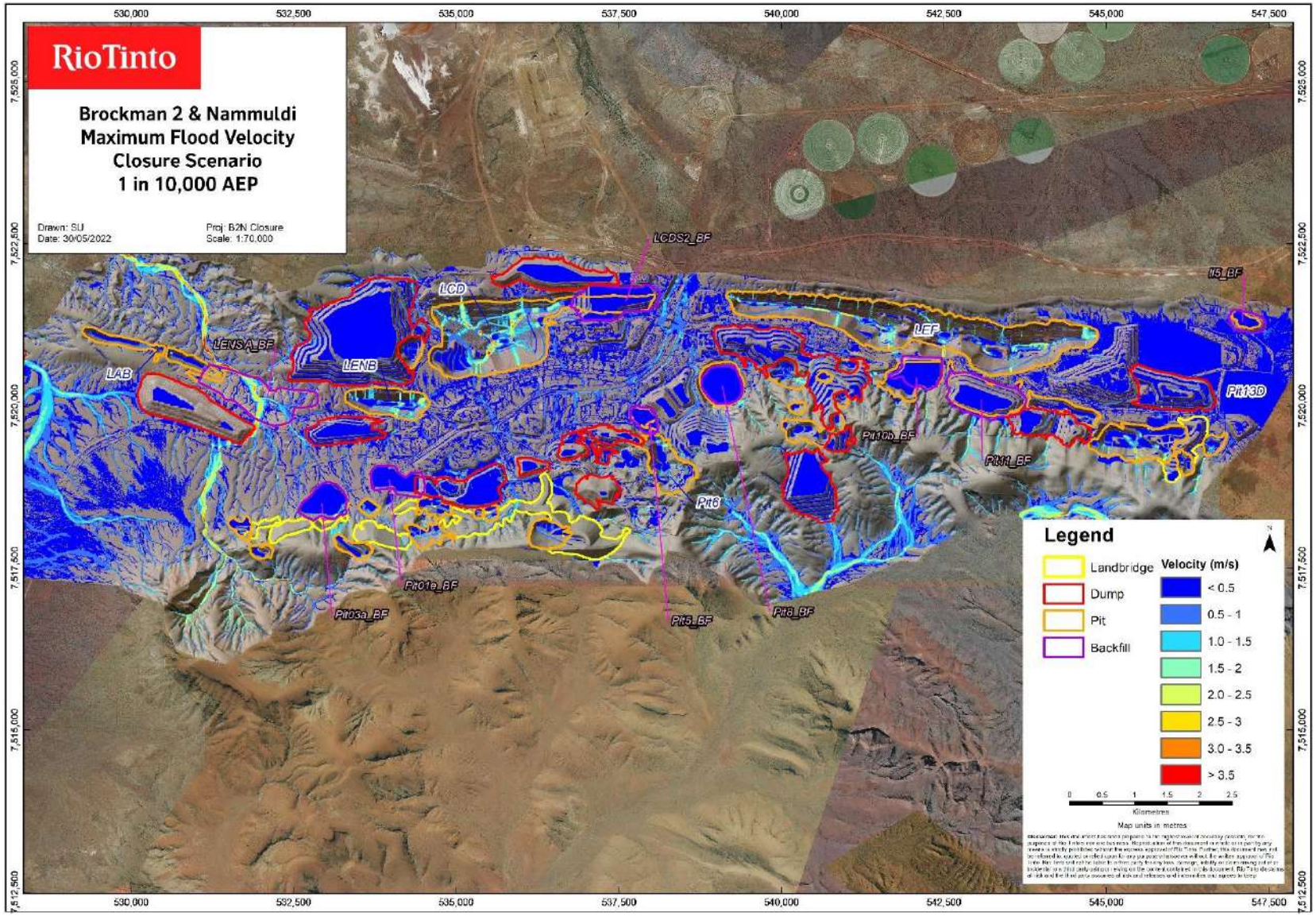


Figure 10-12 1 in 10,000 AEP peak flood velocity for B2N

10.4 Appendix D – Silvergrass Closure Floodplain Mapping

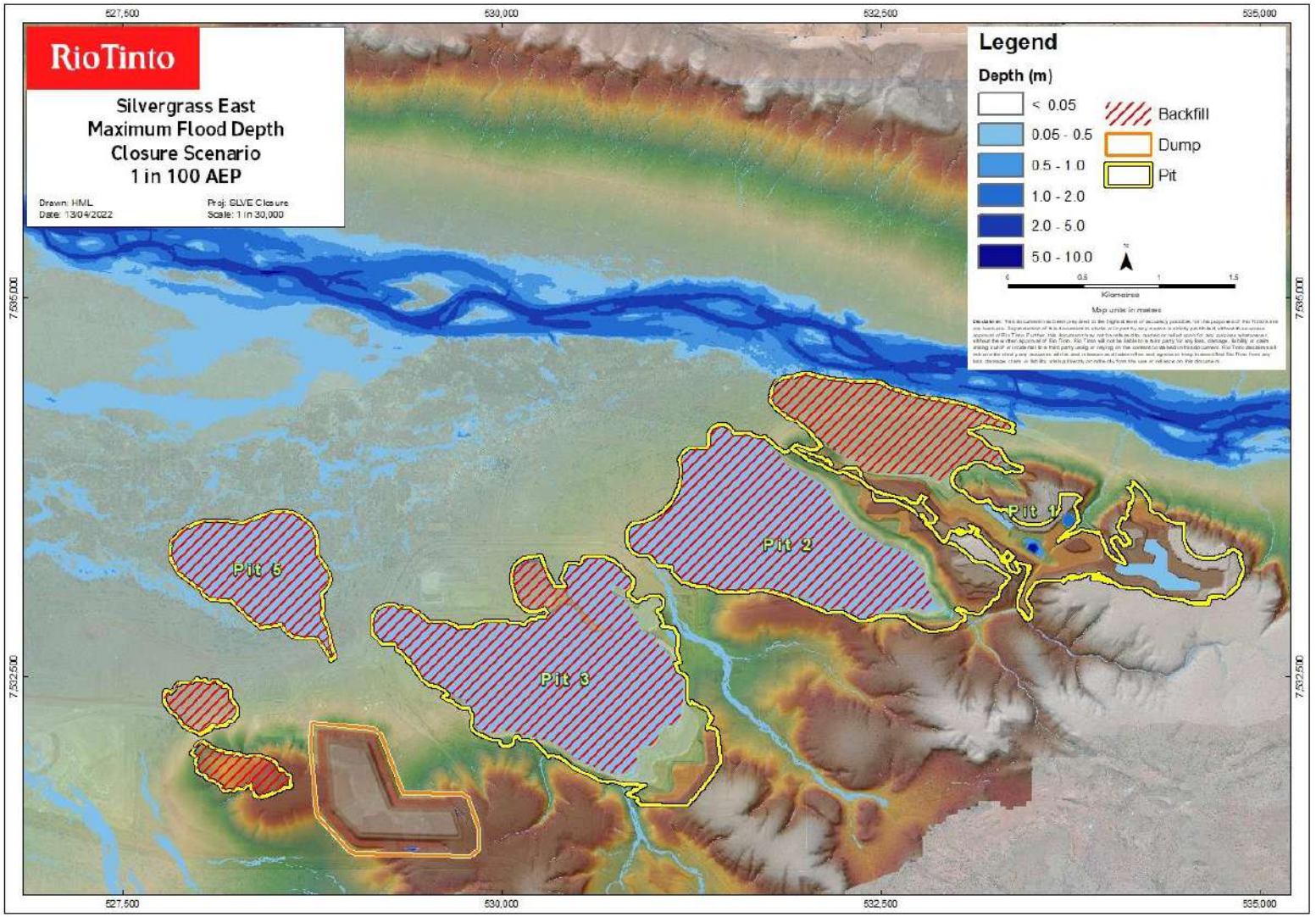


Figure 10-13 Maximum flood depth for the 1 in 100 AEP design event in the closure scenario

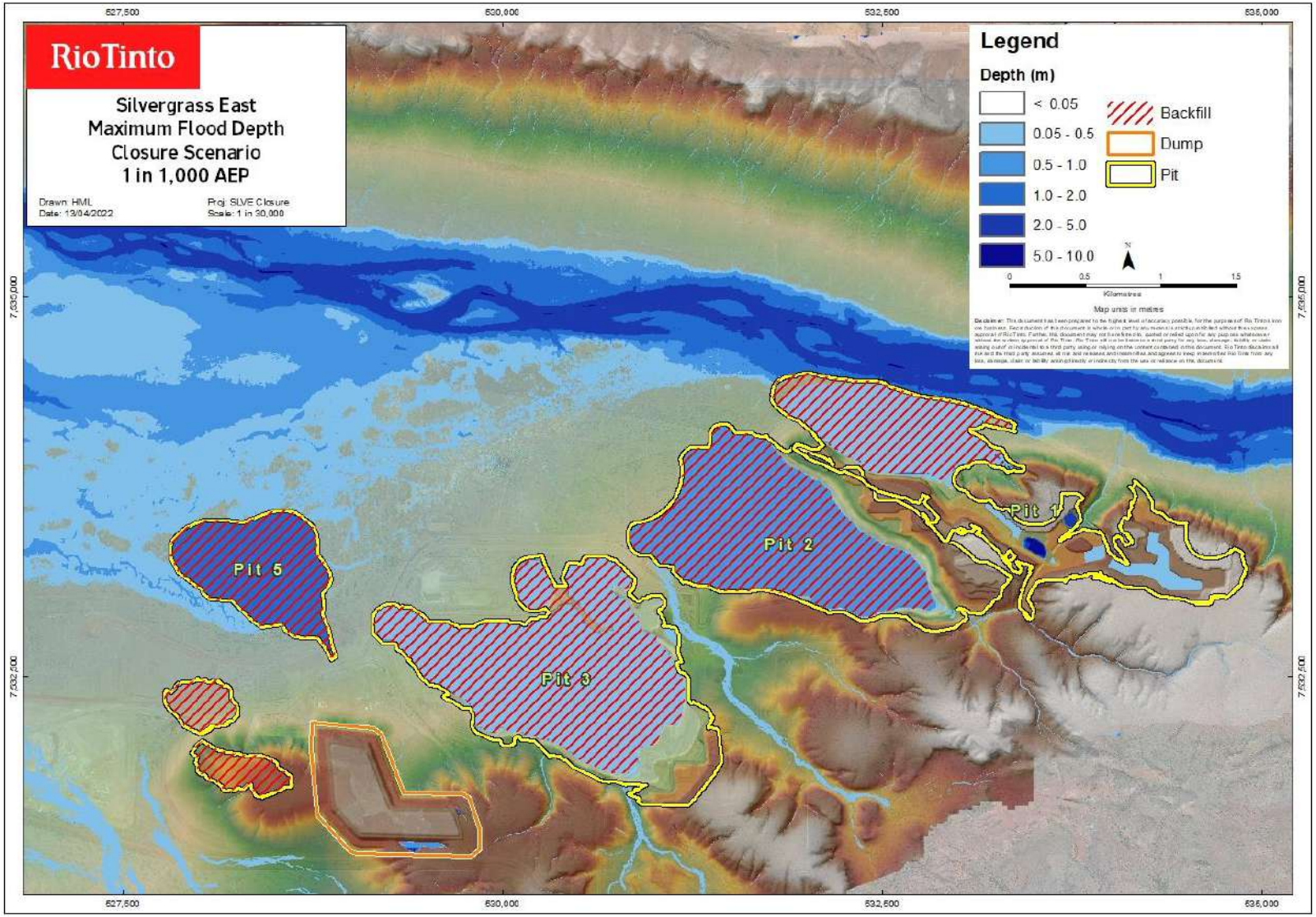


Figure 10-14 Maximum flood depth for the 1 in 1,000 AEP design event in the closure scenario

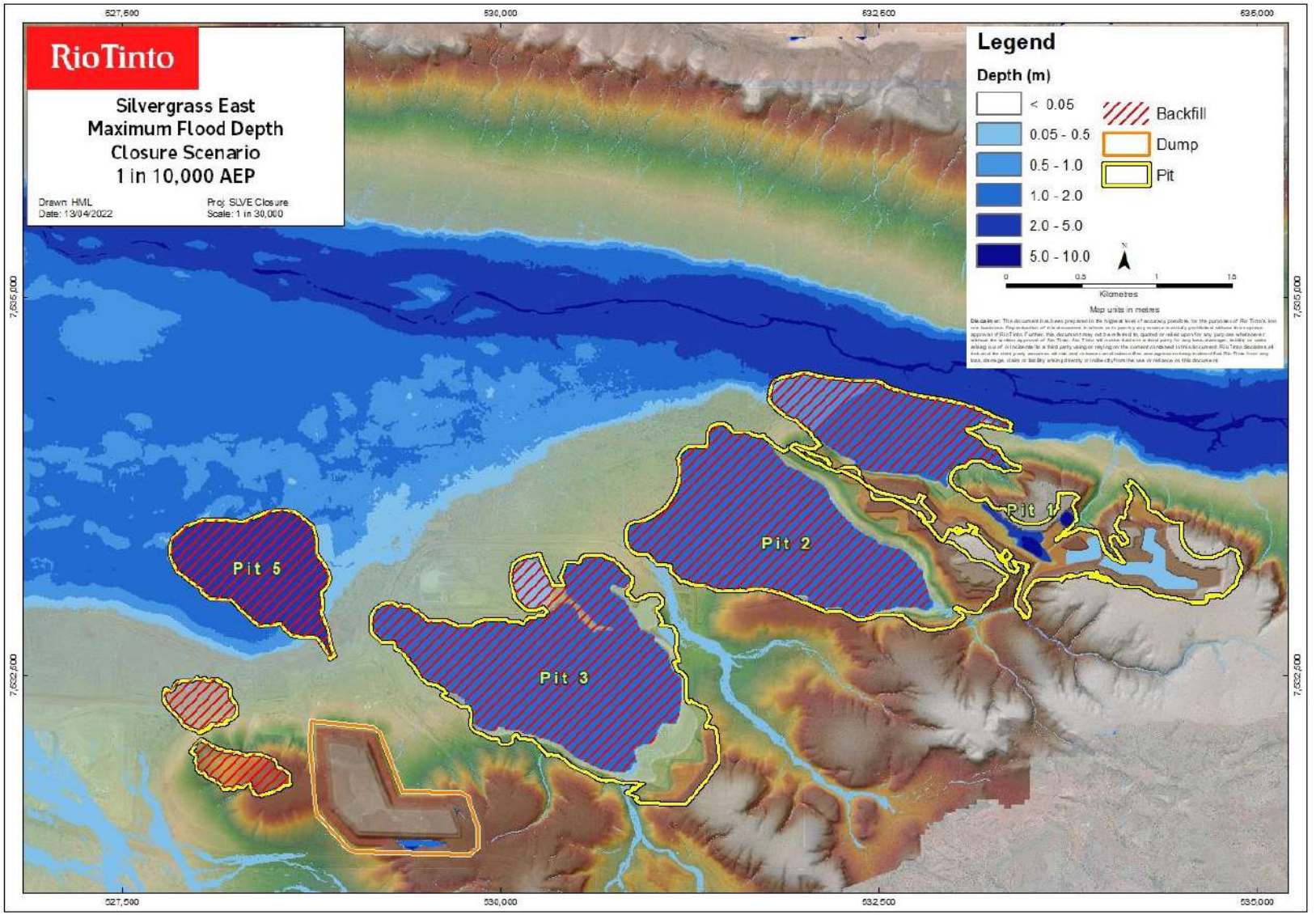


Figure 10-15 Maximum flood depth for the 1 in 10,000 AEP design event in the closure scenario

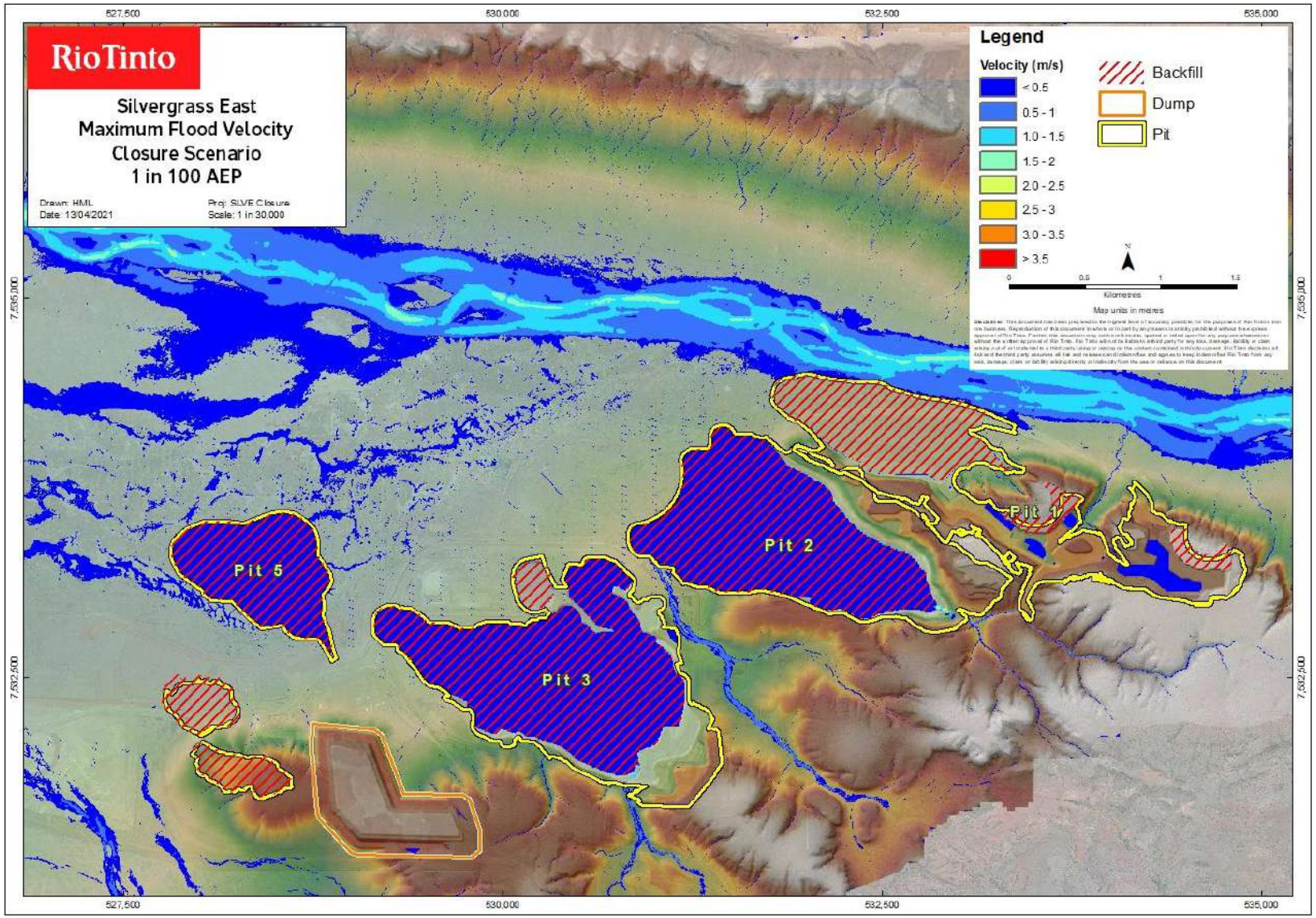


Figure 10-16 Maximum flood velocity for the 1 in 100 AEP design event in the closure scenario

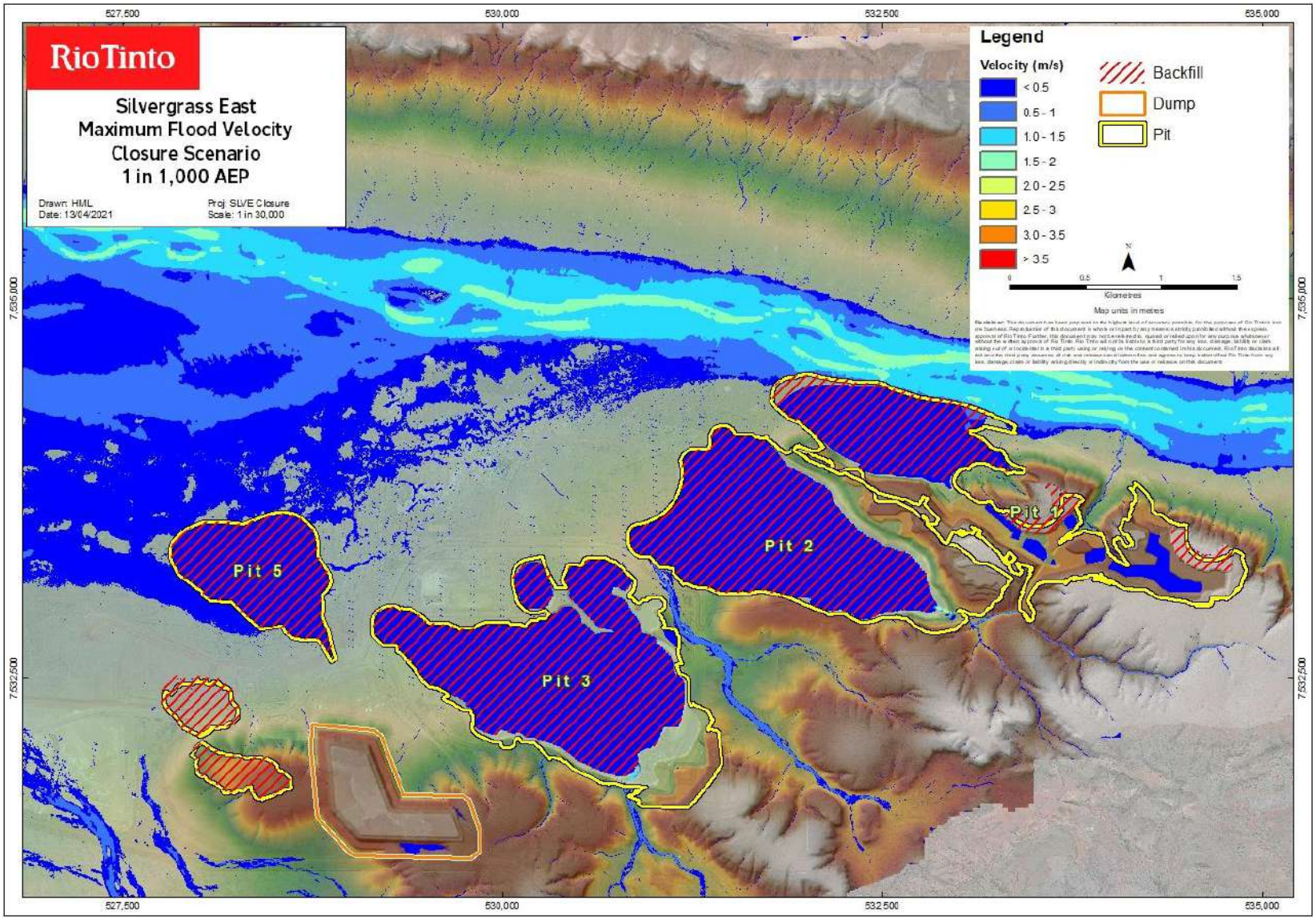


Figure 10-17 Maximum flood velocity for the 1 in 1,000 AEP design event in the closure scenario

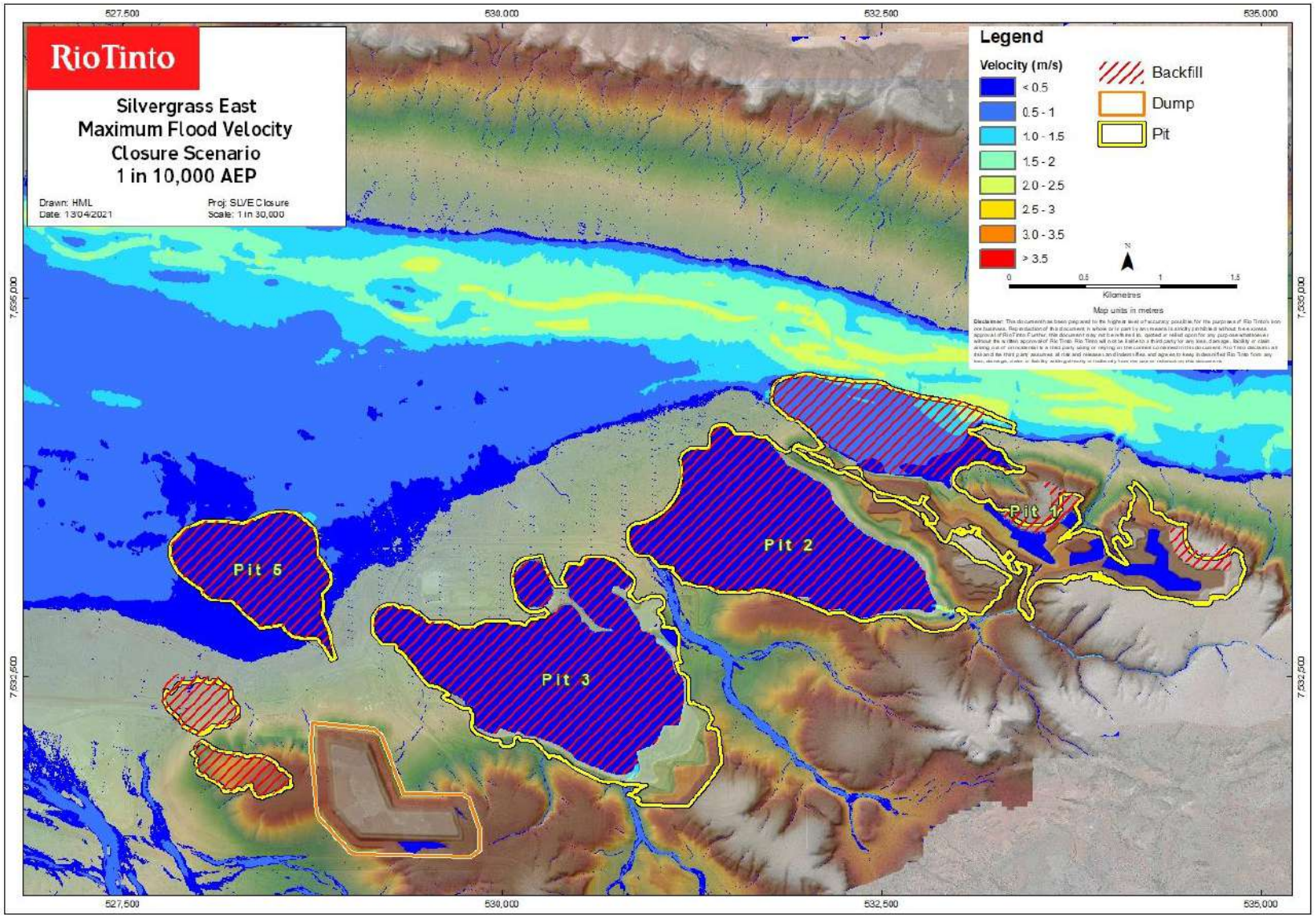


Figure 10-18 Maximum flood velocity for the 1 in 10,000 AEP design event in the closure scenario

10.5 Appendix E – BSP TUFLOW Model Layouts

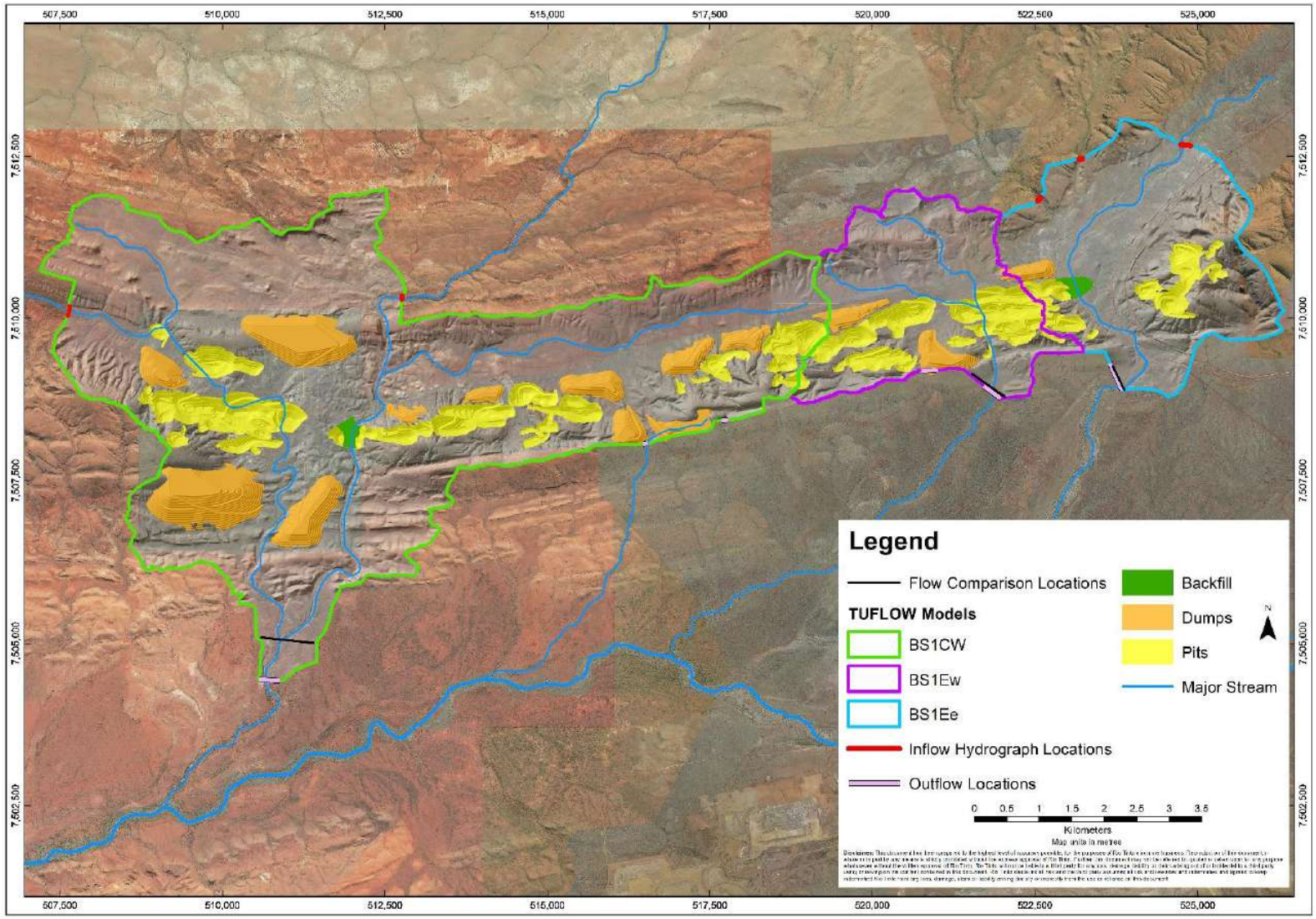


Figure 10-19 TUFLOW Model Layout - BS1CW, BS1Ew and BS1Ee

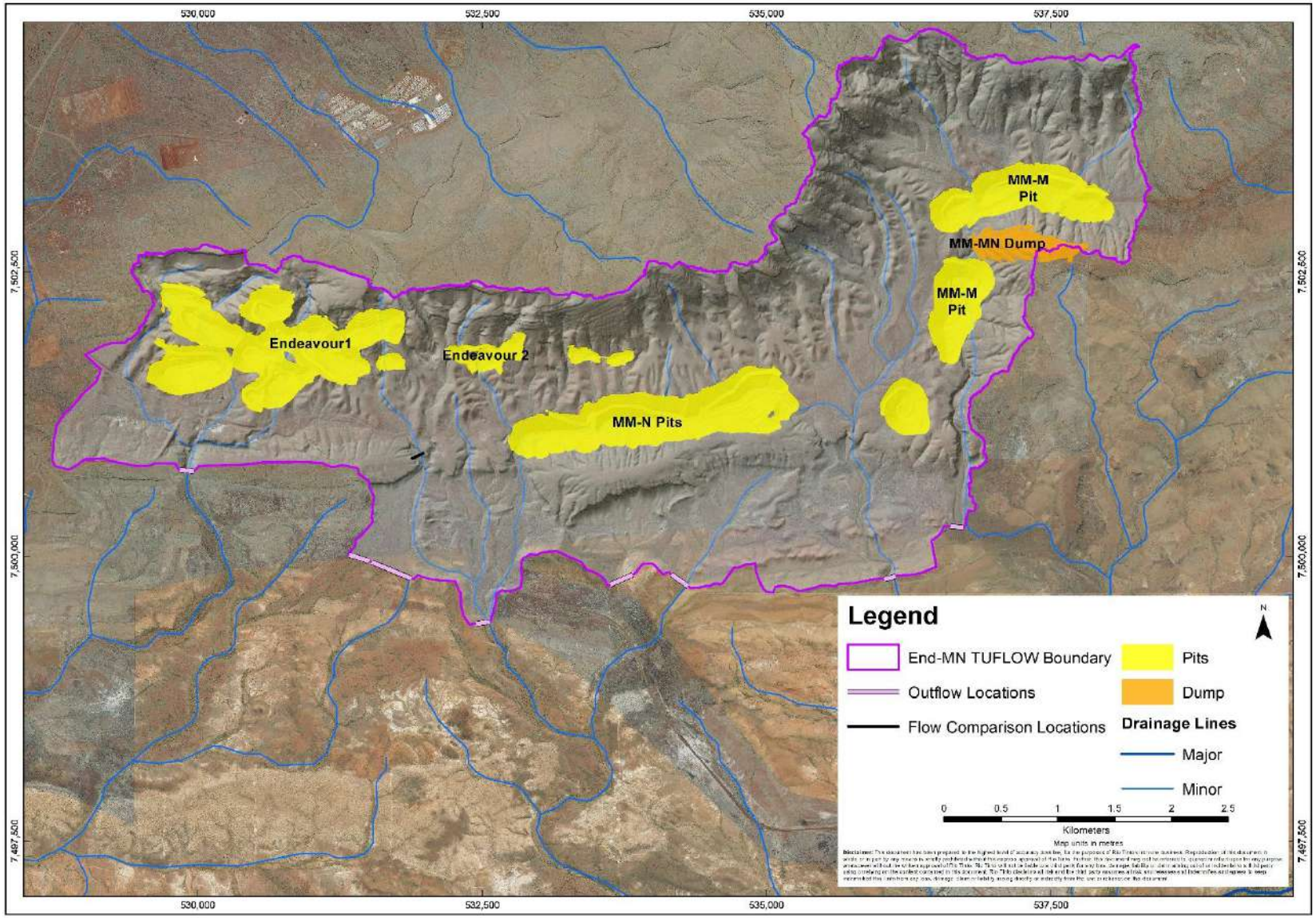


Figure 10-20 TUFLOW Model Layout - Endeavour MN and Kurwillinha Pool

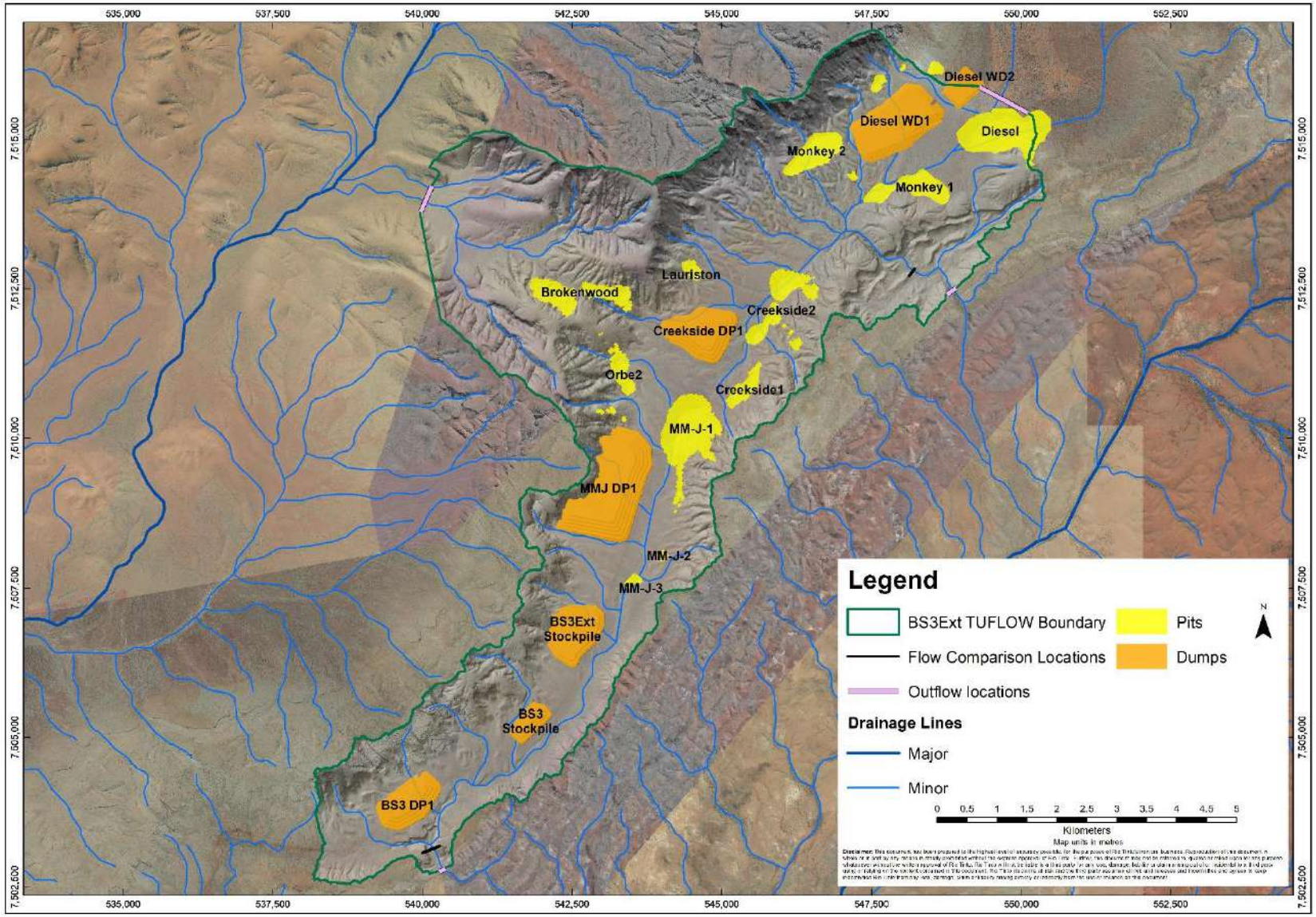


Figure 10-21 TUFLOW Model Layout - BS3Ext

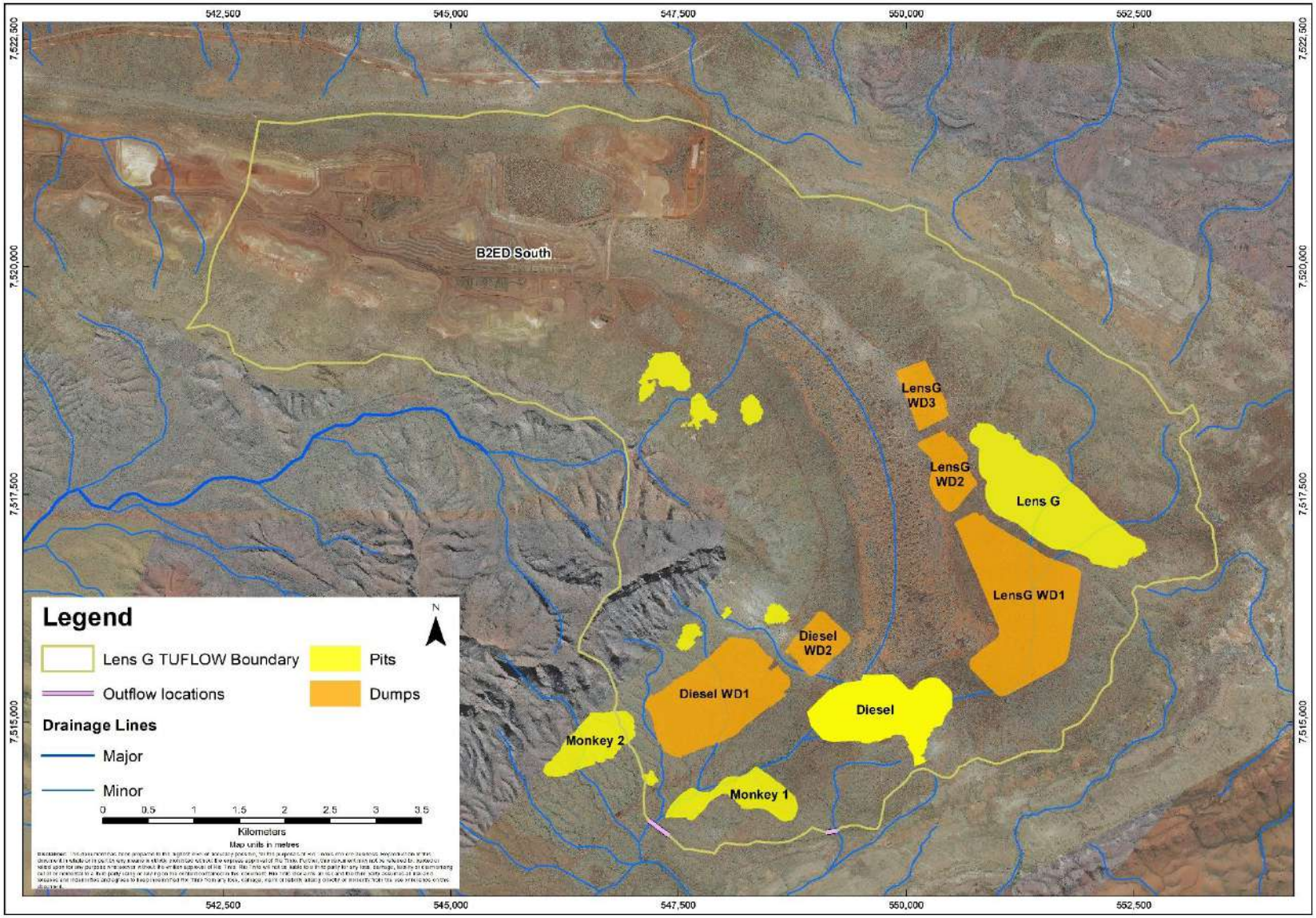


Figure 10-22 TUFLOW Model Layout - Lens G

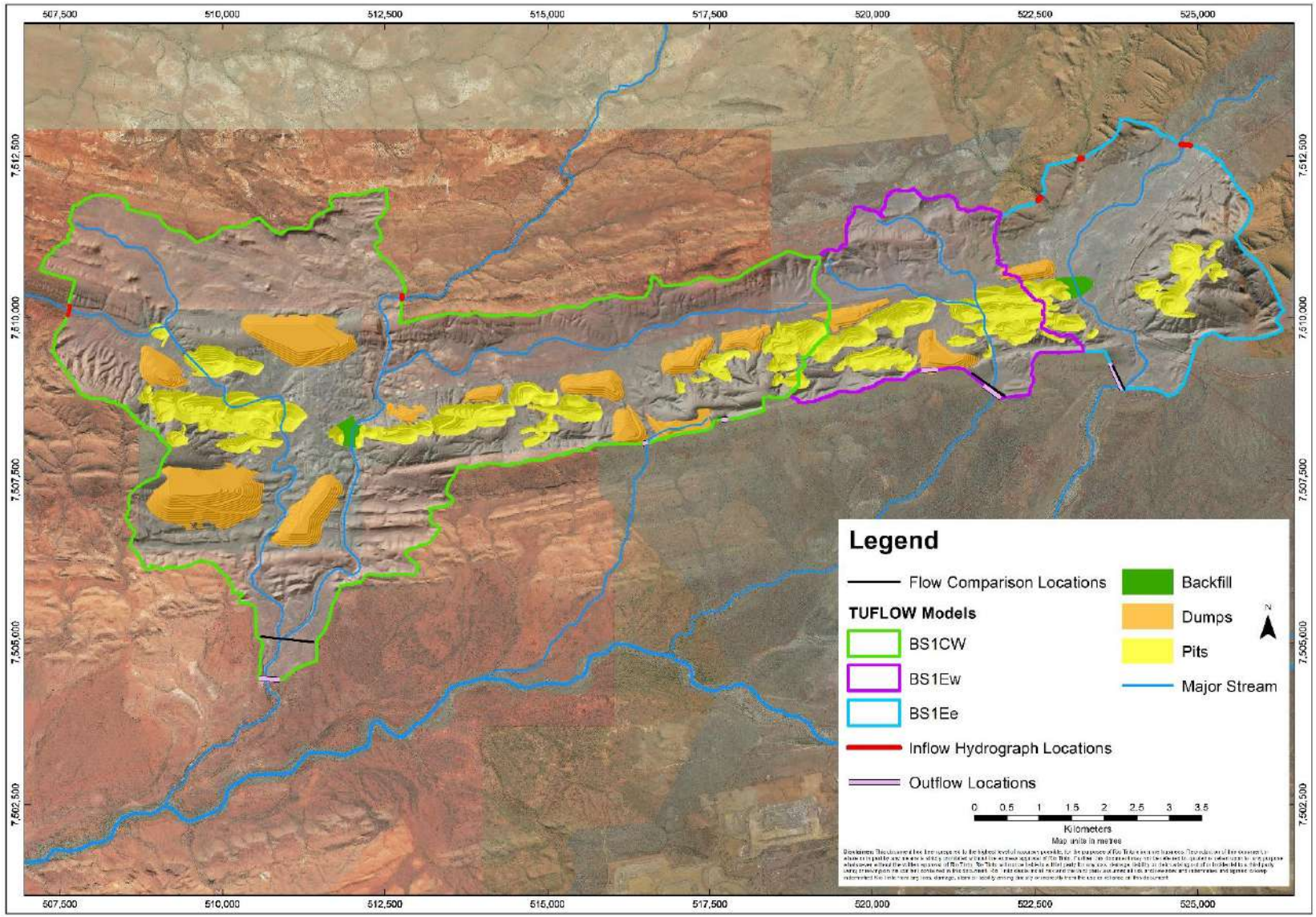


Figure 10-23 TUFLOW Model Layout - BS1CW, BS1Ew and BS1Ee with alternative closure backfill option

10.6 Appendix G – BSP Closure Floodplain Mapping

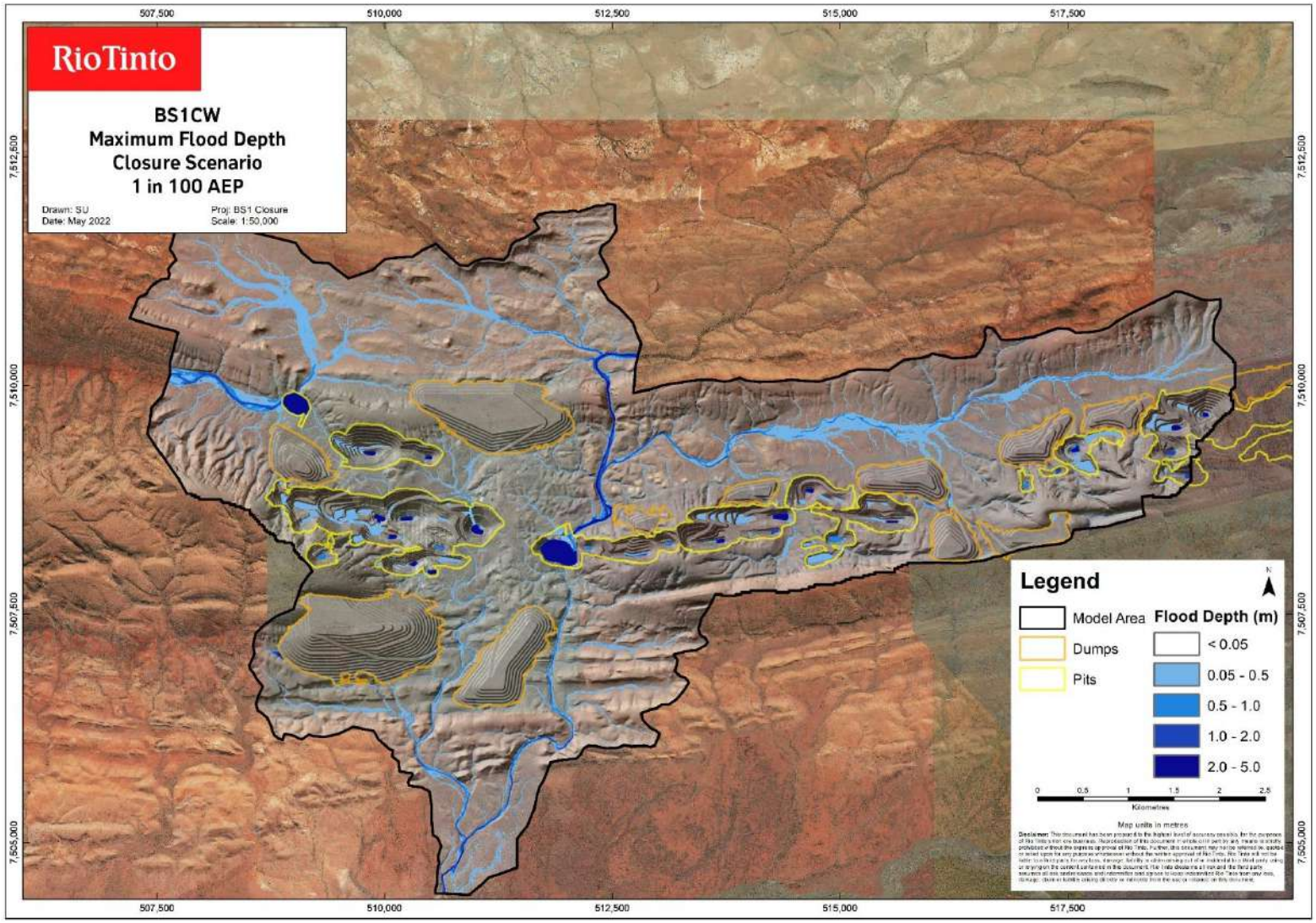


Figure 10-24 BS1-CW: 1 in 100 AEP peak flood depth

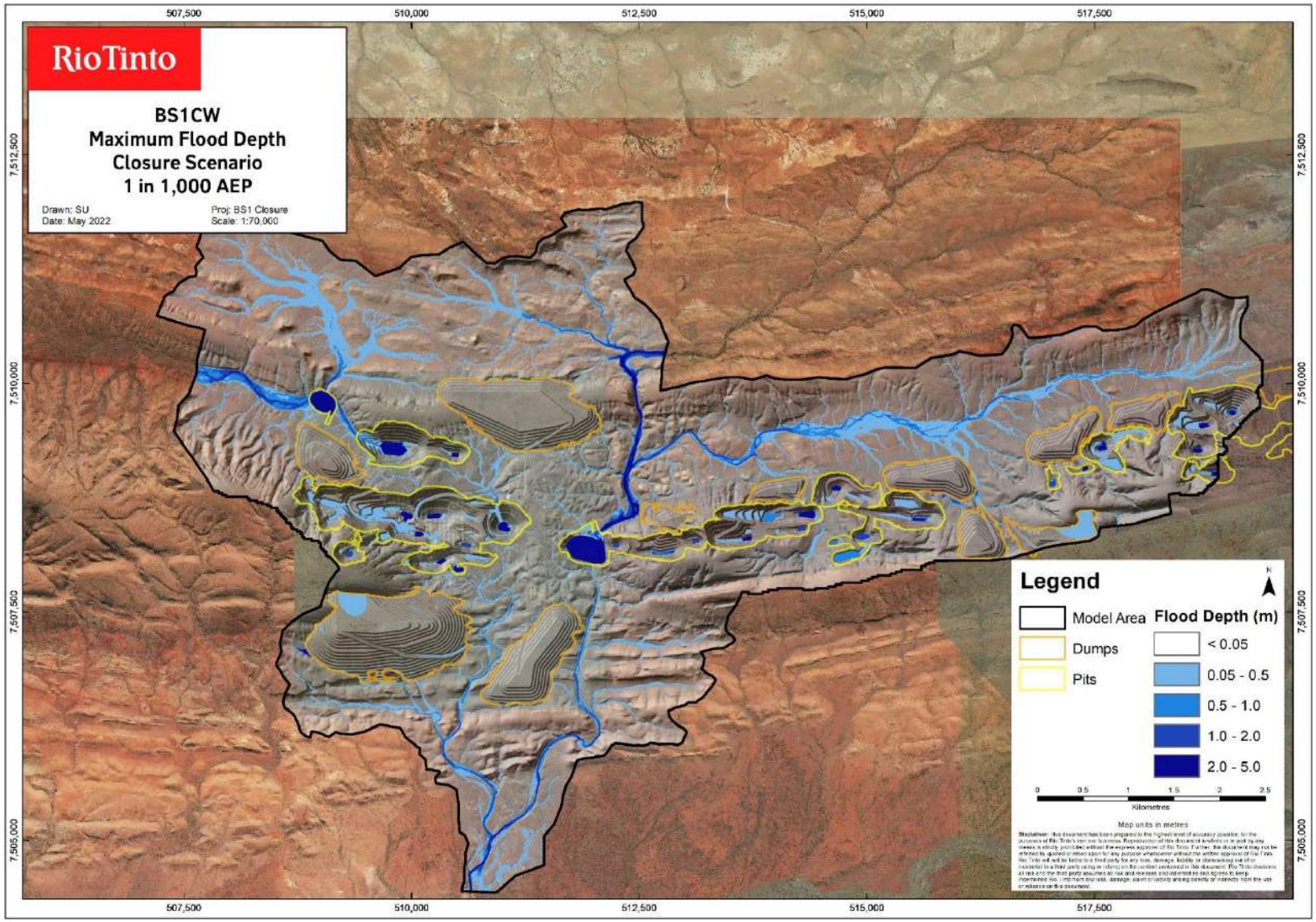


Figure 10-25 BS1-CW: 1 in 1,000 AEP peak flood depth

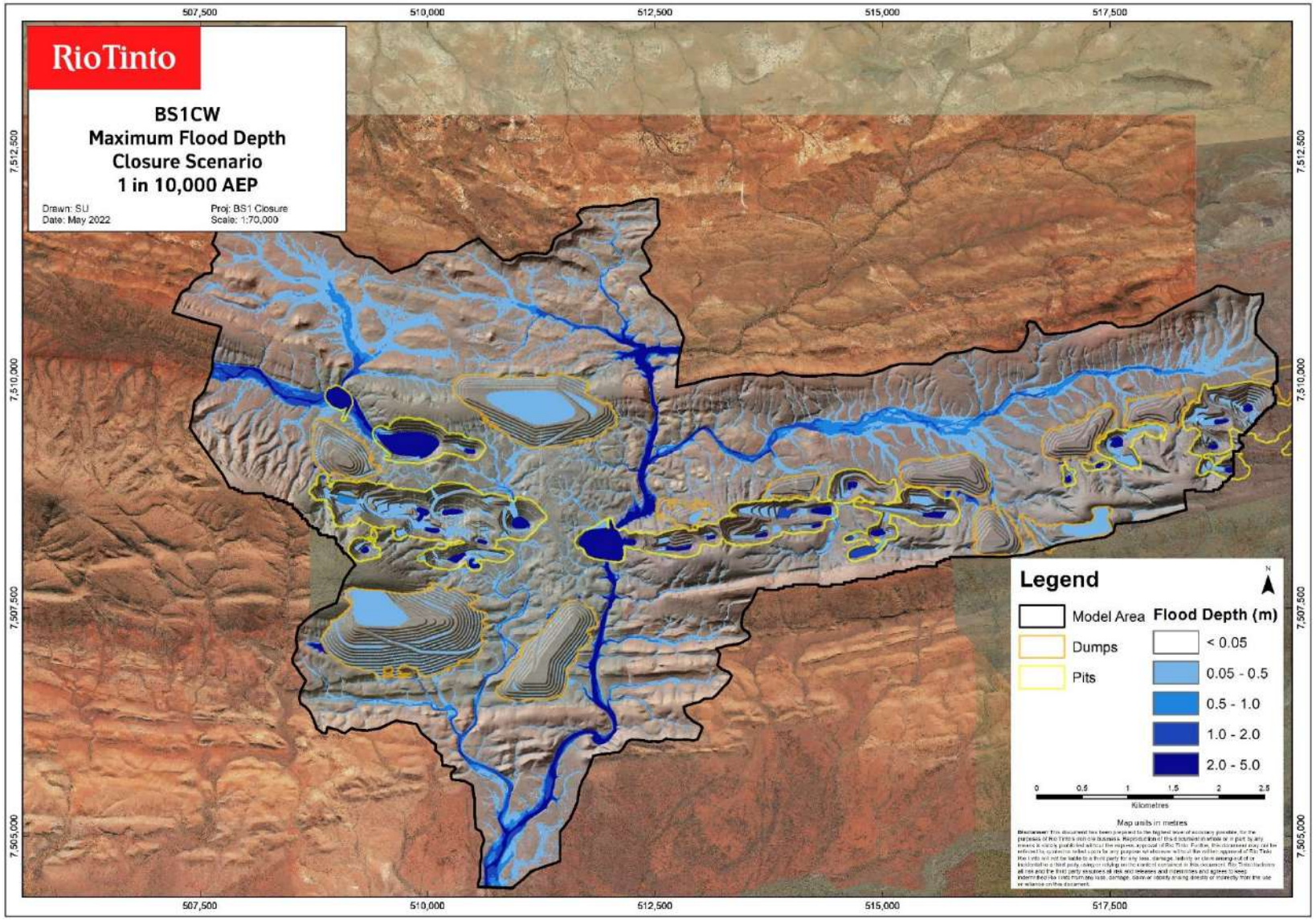


Figure 10-26 BS1-CW: 1 in 10,000 AEP peak flood depth

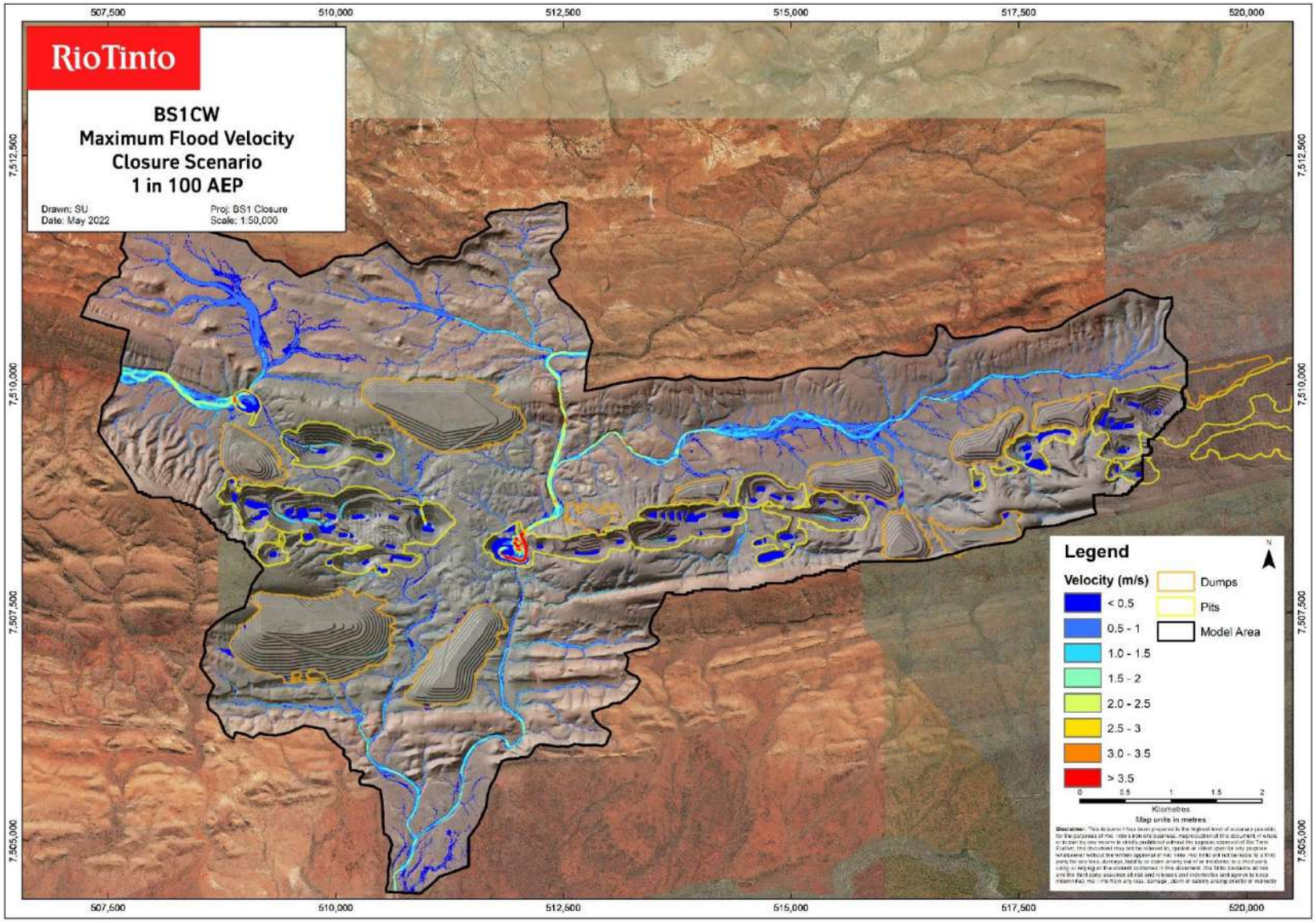


Figure 10-27 BS1-CW: 1 in 100 AEP peak flood velocity

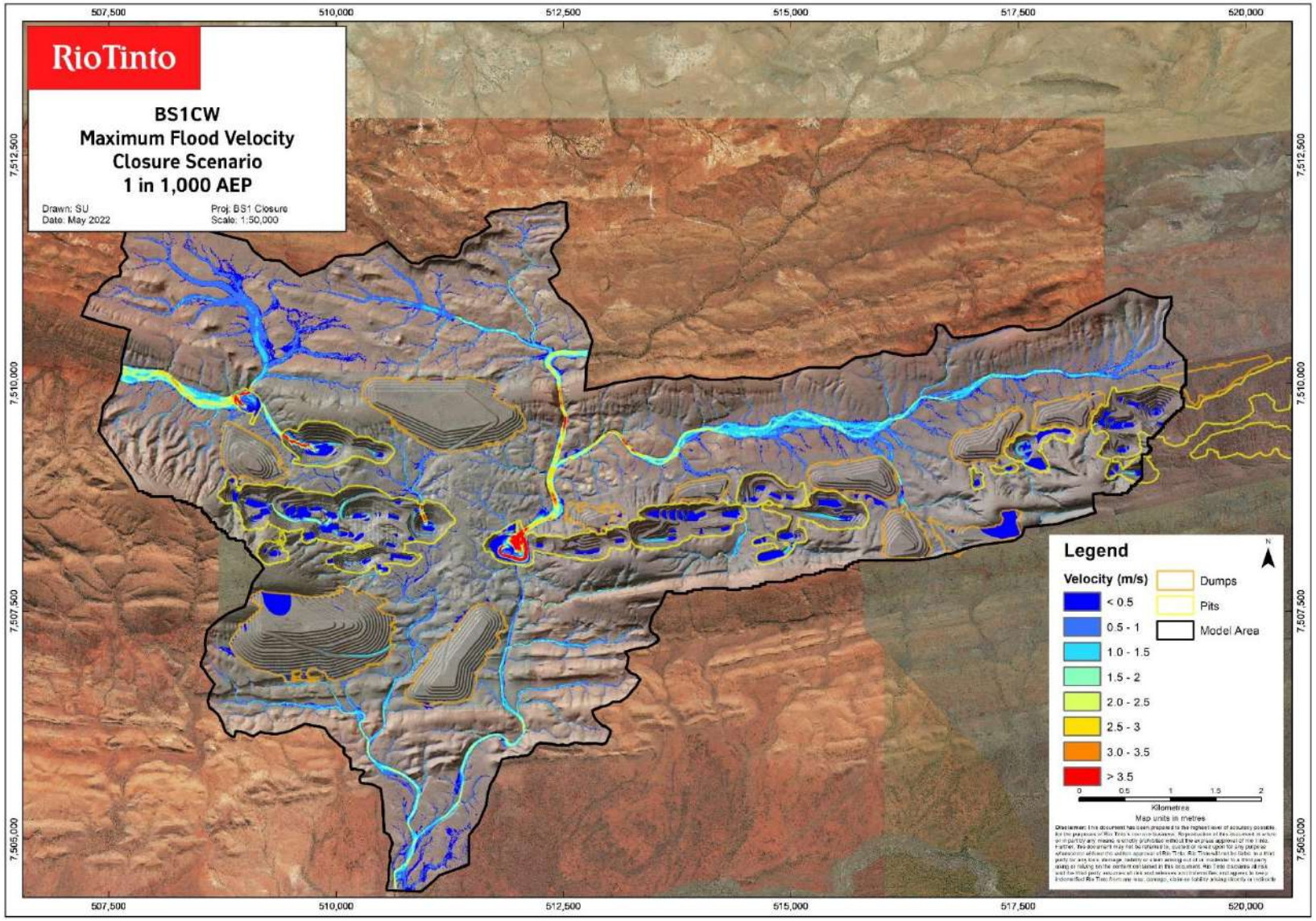


Figure 10-28 BS1-CW: 1 in 1,000 AEP peak flood velocity

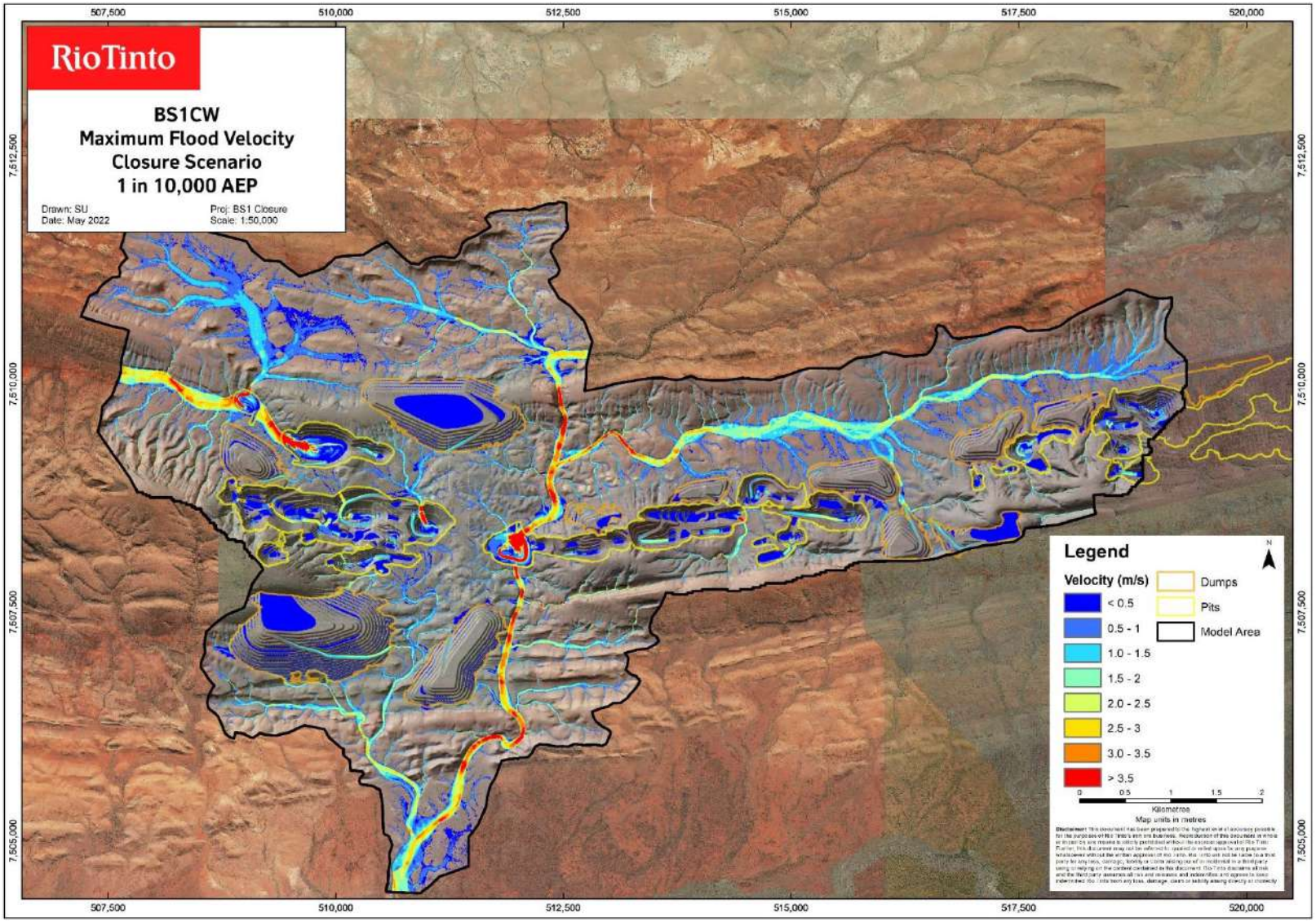


Figure 10-29 BS1-CW: 1 in 10,000 AEP peak flood velocity

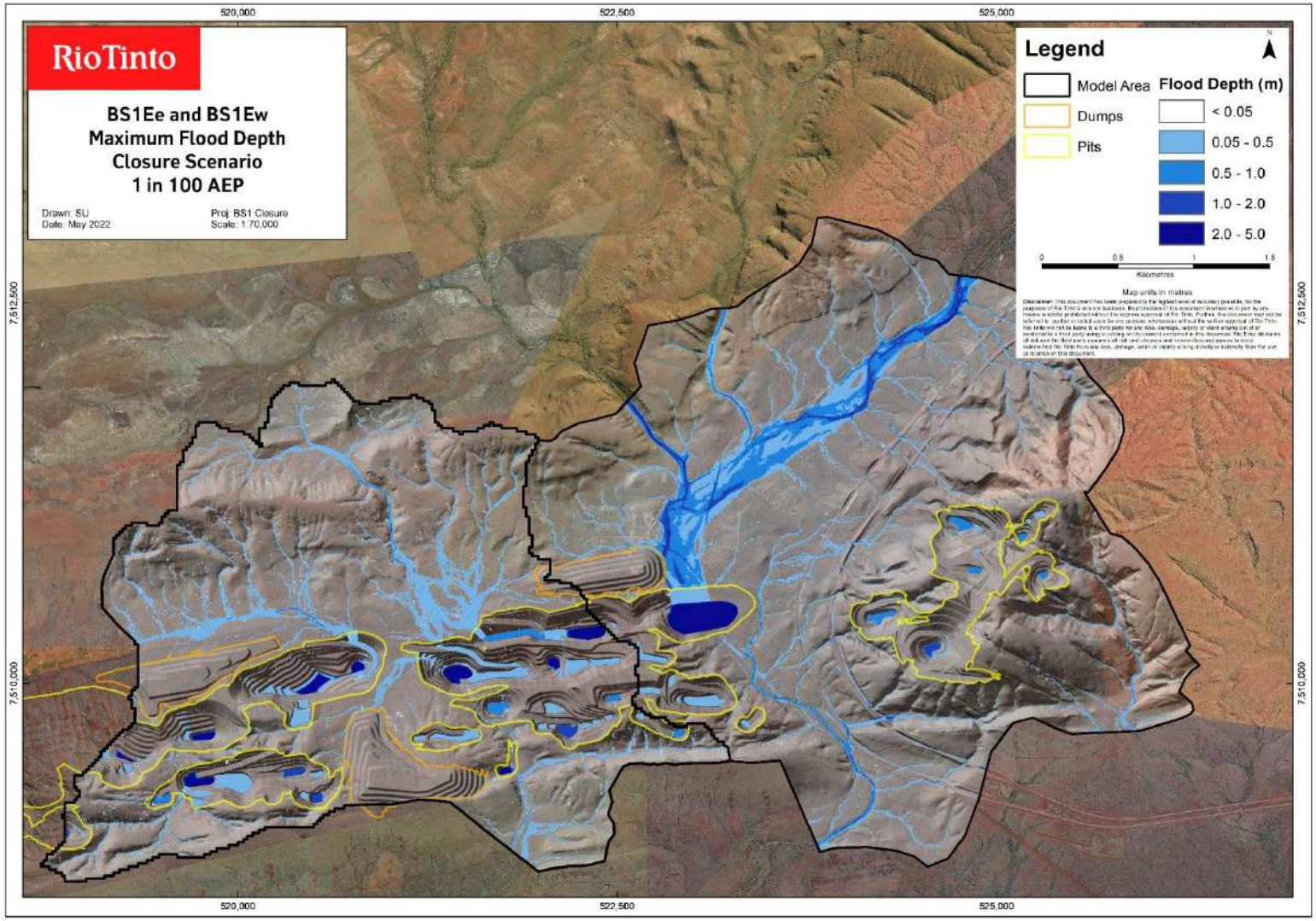


Figure 10-30 BS1-Ee and Ew: 1 in 100 AEP peak flood depth

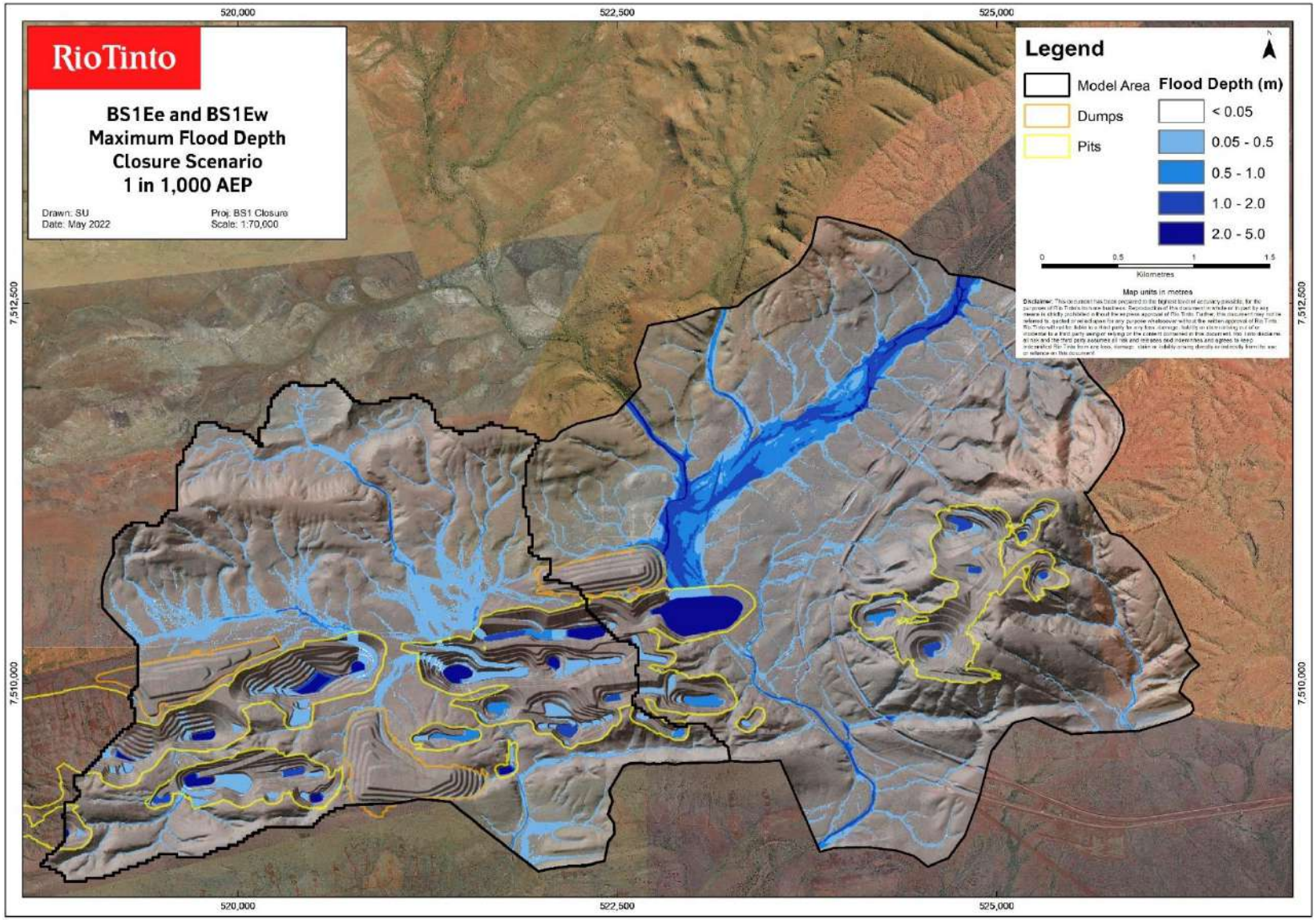


Figure 10-31 BS1-Ee and Ew: 1 in 1,000 AEP peak flood depth

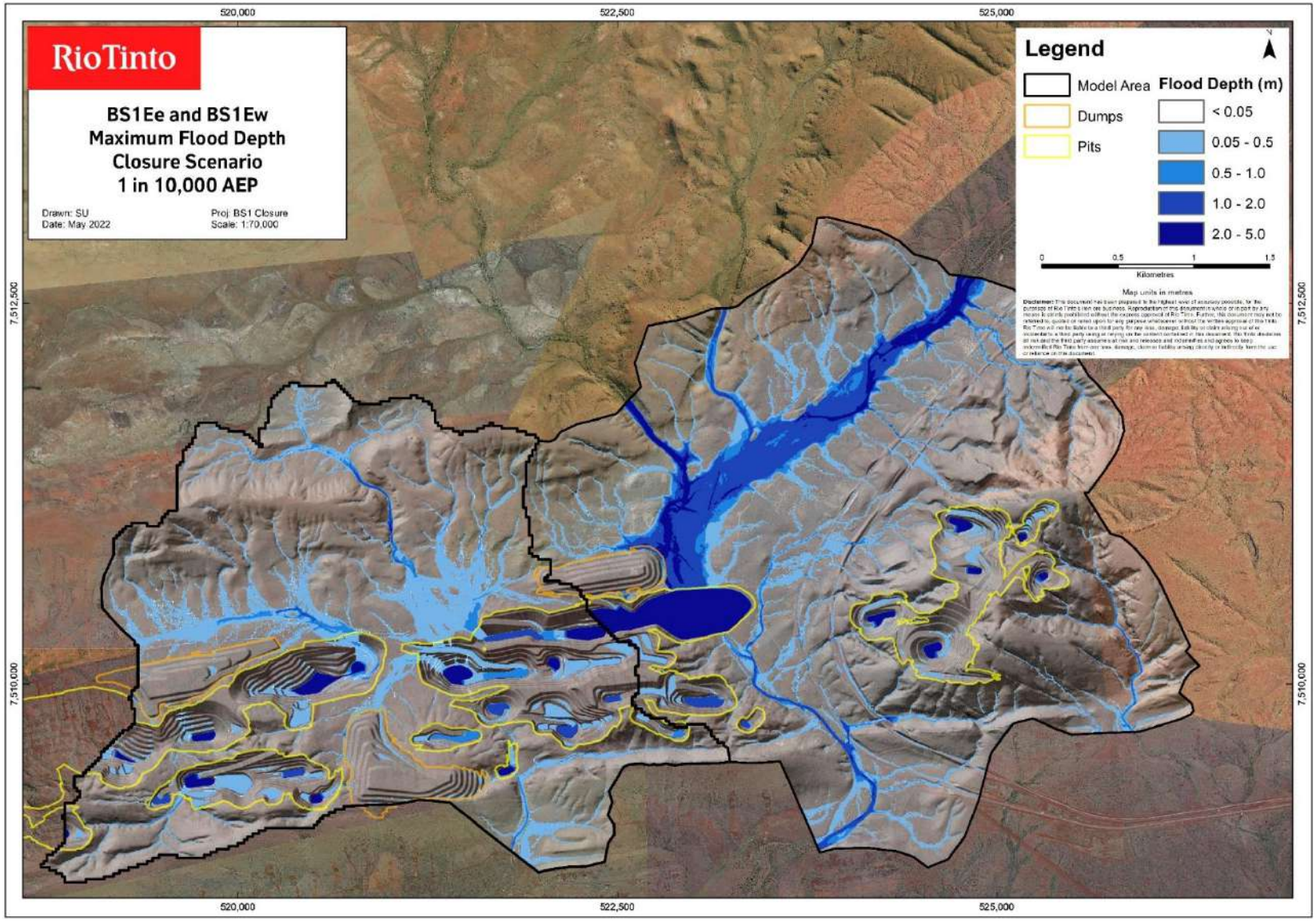


Figure 10-32 BS1-Ee and Ew: 1 in 10,000 AEP peak flood depth

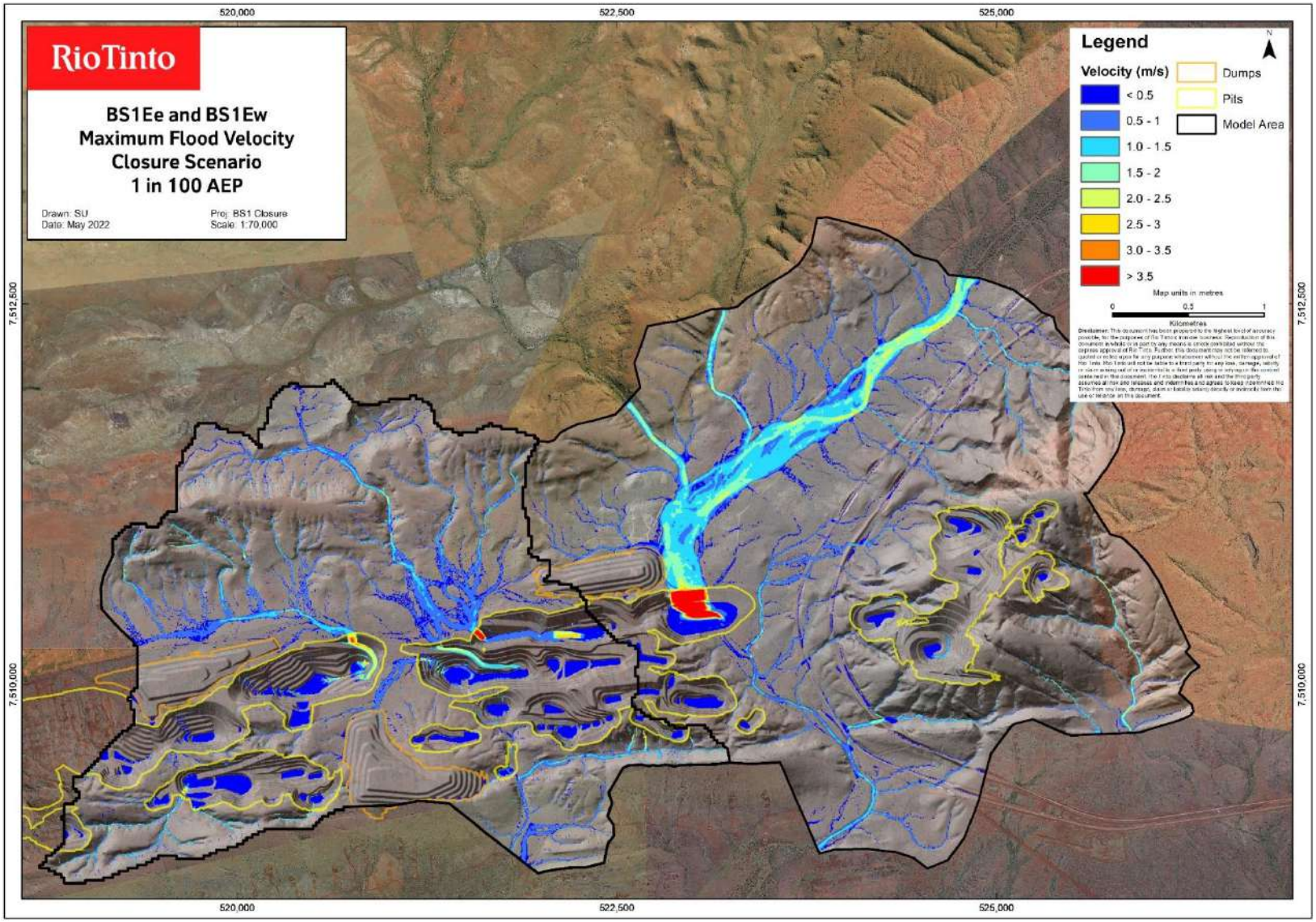


Figure 10-33 BS1-Ee and Ew: 1 in 100 AEP peak flood velocity

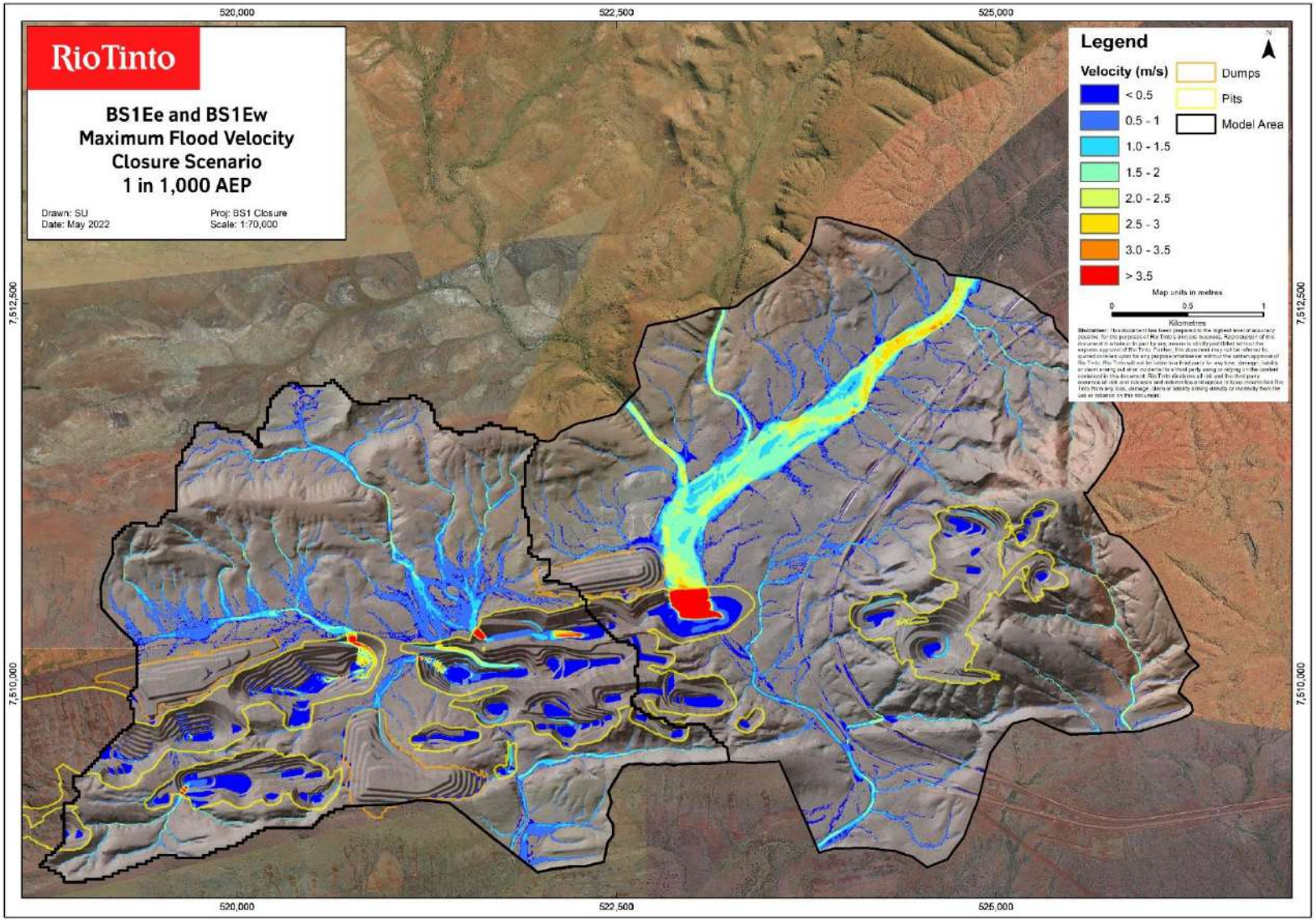


Figure 10-34 BS1-Ee and Ew: 1 in 1,000 AEP peak flood velocity

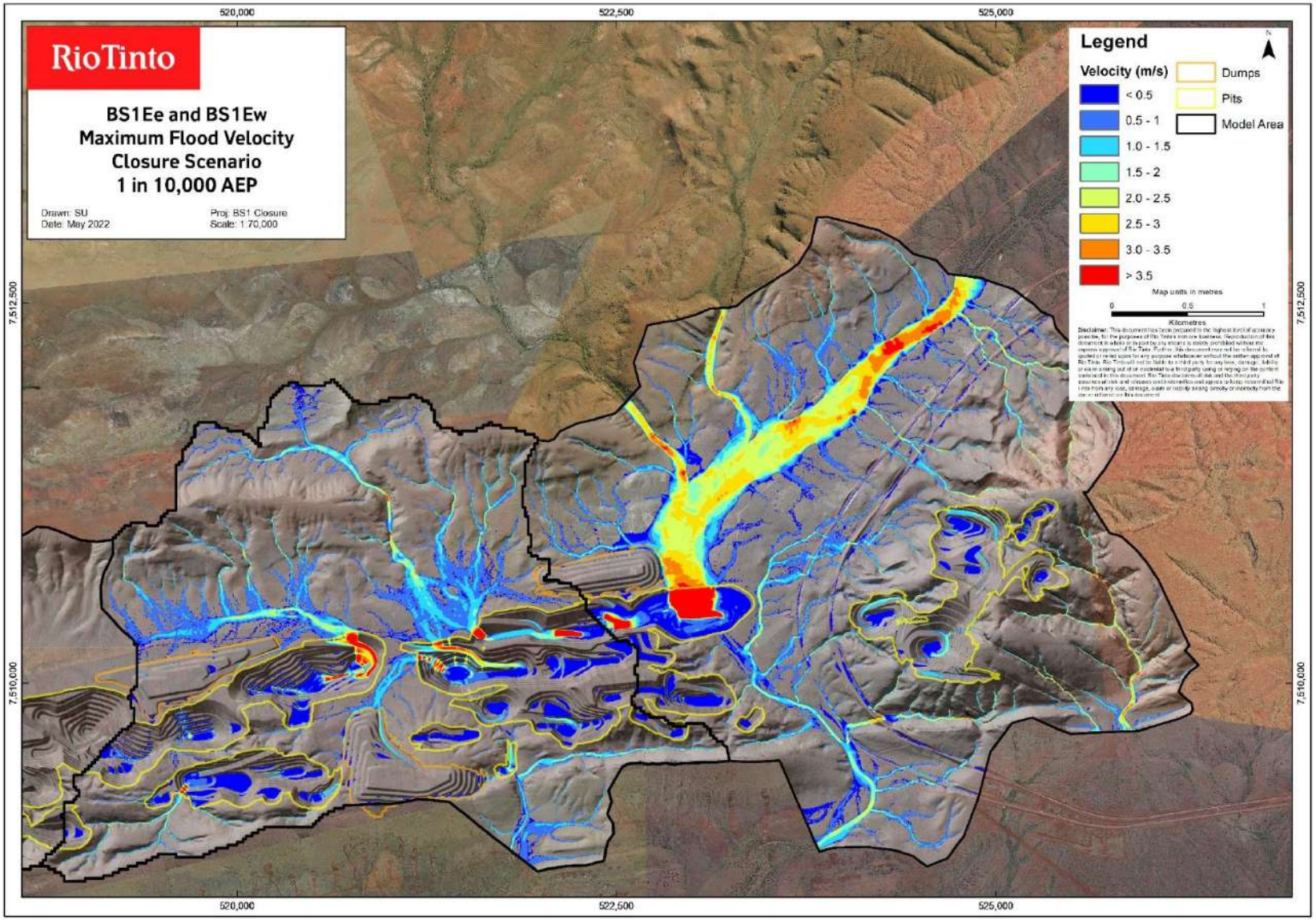


Figure 10-35 BS1-Ee and Ew: 1 in 10,000 AEP peak flood velocity

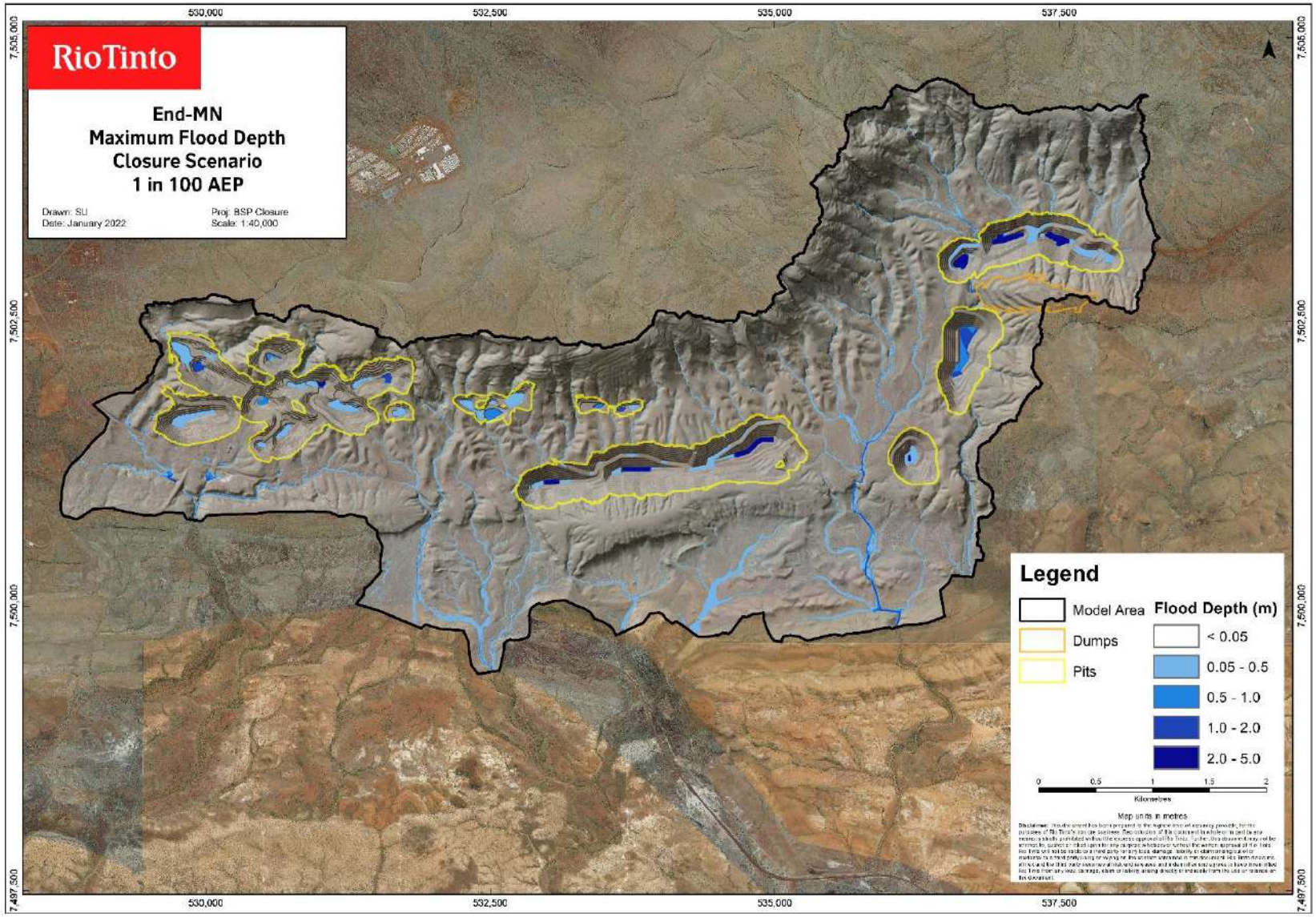


Figure 10-36 End-MN: 1 in 100 AEP peak flood depth

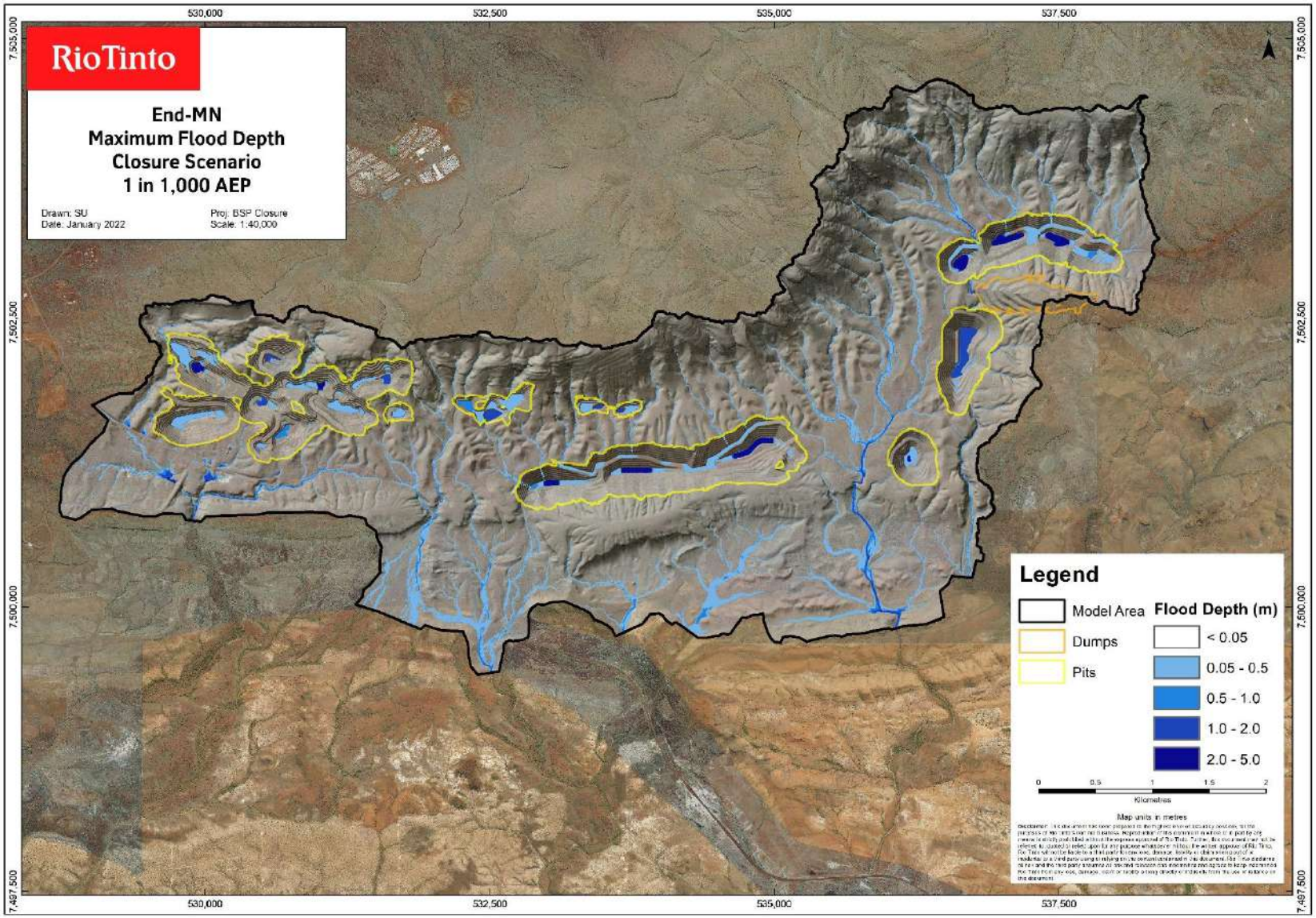


Figure 10-37 End-MN: 1 in 1,000 AEP peak flood depth

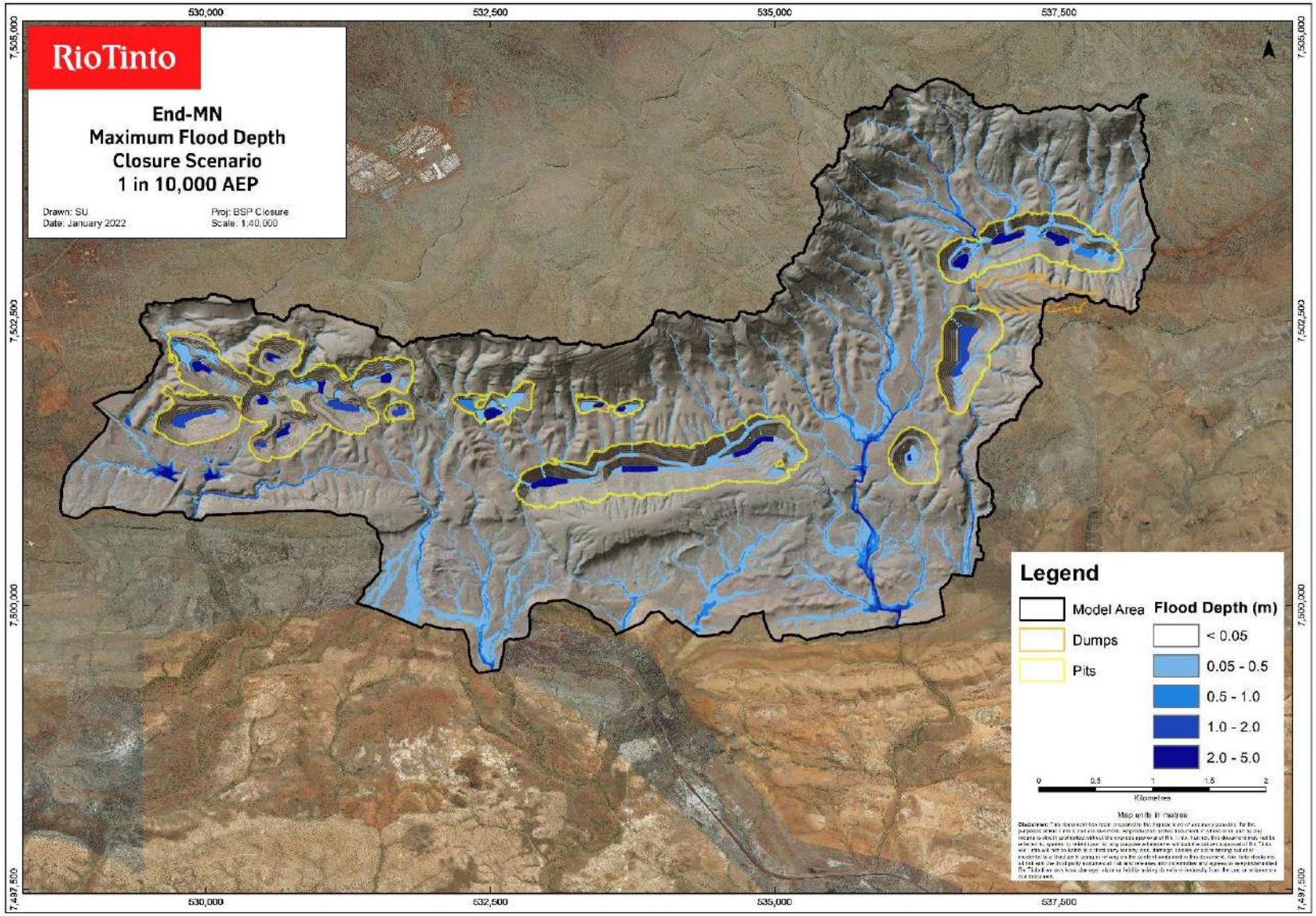


Figure 10-38 End-MN: 1 in 10,000 AEP peak flood depth

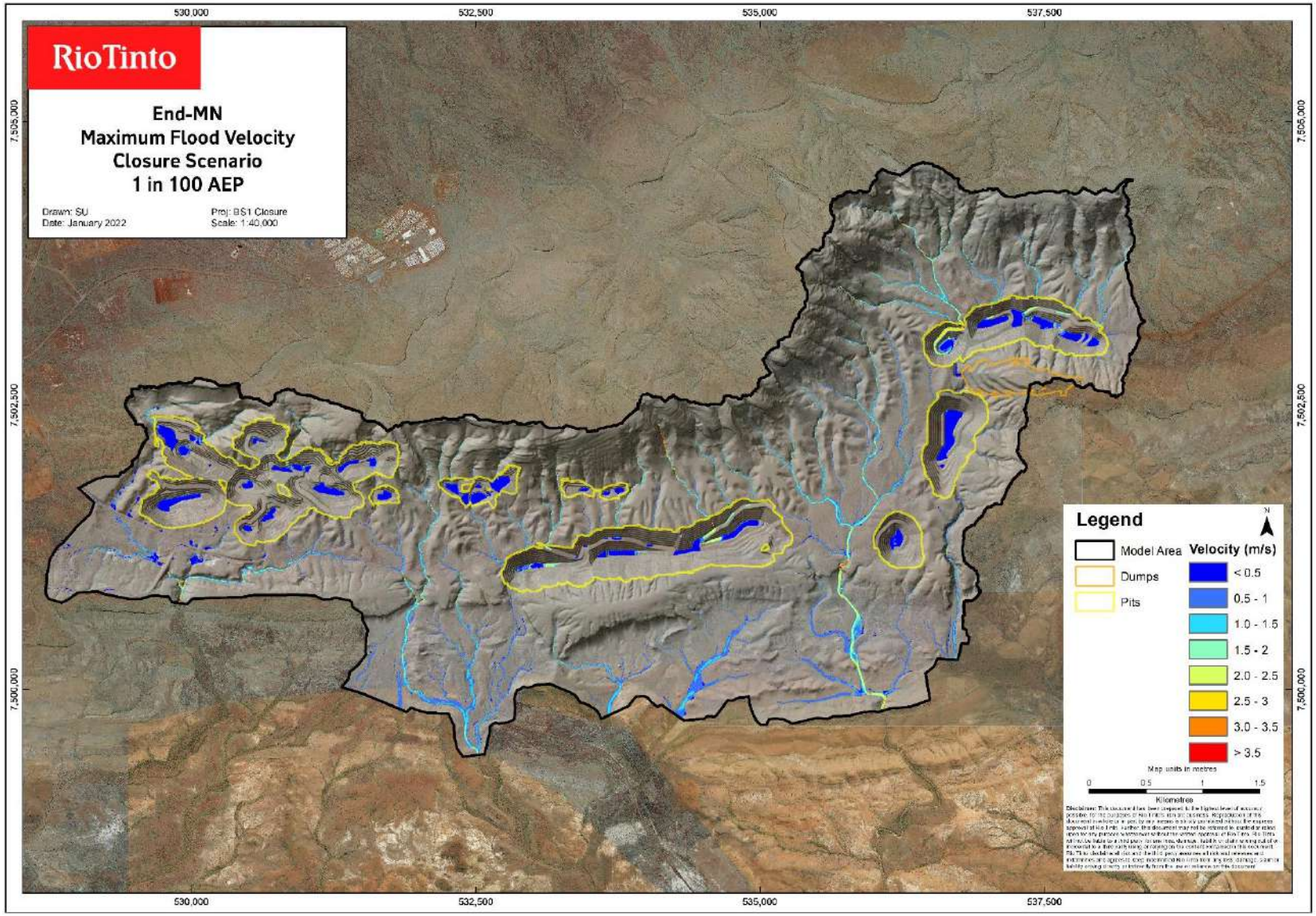


Figure 10-39 End-MN: 1 in 100 AEP peak flood velocity

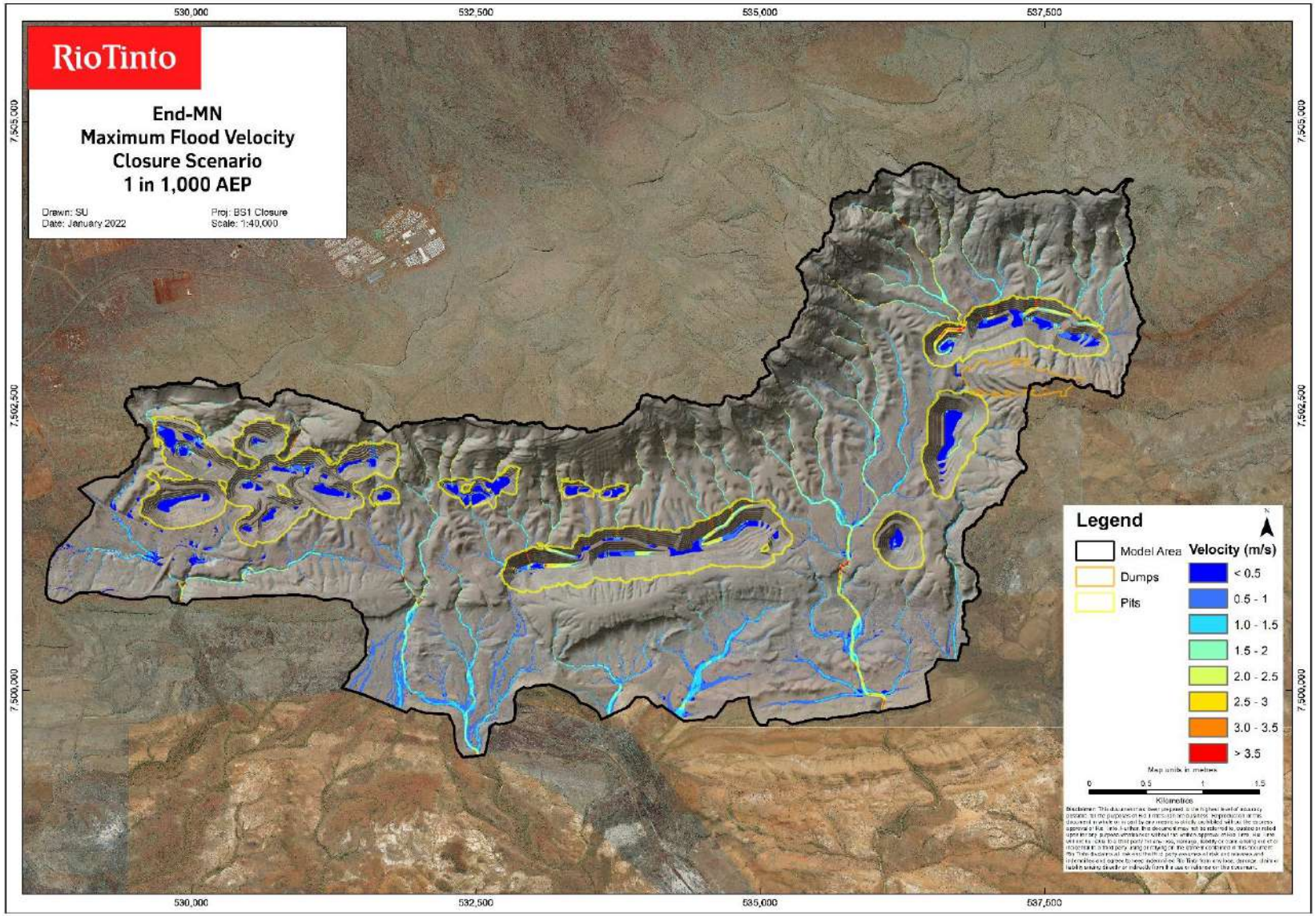


Figure 10-40 End-MN: 1 in 1,000 AEP peak flood velocity

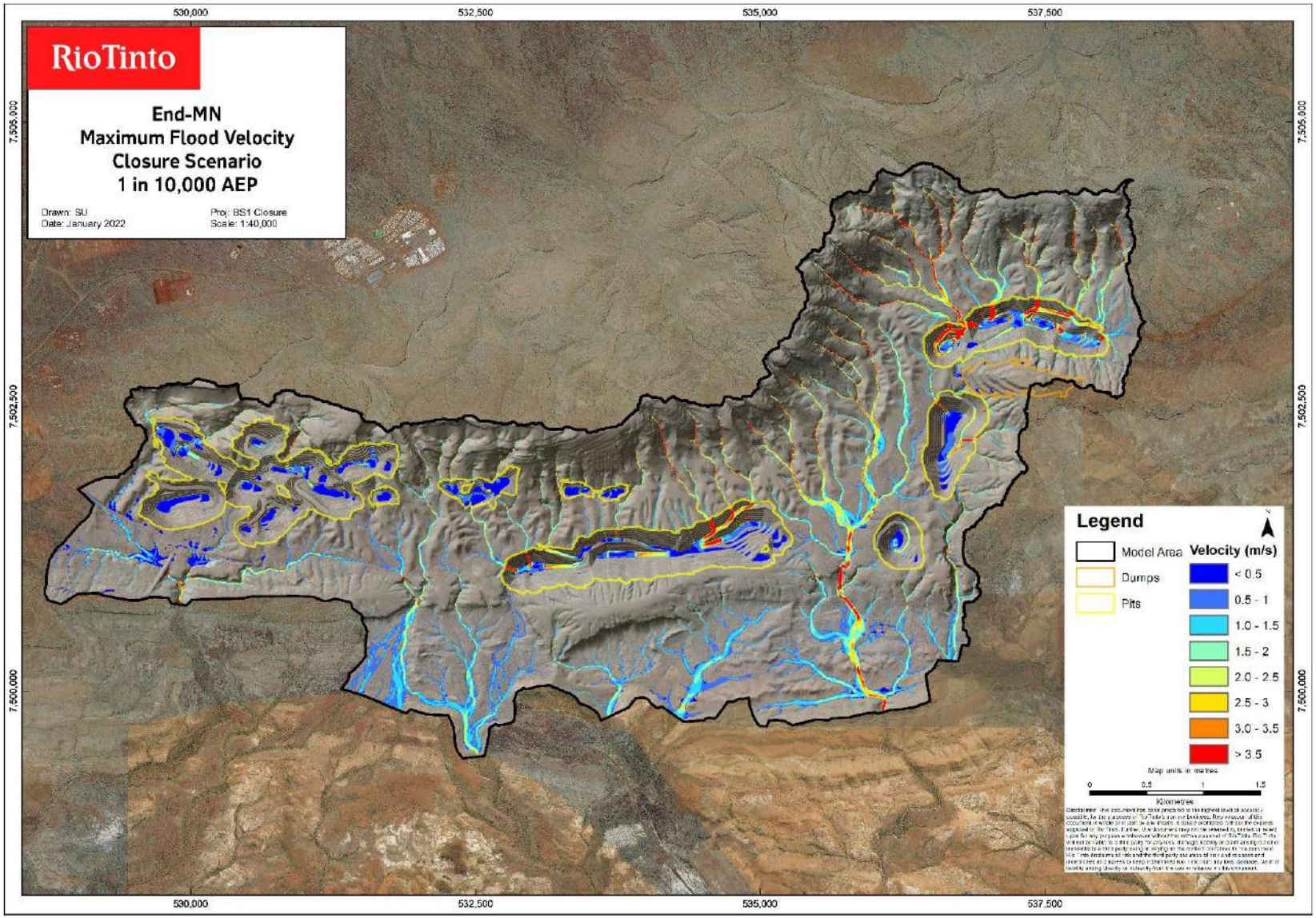


Figure 10-41 End-MN: 1 in 10,000 AEP peak flood velocity

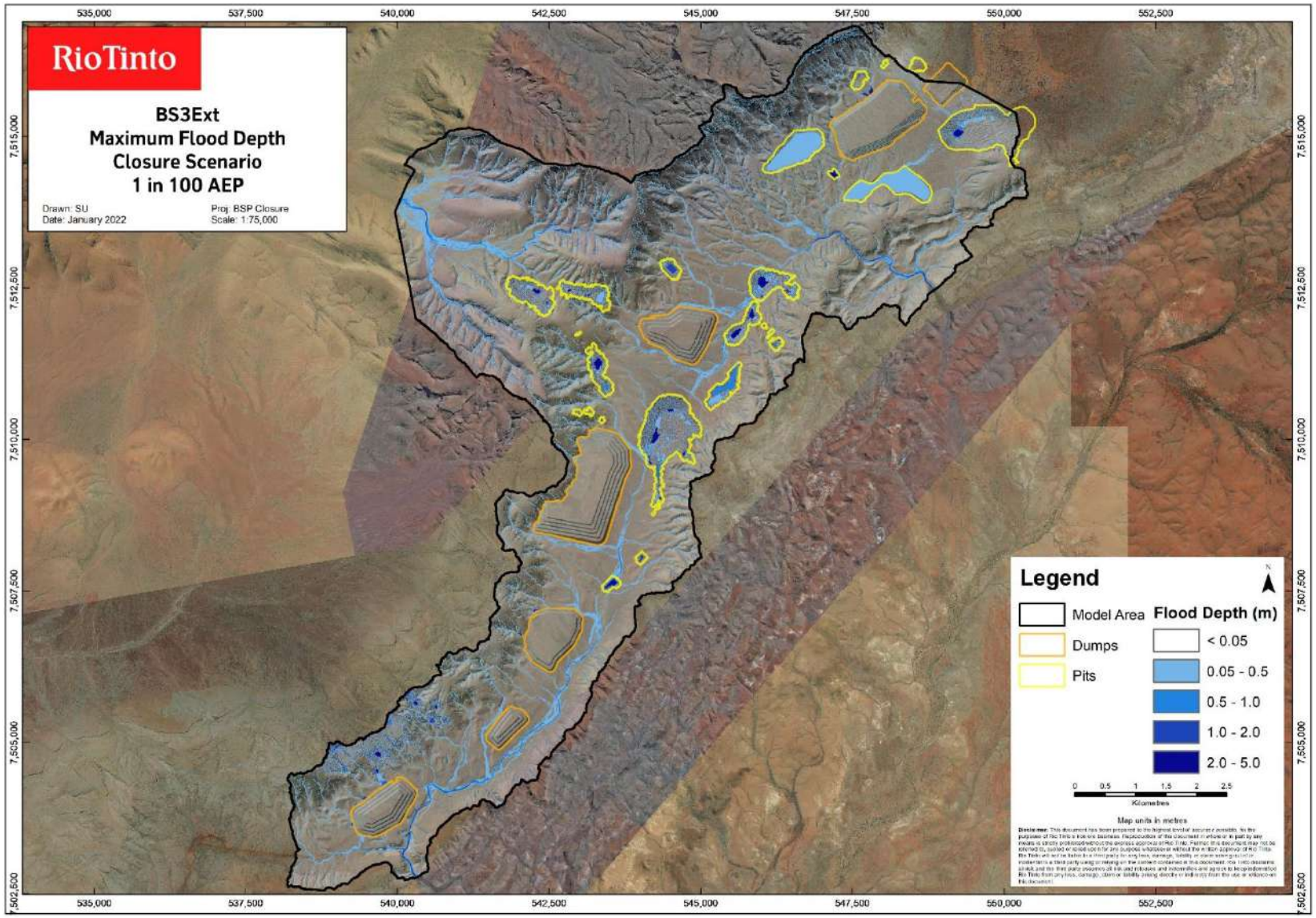


Figure 10-42 Bs3-Ext: 1 in 100 AEP peak flood depth

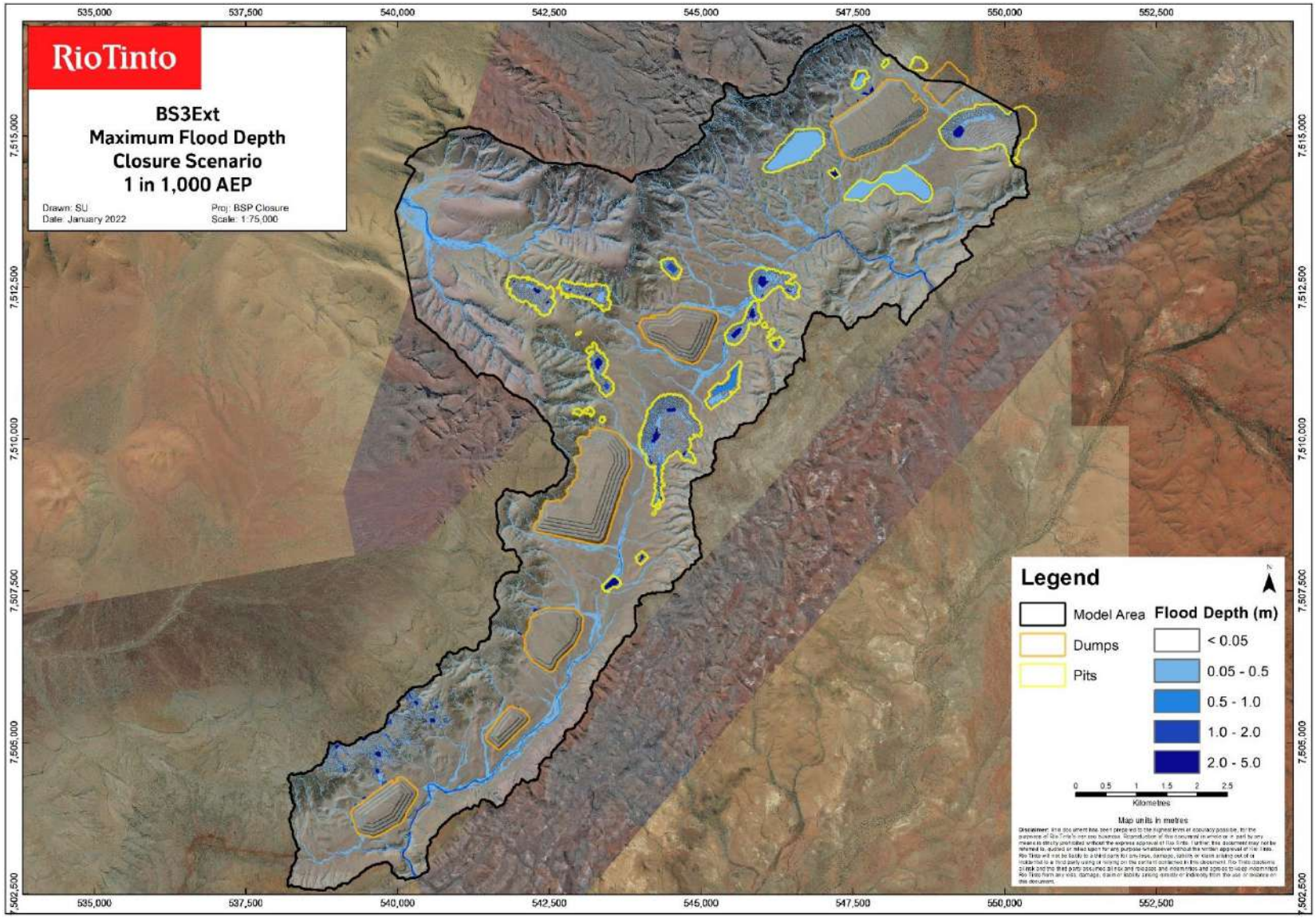


Figure 10-43 Bs3-Ext: 1 in 1,000 AEP peak flood depth

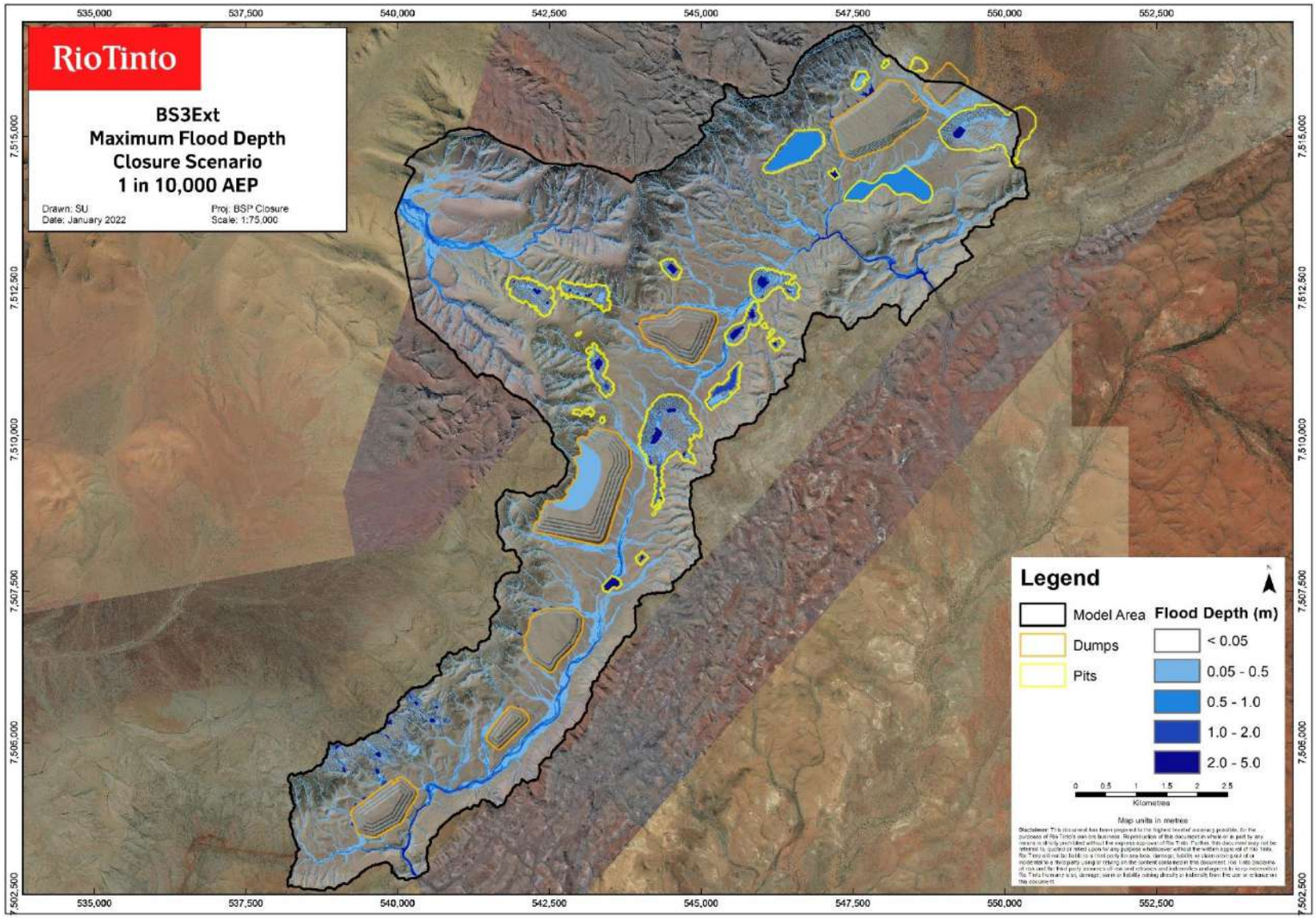


Figure 10-44 Bs3-Ext: 1 in 10,000 AEP peak flood depth

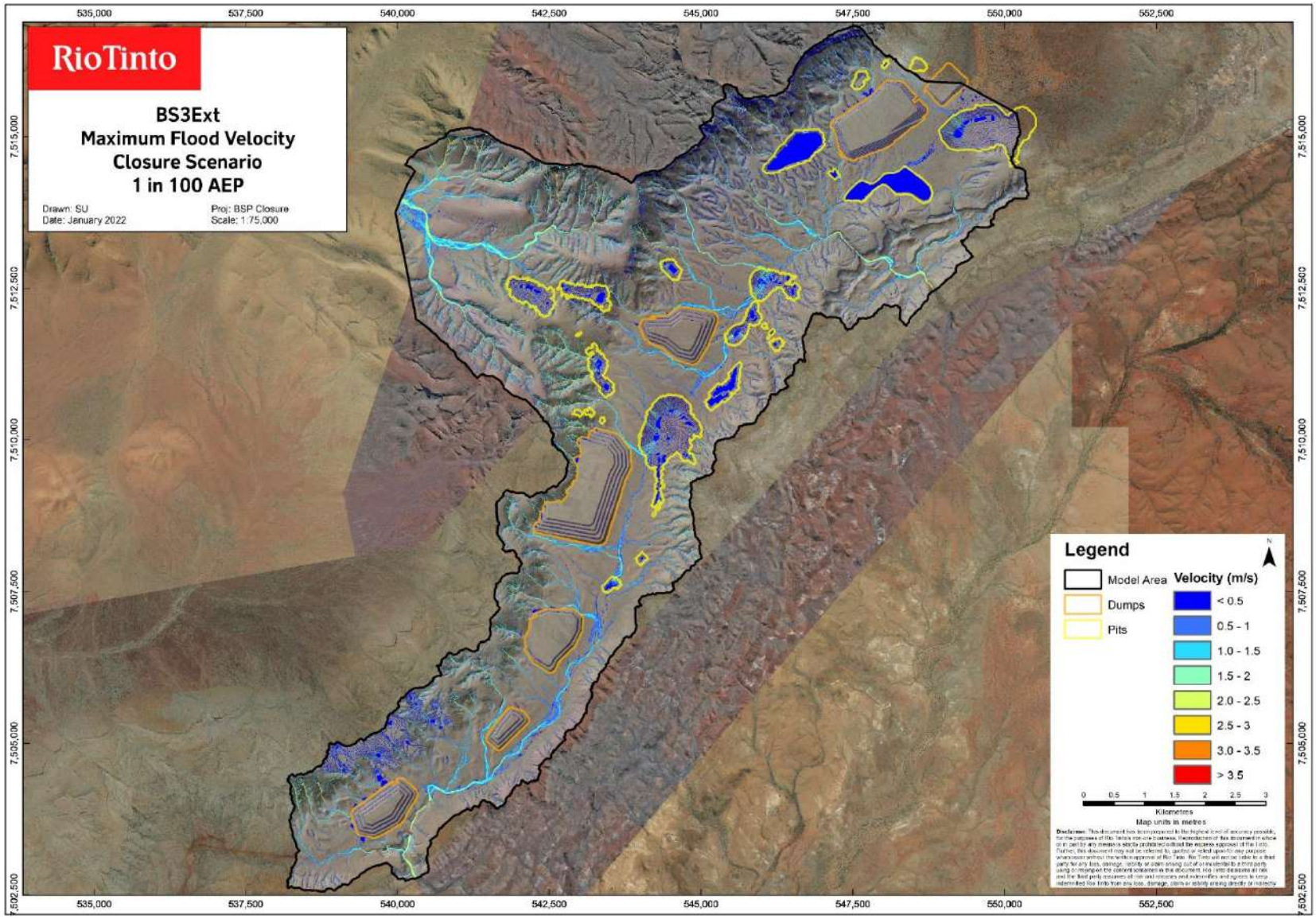


Figure 10-45 Bs3-Ext: 1 in 100 AEP peak flood velocity

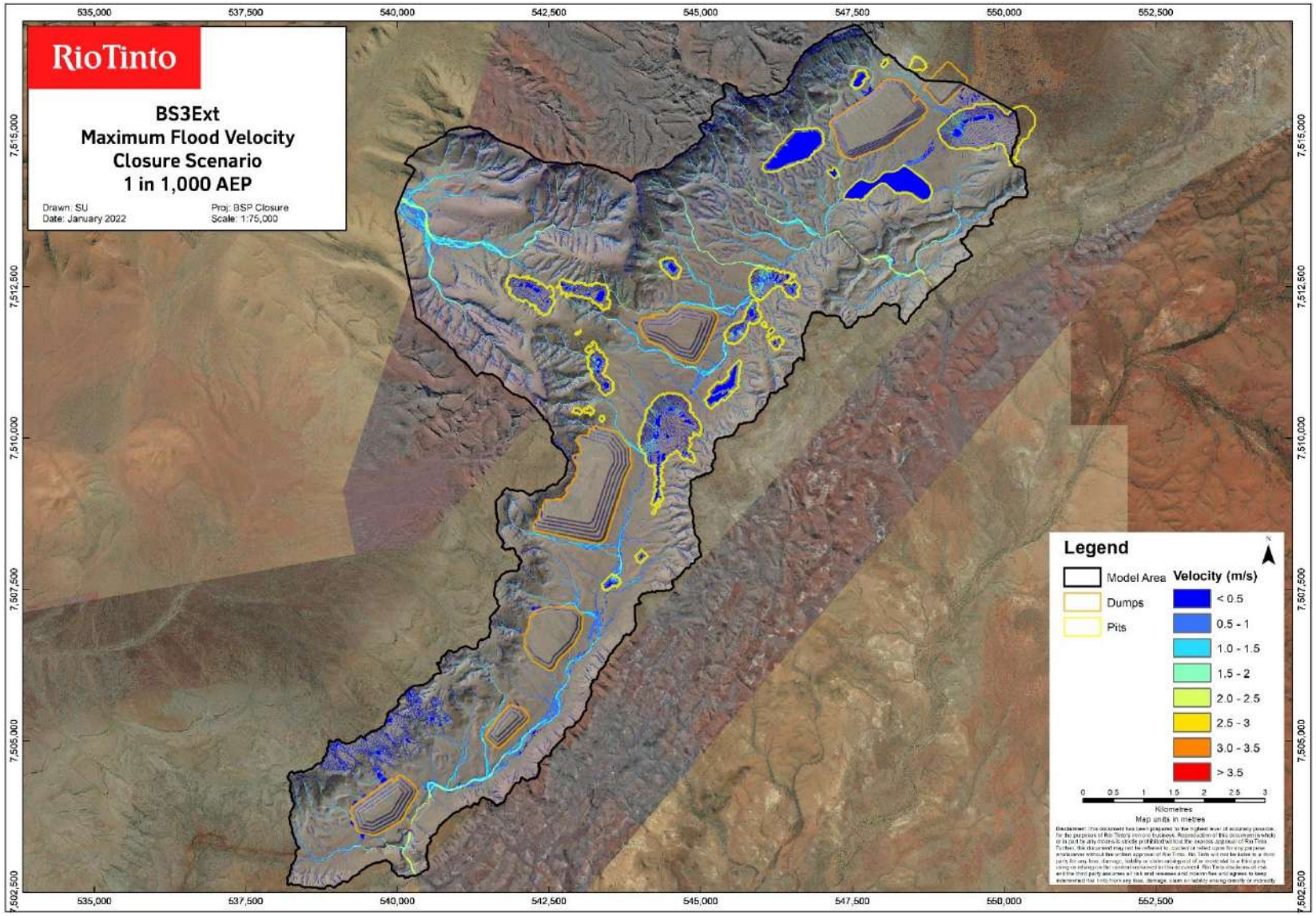


Figure 10-46 Bs3-Ext: 1 in 1,000 AEP peak flood velocity

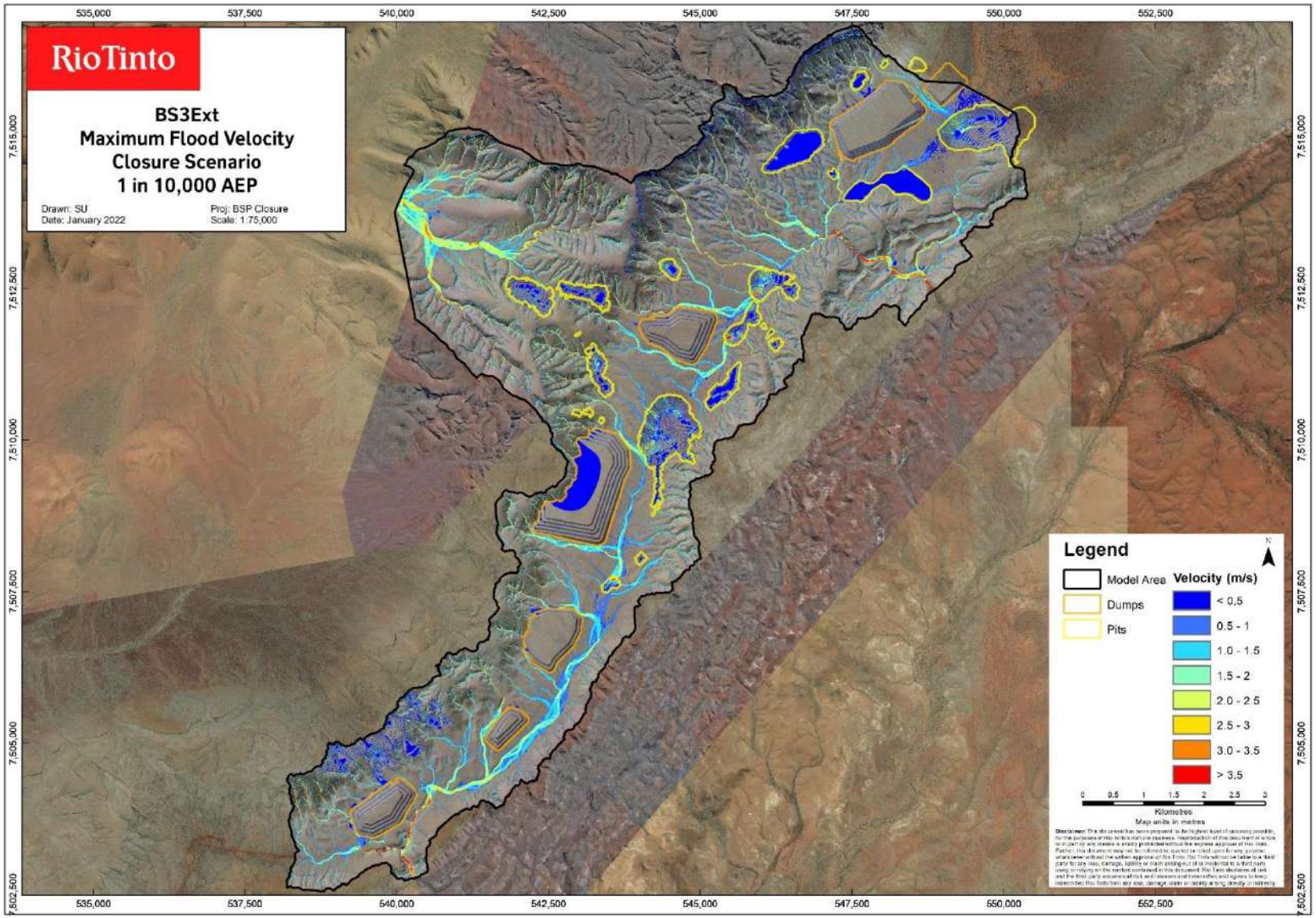


Figure 10-47 Bs3-Ext: 1 in 10,000 AEP peak flood velocity

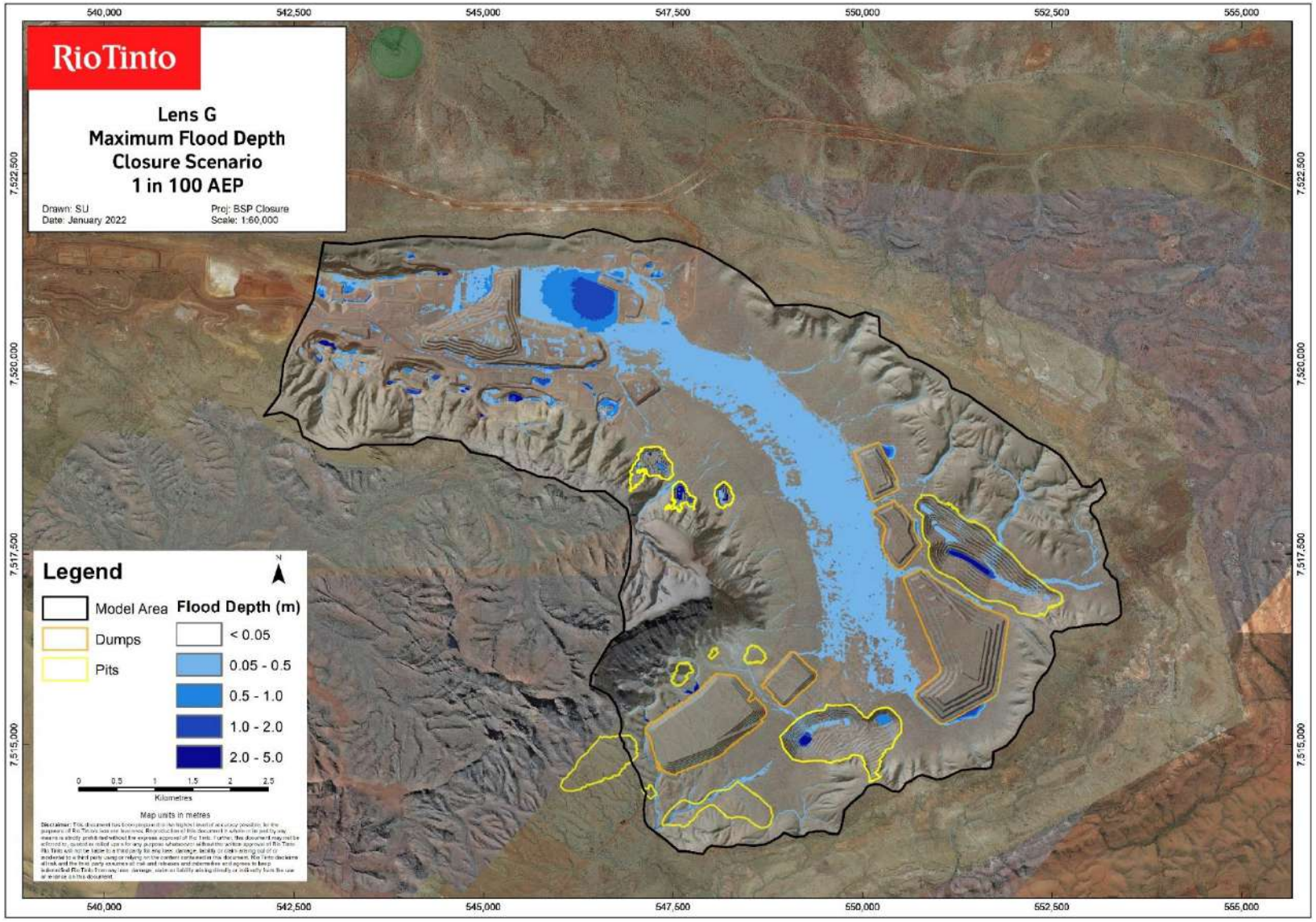


Figure 10-48 Lens G: 1 in 100 AEP peak flood depth

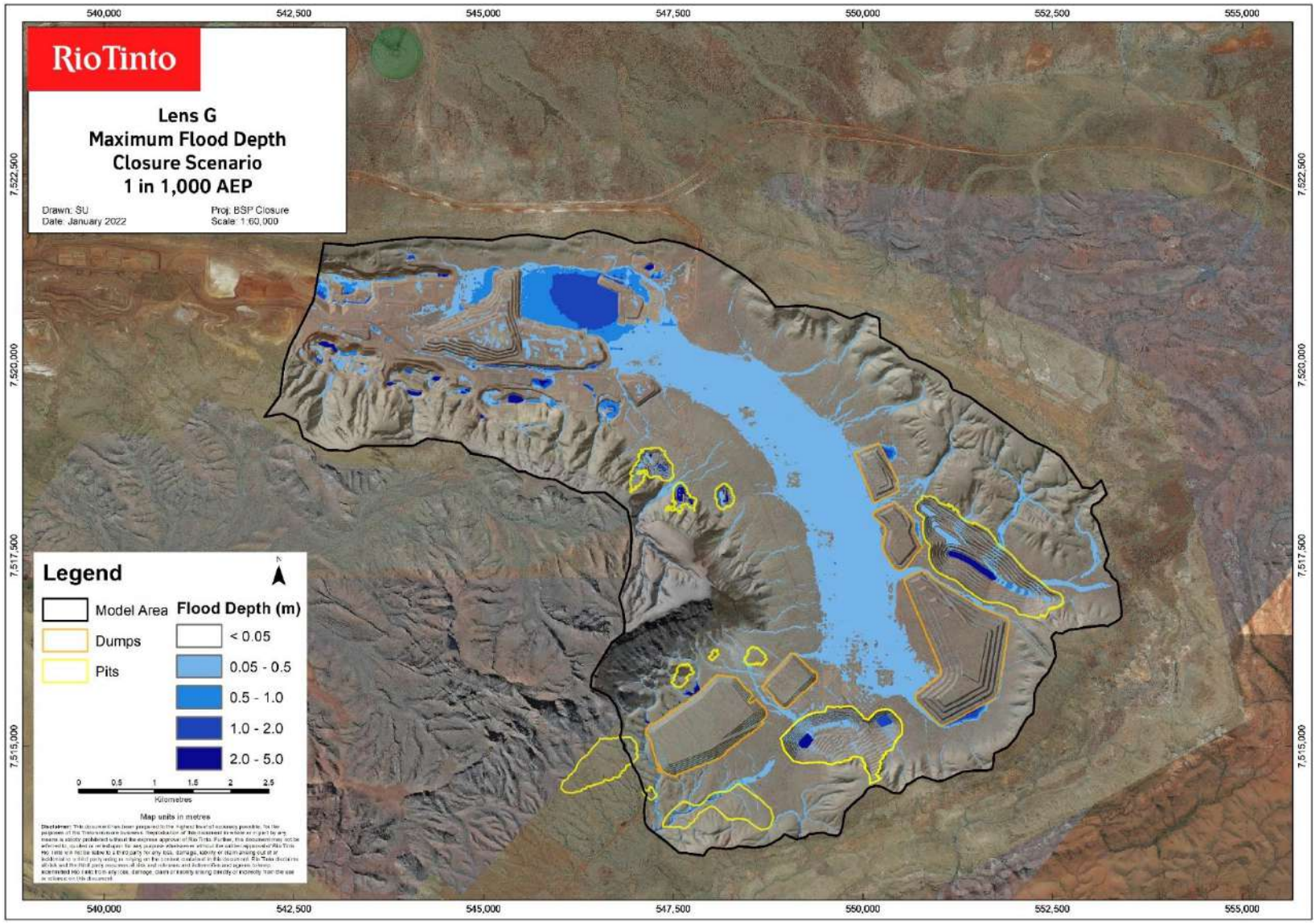


Figure 10-49 Lens G: 1 in 1,000 AEP peak flood depth

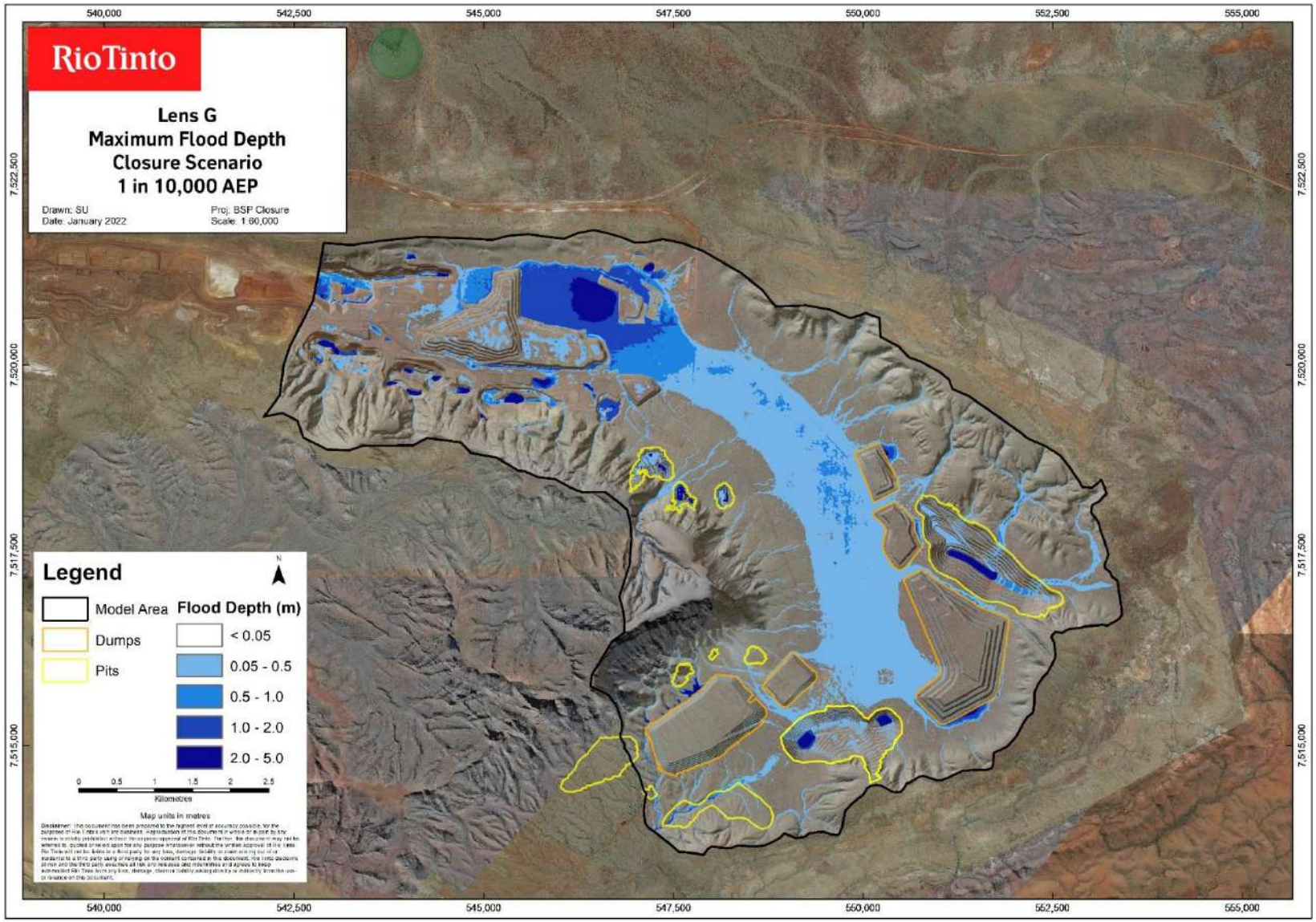


Figure 10-50 Lens G: 1 in 10,000 AEP peak flood depth

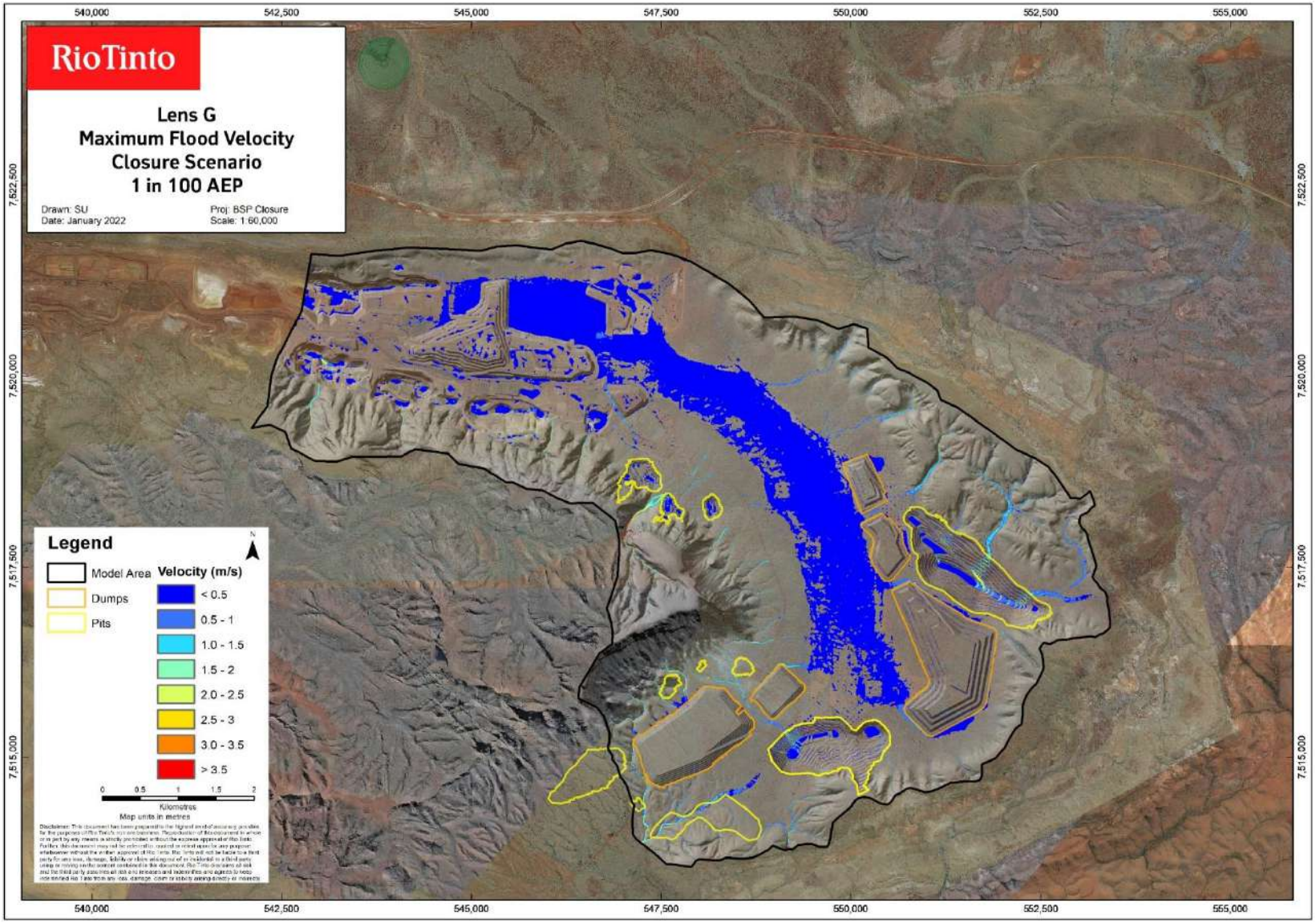


Figure 10-51 Lens G: 1 in 100 AEP peak flood velocity

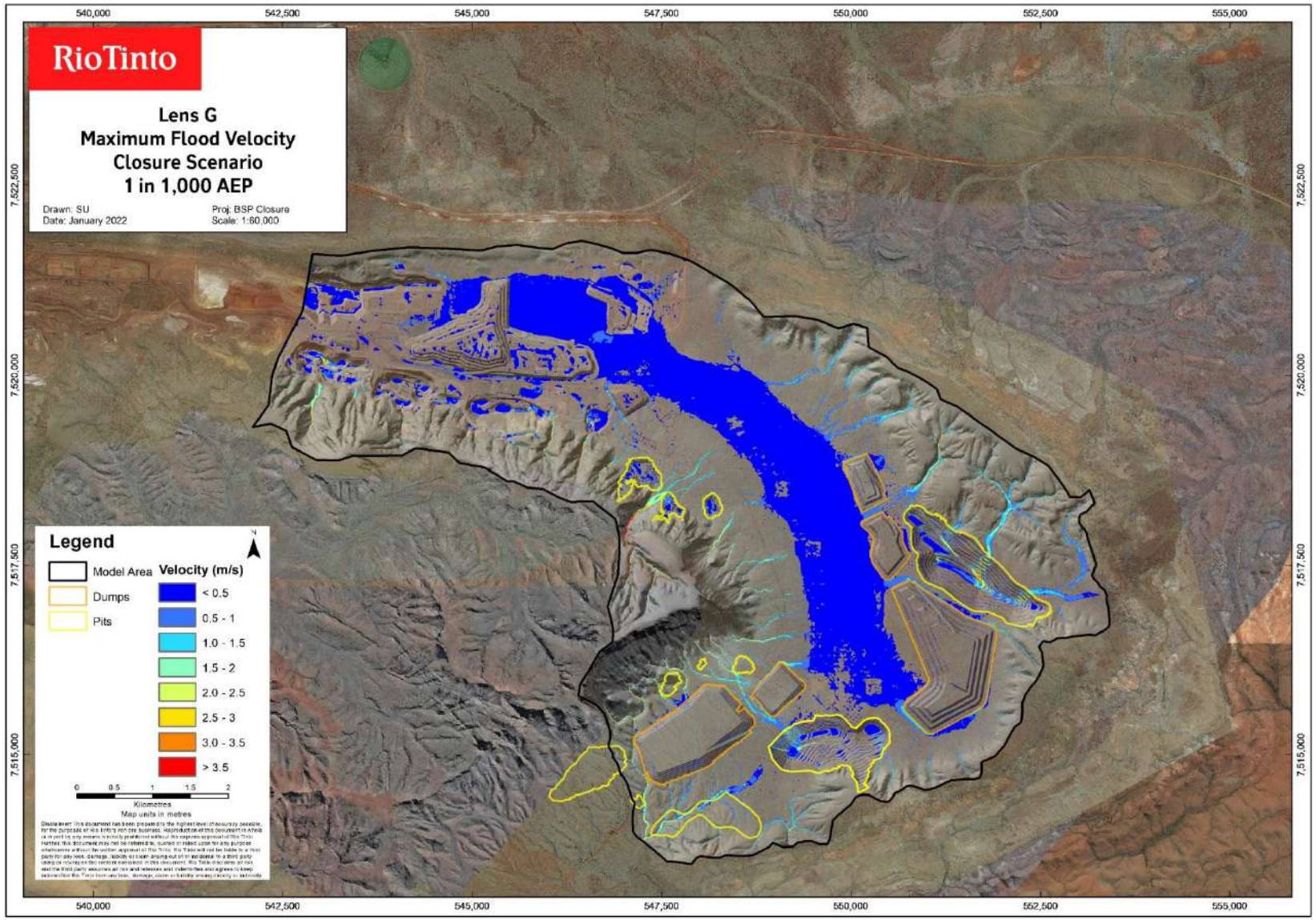


Figure 10-52 Lens G: 1 in 1,000 AEP peak flood velocity

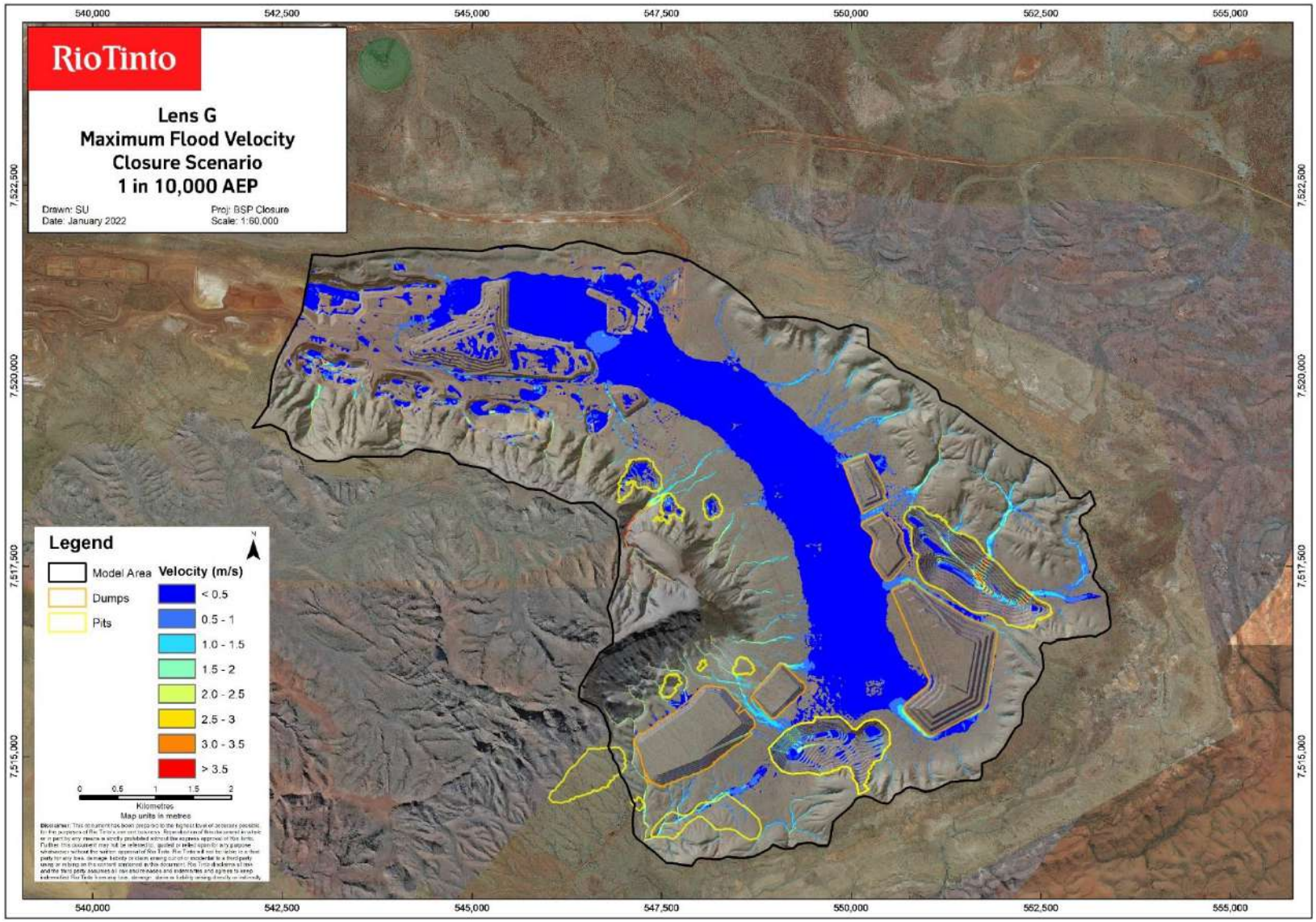


Figure 10-53 Lens G: 1 in 10,000 AEP peak flood velocity

10.7 Appendix H – BS1 Alternative Closure Scenario Floodplain Mapping

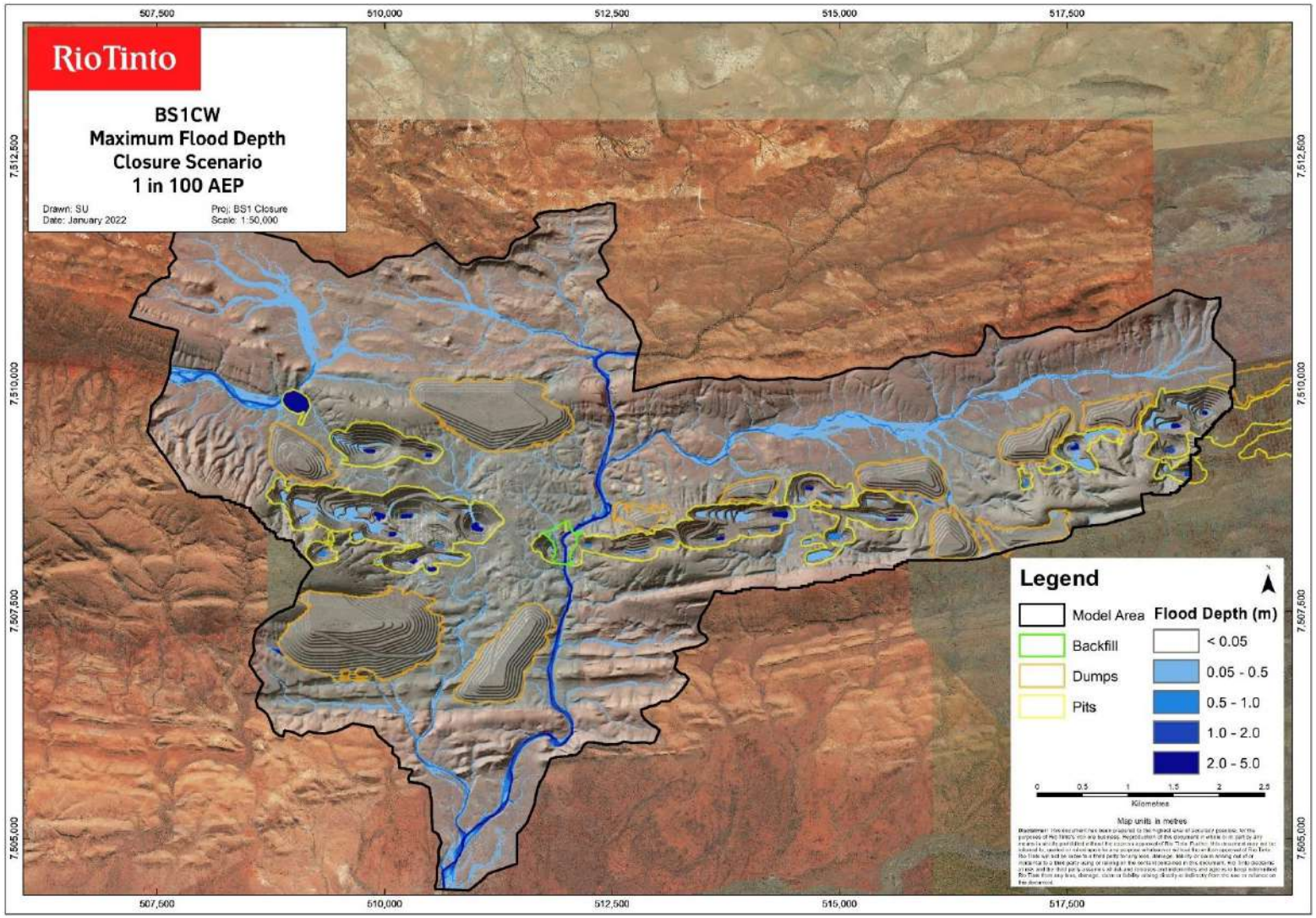


Figure 10-54 BS1-CW: 1 in 100 AEP peak flood depth in the alternative closure scenario

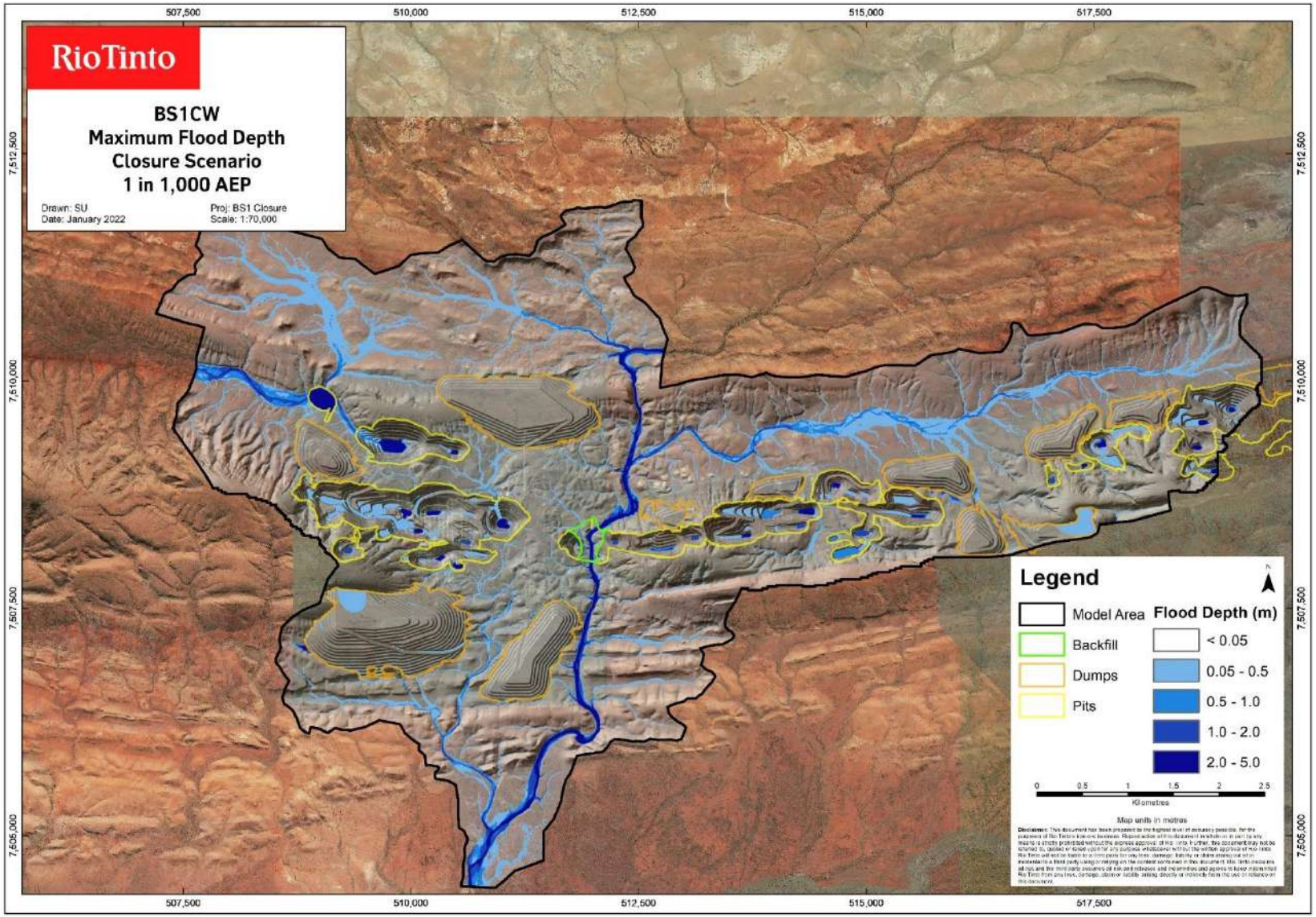


Figure 10-55 BS1-CW: 1 in 1,000 AEP peak flood depth in the alternative closure scenario

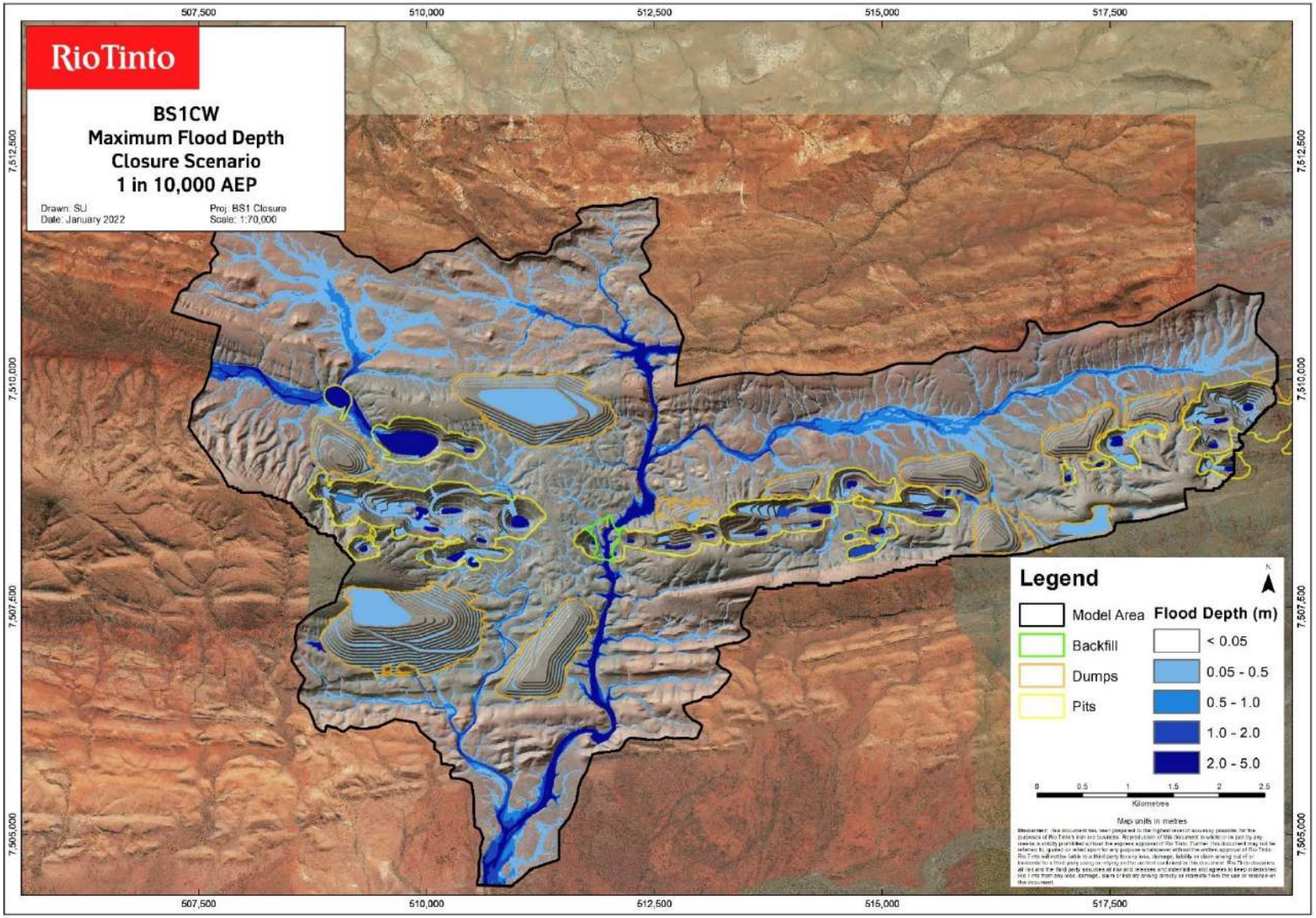


Figure 10-56 BS1-CW: 1 in 10,000 AEP peak flood depth in the alternative closure scenario

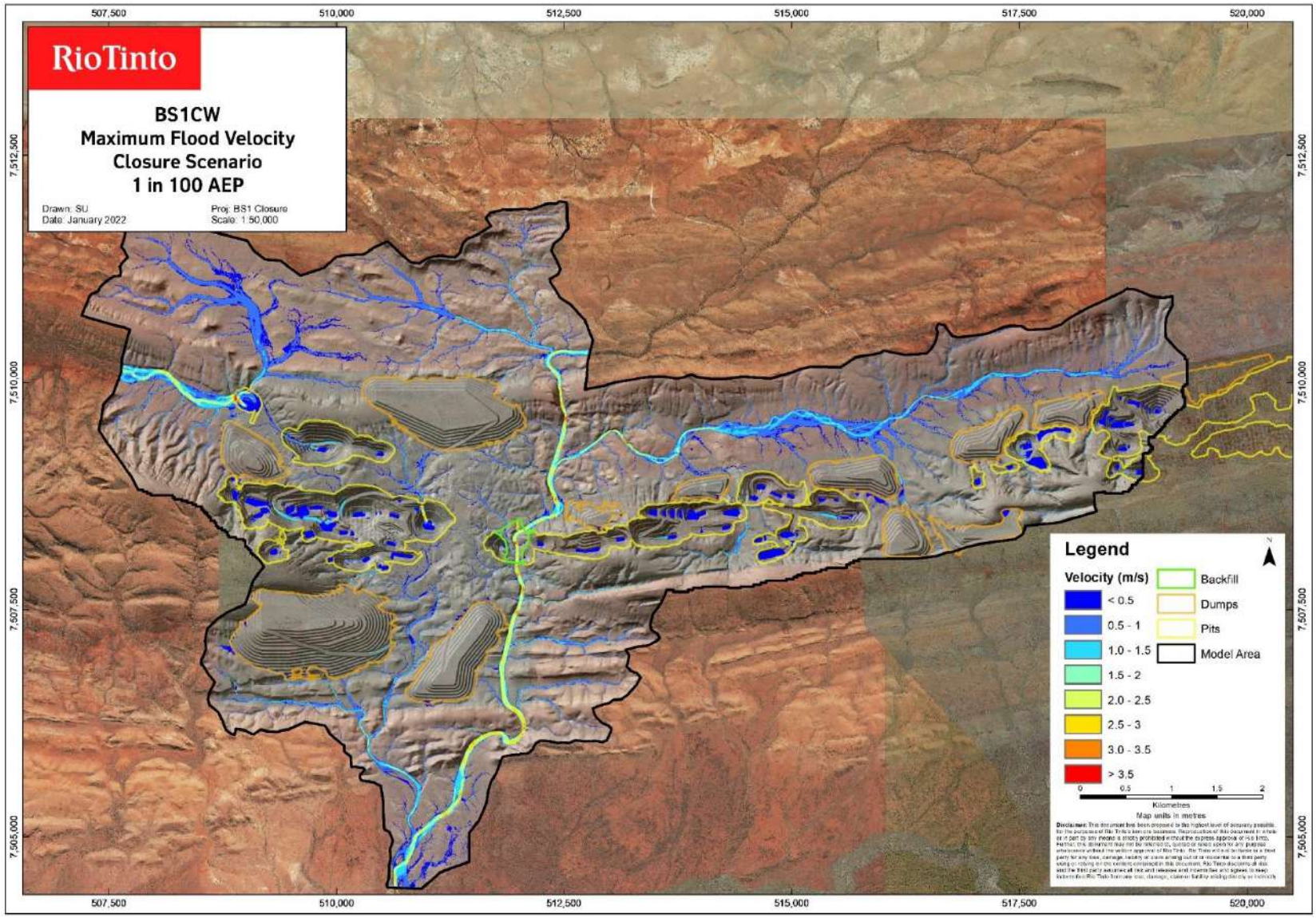


Figure 10-57 BS1-CW: 1 in 100 AEP peak flood velocity in the alternative closure scenario

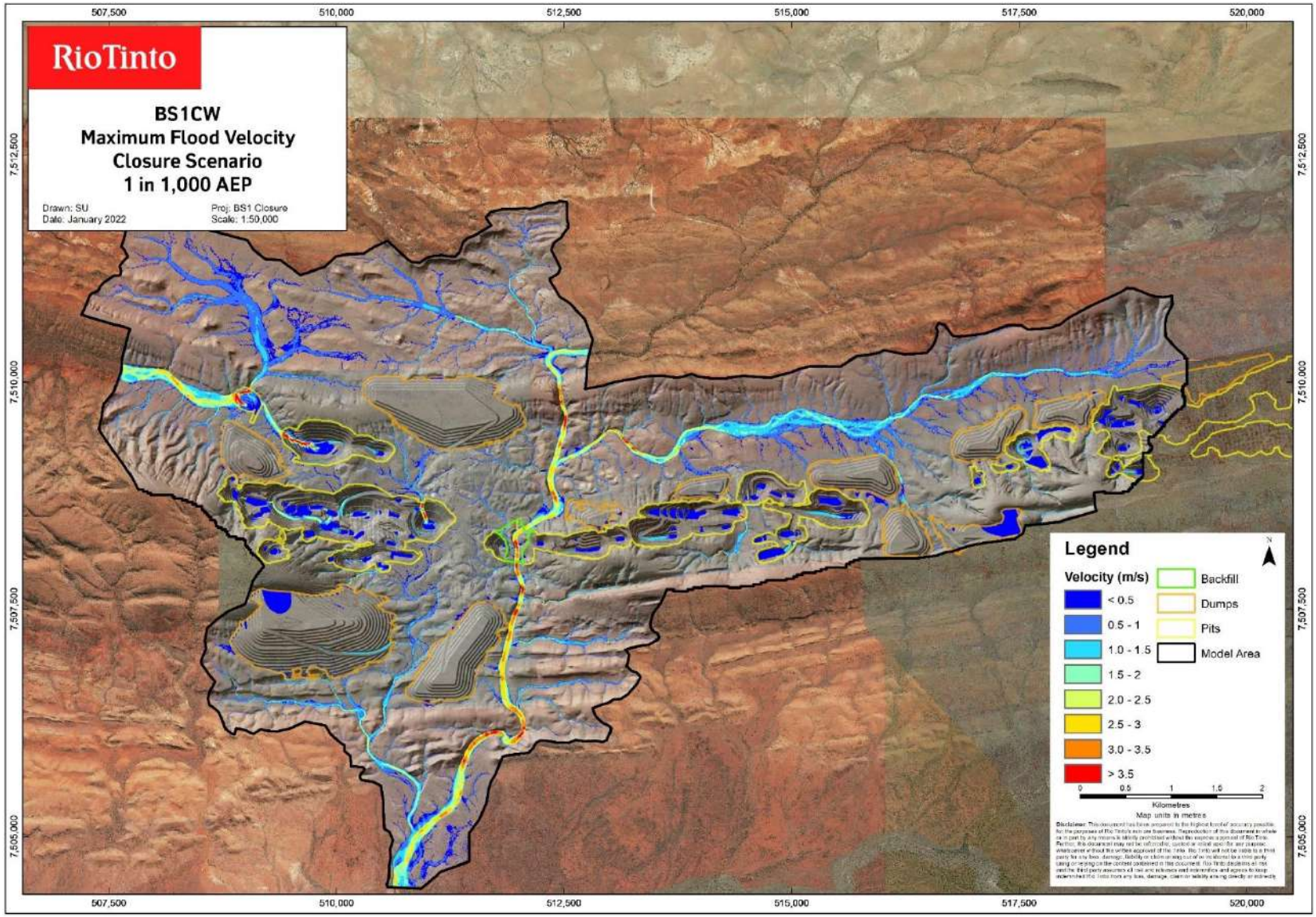


Figure 10-58 BS1-CW: 1 in 1,000 AEP peak flood velocity in the alternative closure scenario

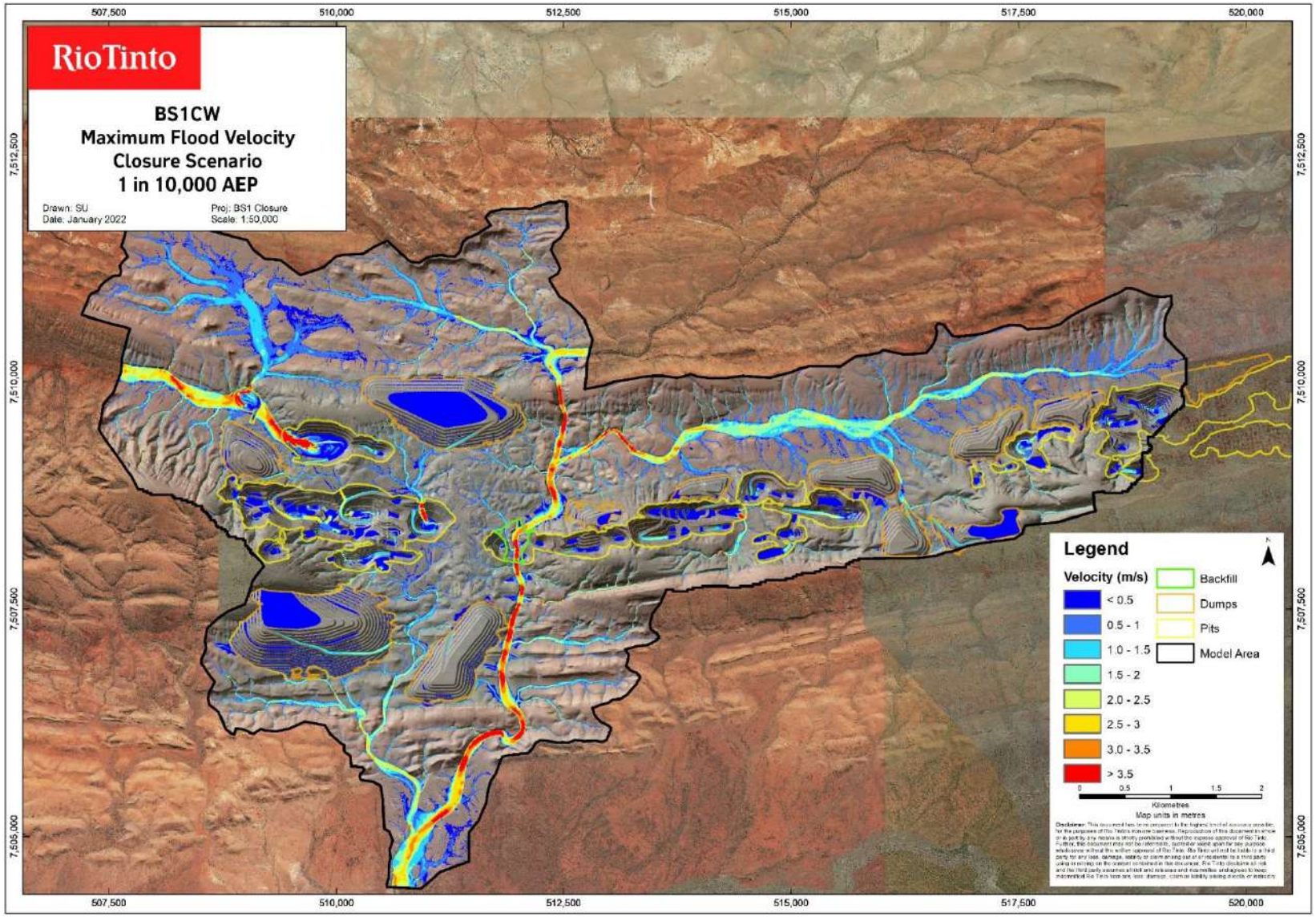


Figure 10-59 BS1-CW: 1 in 10,000 AEP peak flood velocity in the alternative closure scenario

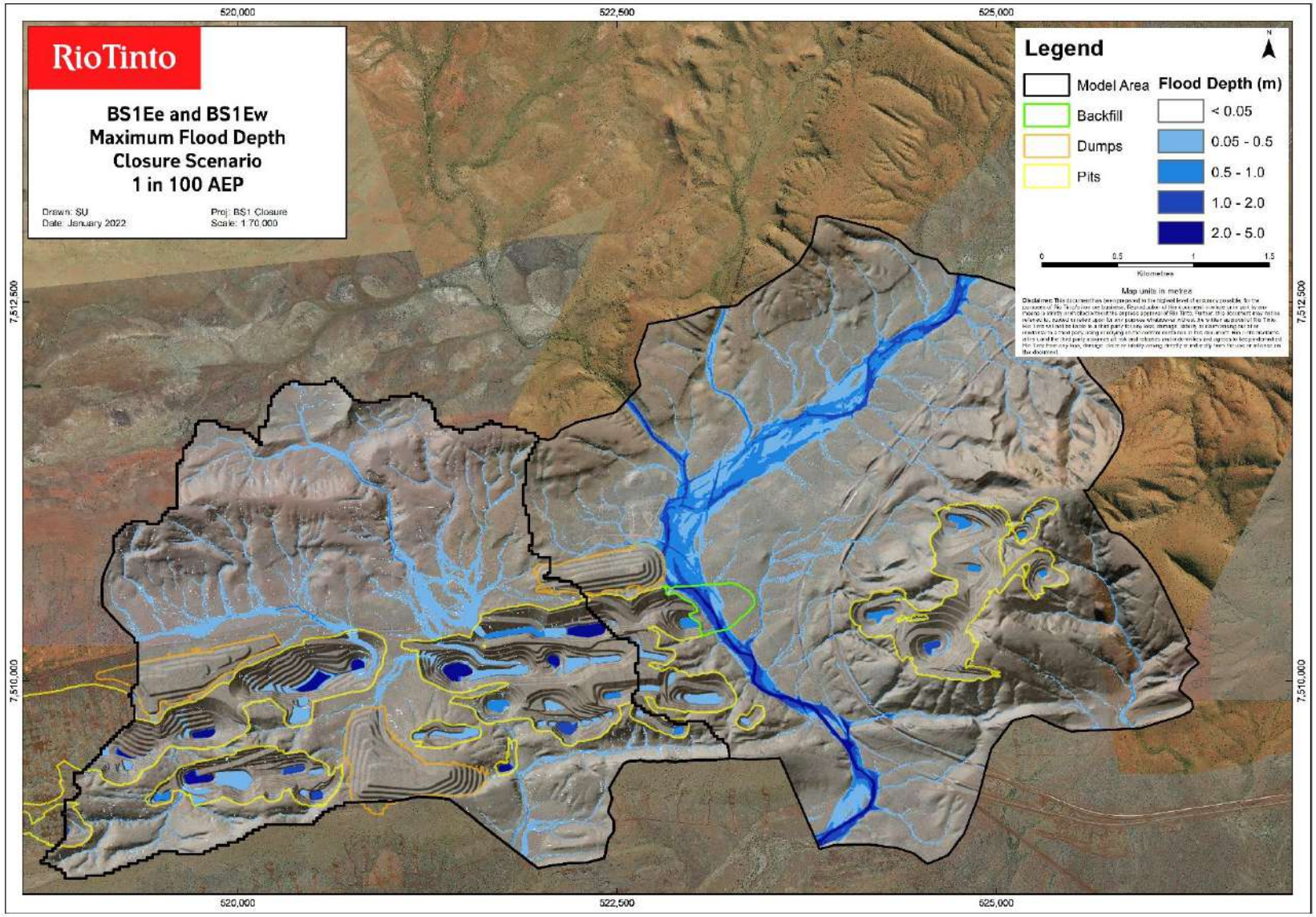


Figure 10-60 BS1-Ee and Ew: 1 in 100 AEP peak flood depth in the alternative closure scenario

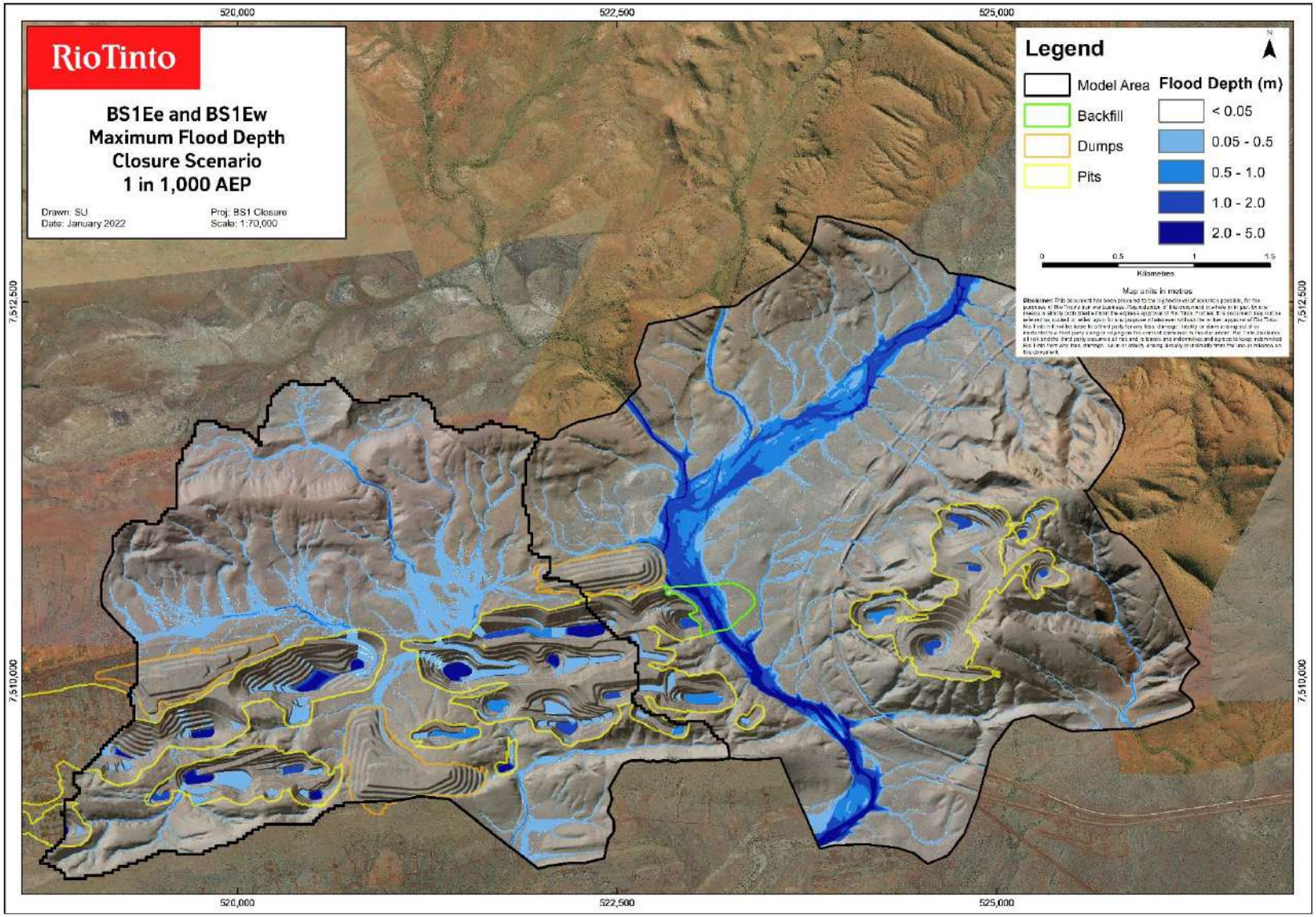


Figure 10-61 BS1-Ee and Ew: 1 in 1,000 AEP peak flood depth in the alternative closure scenario

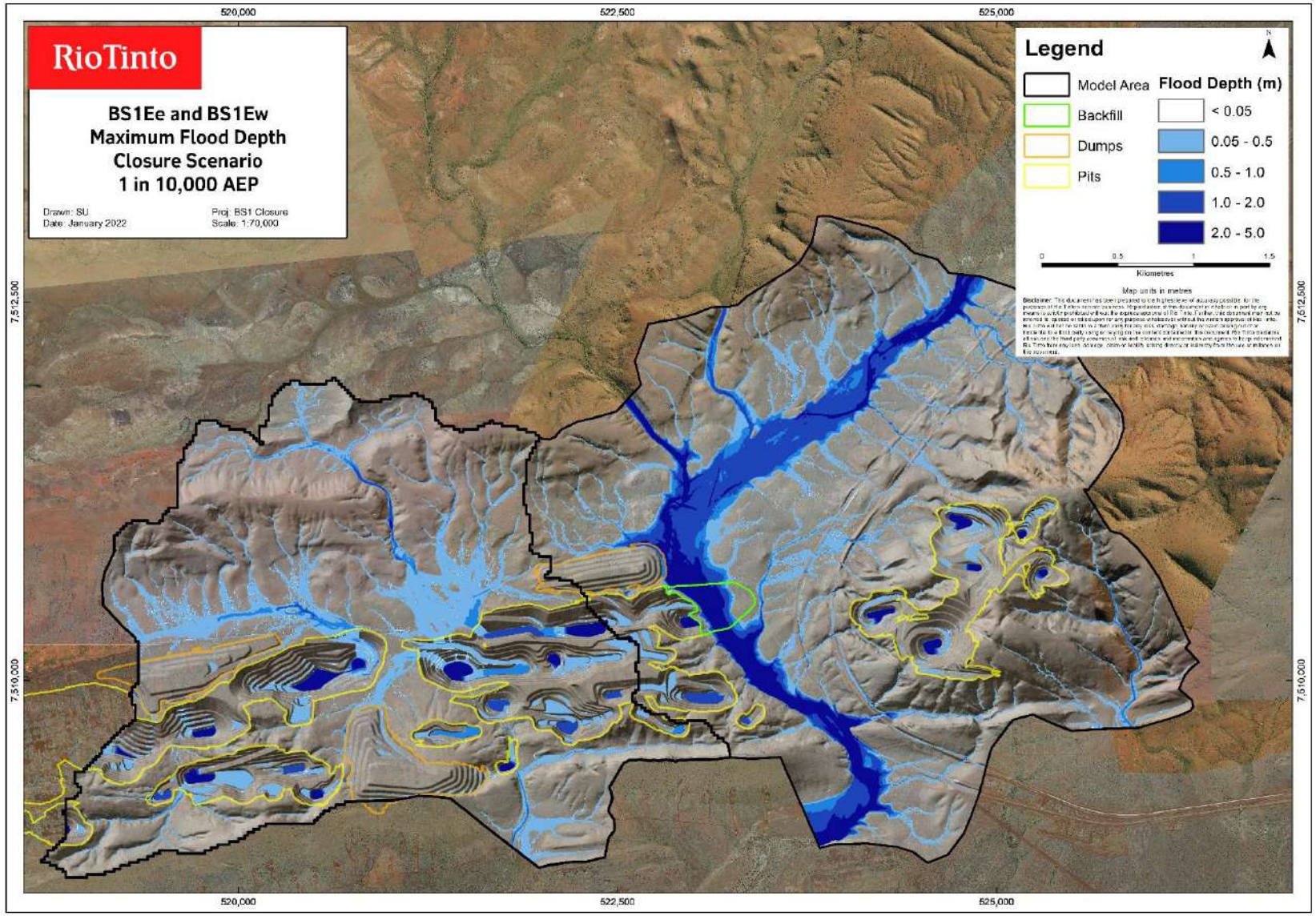


Figure 10-62 BS1-Ee and Ew: 1 in 10,000 AEP peak flood depth in the alternative closure scenario

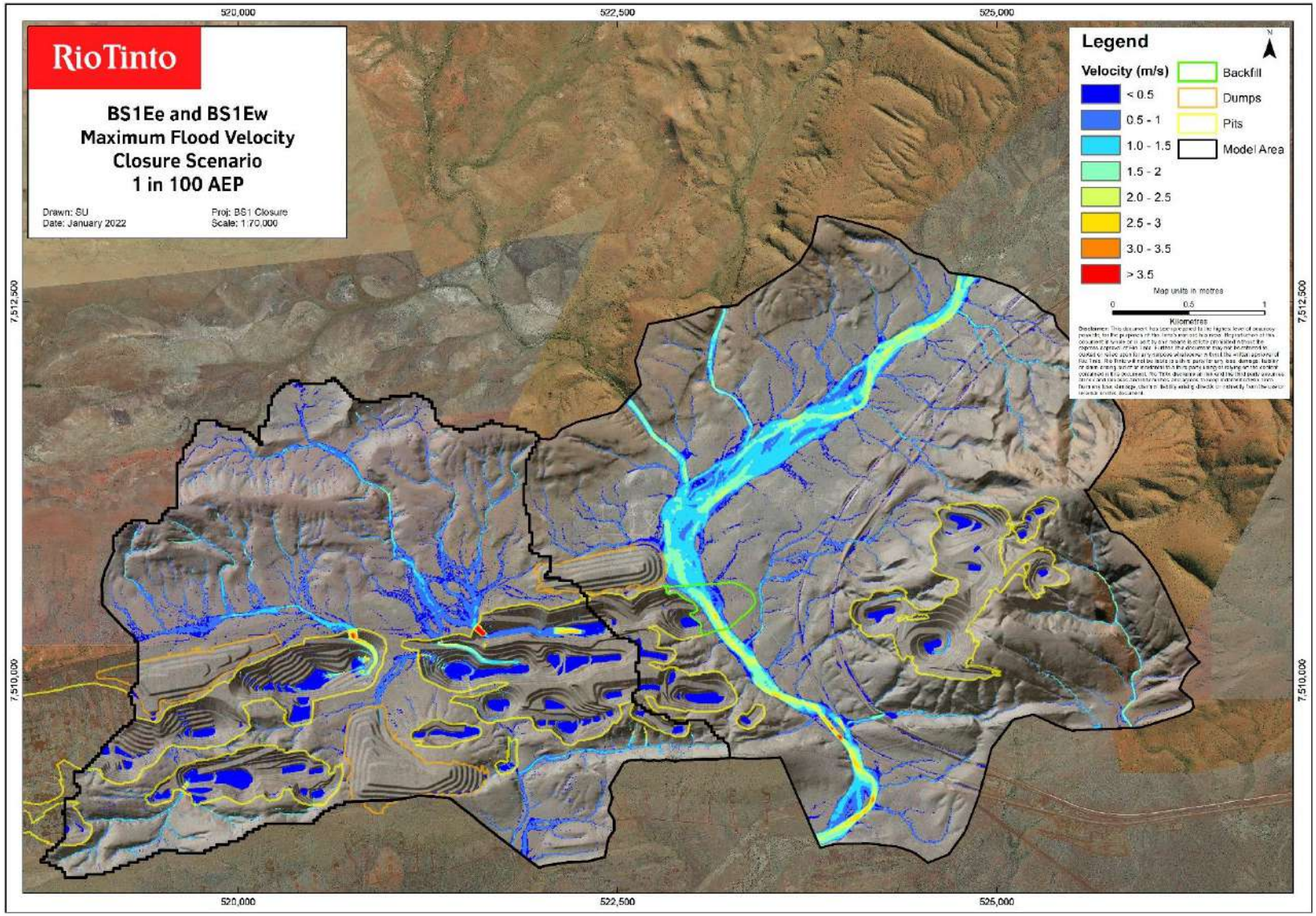


Figure 10-63 BS1-Ee and Ew: 1 in 100 AEP peak flood velocity in the alternative closure scenario

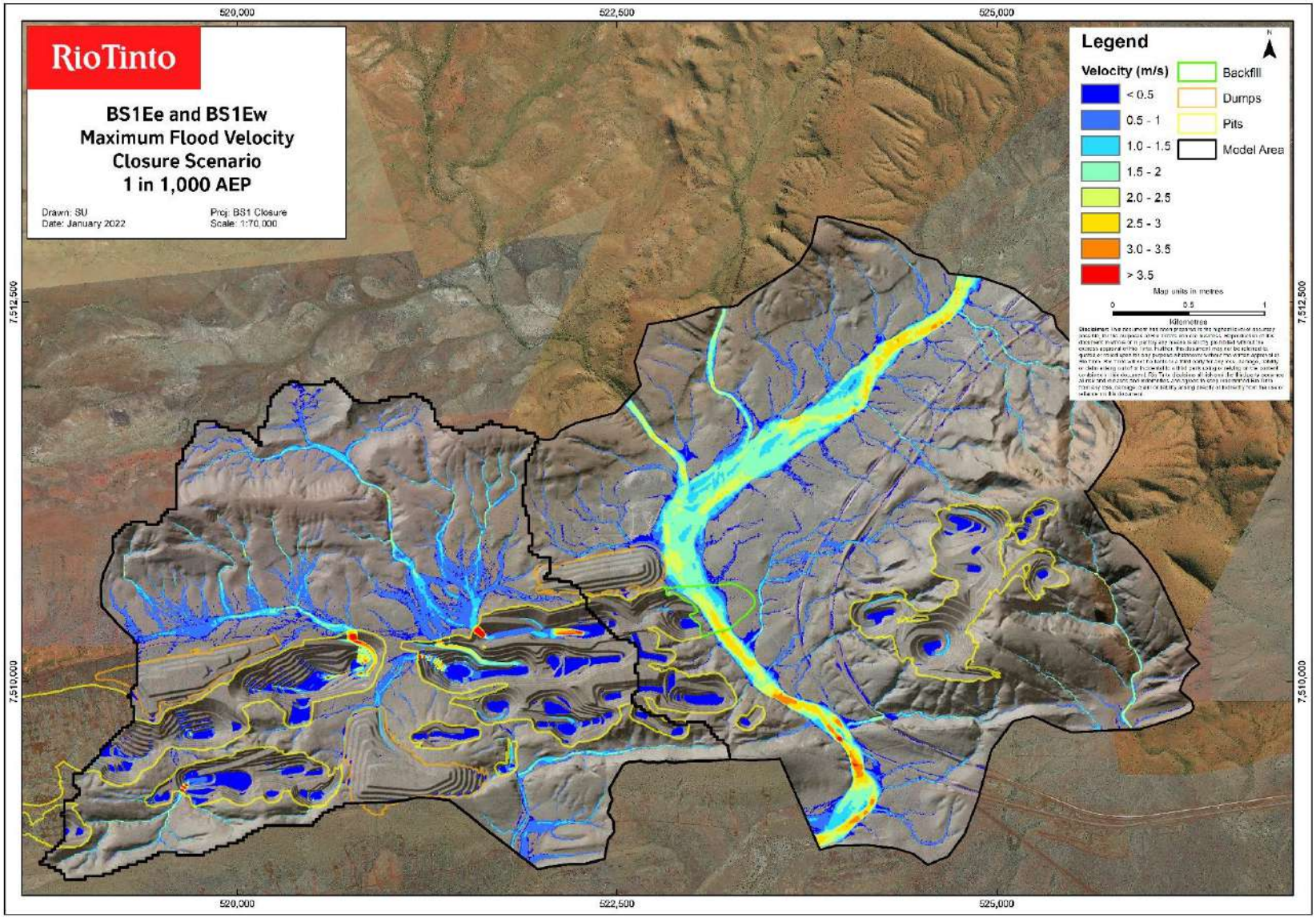


Figure 10-64 BS1-Ee and Ew: 1 in 1,000 AEP peak flood velocity in the alternative closure scenario

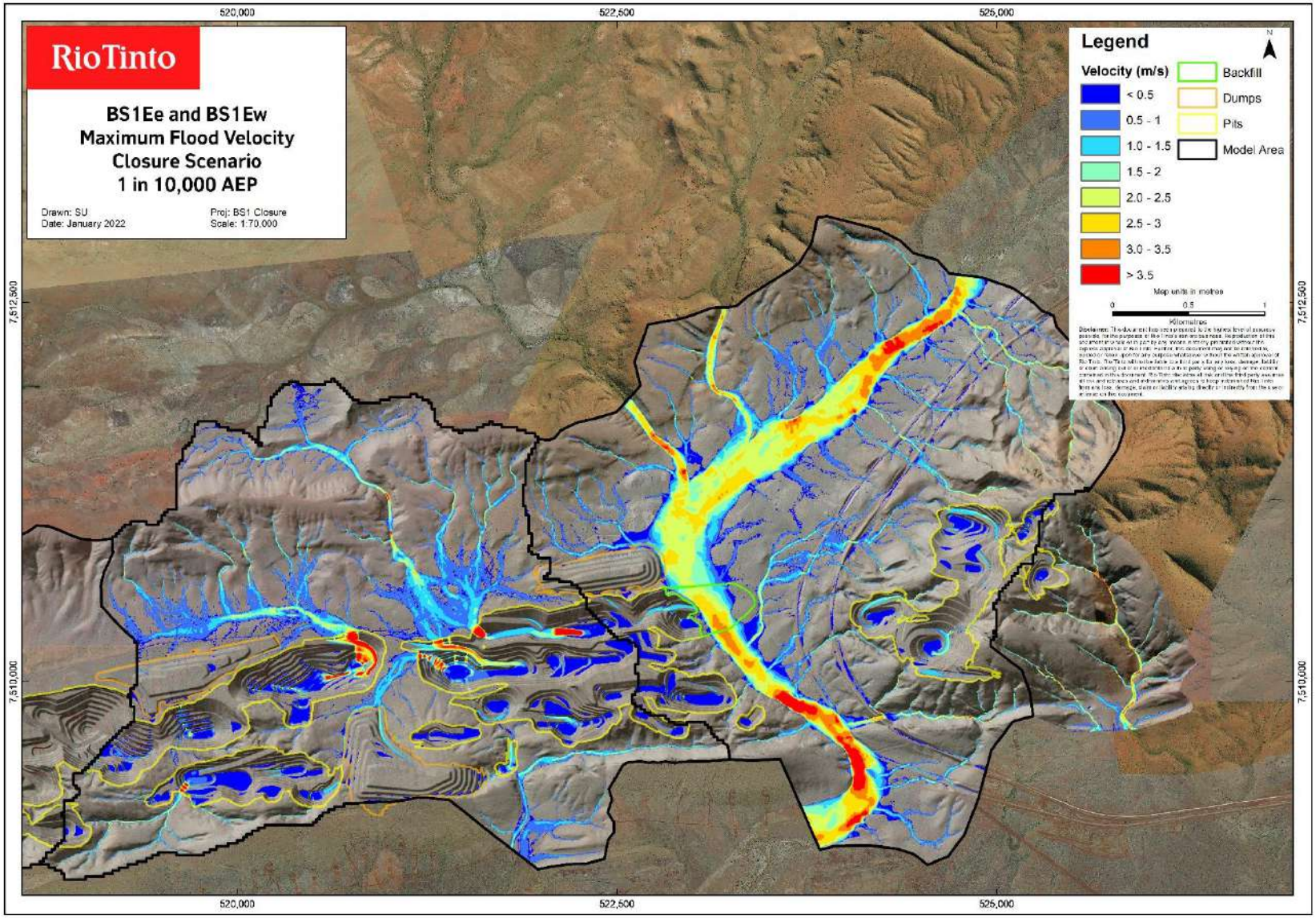


Figure 10-65 BS1-Ee and Ew: 1 in 10,000 AEP peak flood velocity in the alternative closure scenario

Appendix 22: Brockman Operation Progressive Rehabilitation Summary

Rio Tinto Iron Ore Rehabilitation and Closure

Brockman Operations Proposal

Progressive Rehabilitation Performance Summary

August 2022

Proponent name

Address

RTIO-FDMS #

RioTinto

Disclaimer and Limitation

This report has been prepared by Rio Tinto's Iron Ore Group (Rio Tinto), on behalf of Hamersley Iron Pty Limited (the Proponent), specifically for the Brockman Operations Iron Ore Project. Neither the report nor its contents may be referred to without the express approval of Rio Tinto, unless the report has been released for referral and assessment of proposals.

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TABLE OF ABBREVIATIONS

AGM	Alternative growth media
ANFO	Ammonium Nitrate Fuel Oil
B2N	Brockman 2 Nammuldi
BS2	Brockman Syncline 2
BS4	Brockman Syncline 4
BWT	Below water table
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DJTSI	Department of Jobs, Tourism, Science and Innovation
DMIRS	Department of Mines, Industry Regulation and Safety
EPA	Environmental Protection Authority
ESD	Environmental Scoping Document
HV	Heavy Vehicle
LOM	Life of Mine
MCP	Mine closure plan
PAF	Potentially acid forming
PRG	Pilbara Rehabilitation Group
NBWT	Nammuldi below water table
RQA	Rehabilitation Quality Assessment
Rio Tinto	Rio Tinto Iron Ore
SGE	Silvergrass East
SMART	Specific, Measurable, Achievable, Relevant and Time-Bound
UWA	University of Western Australia
WABSI	Western Australian Biodiversity Science Institute
WQR	White Quartz Road

EXECUTIVE SUMMARY

This Progressive Rehabilitation Performance Summary (Summary) has been prepared primarily to support the update and submission of the Brockman Operation 2022 Mine Closure Plan (MCP). The MCP has been developed in accordance with the decision of the Environmental Protection Authority (EPA) to assess the Brockman Syncline Proposal under Part IV s38 of the Environmental Protection Act 1986 (EP Act). The outcomes of rehabilitation undertaken, to date, at the Brockman Operation mine sites, Brockman Syncline 4 (BS4), Brockman Syncline 2 and Nammuldi (collectively B2N) are discussed in this Summary. Evidence obtained from analyses of outcomes at these sites will inform rehabilitation strategies for current and future projects and will also provide evidence that current and future rehabilitation activities will be successful in establishing a self-sustaining functional native ecosystem.

Rio Tinto has a dedicated Rehabilitation and Closure team responsible for closure planning, progressive rehabilitation, ongoing development of closure knowledge, and closure cost estimation. This team is supported by a robust internal governance framework and embedded partnerships with multi-disciplinary technical experts.

Rio Tinto undertakes progressive rehabilitation across its network of Pilbara iron ore operations to actively reduce closure liability. A key driver for completion of progressive rehabilitation is growth in confidence in the ability to deliver quality rehabilitation and reduce associated closure liabilities. Lessons learnt, and information gathered, from progressive rehabilitation will be used to indicate the likely success of future rehabilitation and inform the development of final closure criteria. Local undisturbed vegetation is used as a reference to guide rehabilitation activities such as seed list development and rehabilitation quality assessment.

To date, the success of the Rio Tinto rehabilitation in the Pilbara has been variable, with some poor to moderately successful rehabilitation outcomes observed across historical and recent rehabilitation areas. Significant improvements have been made recently in mineral waste characterisation and landform design and earthwork conformance to design practices, leading to closure designs with reduced erosion rates and related impacts and improved outcomes for rehabilitated areas.

Broad outcomes observed in rehabilitation performance at the Brockman Operations include:

- Rainfall is integral to the success of rehabilitation. Good results in plant density and spinifex cover are achieved if rainfall is received soon after seeding i.e., soil moisture assists in germination and establishment of seedlings. However, if the quantity of rainfall after seeding is too high, detrimental impacts upon rehabilitation success may occur. This makes the timing of seeding an important factor in the success of rehabilitation.
- Generally, the addition of topsoil as a growth medium provides better revegetation results than those achieved at sites where no topsoil was available. However, there has been some successful revegetation at sites where no topsoil was utilised.
- Higher species richness values can be observed at the seeded sites, suggesting a potential correlation. Similarly, higher numbers of flowering / fruiting species appear to be associated with the application of seed.
- Knowledge of vegetation parameter dynamics in post-fire communities is highly valuable for rehabilitation understanding. The parallels observed between vegetation parameter trends at early rehabilitation sites and at burnt sites are also cause for furthering the current knowledge base on fire-affected communities.
- Selection and monitoring of a range of appropriate reference sites is critical in understanding rehabilitation performance towards achieving closure completion criteria.

1. SCOPE AND PURPOSE

This Progressive Rehabilitation Performance Summary (Summary) has been prepared primarily to support the update and submission of the Brockman Operation 2022 Mine Closure Plan (MCP). The MCP has been developed in accordance with the decision of the Environmental Protection Authority (EPA) to assess the Brockman Syncline Proposal under Part IV s38 of the *Environmental Protection Act 1986* (EP Act). The environmental scoping requirements prescribed by the EPA (EPA 2020) relevant to this Summary, and for which it has been developed to accomplish, are provided in Table 1.

This Summary is aligned with the Department of Mines, Industry Regulation and Safety (DMIRS) statutory requirements for MCP content and structure (DMIRS 2020a & b). This Summary may also be used to support the submission of:

- Native Vegetation Clearing Permits; and
- Annual Environment Reports requirements for:
    - *Iron Ore (Hamersley Range) State Agreement Act 1963* and Annual Compliance assessment reporting for Ministerial Statements to the Department of Jobs, Tourism, Science and Innovation (JTSI); or
    - Mining Act tenure to DMIRS.

The outcomes of rehabilitation undertaken, to date, at the Brockman Operation mine sites, Brockman Syncline 4 (BS4), Brockman Syncline 2 and Nammuldi (collectively B2N) are discussed in this Summary and provides an overview of the reference sites established at Silvergrass East (SGE), installed as part of regulatory approvals for this site. Evidence obtained from analyses of outcomes at these sites will inform rehabilitation strategies for current and future projects and will also provide evidence that current and future rehabilitation activities will be successful in establishing a self-sustaining functional native ecosystem (Table 1 – Item 9). Any relevant rehabilitation trials installed at other sites are also discussed.

Table 1 Brockman Syncline Proposal scoping document requirements relevant to this Summary

ESD WORK ITEM NO.	REQUIRED WORK		SUMMARY SECTION
8 (flora and vegetation) **23 (terrestrial fauna)** **40 (subterranean fauna)**	Prepare a Mine Closure Plan, consistent with DMIRS Mine Closure Plan Guidance – How to Prepare in Accordance with Part 1 of the Statutory Guidelines (March 2020) and DMIRS Statutory Guidelines for Mine Closure Plans (March 2020), which:	Includes methodologies to ensure progressive rehabilitation of disturbed land	Sections 2.3. Section 3
		Meets closure objectives, including vegetation composed of native species of local provenance	Section 4.2.1
		Includes consideration of backfilling mine pits, final landforms and rehabilitation of disturbed areas.	Section 2
9 (flora and vegetation) 24 (terrestrial fauna)	Provide a report that details the likely success of future rehabilitation activities in establishing self-sustaining areas of rehabilitation, taking into account	Evidence of success of rehabilitation undertaken to date in the region	Section 5
		Relevant contemporary scientific evidence	Section 5 Section 6
		The types of area to be rehabilitated	Section 3

2. GENERAL OVERVIEW OF PILBARA REHABILITATION

2.1. Progressive rehabilitation planning

Rio Tinto has a dedicated Rehabilitation and Closure team responsible for closure planning, progressive rehabilitation, ongoing development of closure knowledge, and closure cost estimation. This team is supported by a robust internal governance framework and embedded partnerships with multi-disciplinary technical experts.

Rio Tinto undertakes progressive rehabilitation across its network of Pilbara iron ore operations to actively reduce closure liability. A key driver for completion of progressive rehabilitation is growth in confidence in the ability to deliver quality rehabilitation and reduce associated closure liabilities. However, as the Rio Tinto Pilbara operations are typically large scale and long lived with multiple pits being mined simultaneously to meet grade and product requirements, the disturbance areas are usually active for long periods. Consequently, the pace of progressive rehabilitation is not always commensurate with the associated pace of clearing, and long periods of time may elapse between the construction and mining and the commencement of rehabilitation.

Lessons learnt, and information gathered, from progressive rehabilitation will be used to indicate the likely success of future rehabilitation and inform the development of final closure criteria. Local undisturbed vegetation is used as a reference to guide rehabilitation activities such as seed list development and rehabilitation quality assessment. Due to the nature of the mining activity undertaken, it must be recognised that rehabilitation will not reflect the pre-mining environment (i.e. as compared to ‘restoration’, as defined in SERA 2021).

To date, the success of the Rio Tinto rehabilitation in the Pilbara has been variable, with some poor to moderately successful rehabilitation outcomes observed across historical and recent rehabilitation areas. Significant improvements have been made recently in mineral waste characterisation and landform design and earthwork conformance to design practices, leading to closure designs with reduced erosion rates and related impacts and improved outcomes for rehabilitated areas. Generally, vegetation parameters in rehabilitation are good but are highly dependent on both the rainfall volume received in the months and years following the completion of rehabilitation works and the quality of soil or growth media material utilised.

2.2. Definition of land disturbance types

The following categories are applied to disturbance features at Rio Tinto operations.

2.2.1. Low impact disturbance

Low impact disturbance areas are defined as areas where vegetation has been cleared and there has been minimal disturbance to the soil profile. Examples include laydowns; above surface linear infrastructure corridors (pipelines, tracks etc.); topsoil stockpile footprints; and exploration disturbance. Rehabilitation of such areas includes backfilling sumps, contour ripping and spreading of topsoil (if available). Seed may also be spread, if required.

2.2.2. Moderate impact disturbance

Moderate impact disturbance areas are defined as areas requiring minor earthworks to either return the area to natural relief or create a compatible landform consistent with the surrounding natural relief and landforms. Examples include airstrips; buildings; infrastructure; mine access roads; and borrow pits. Typically, rehabilitation of such areas involves removal of infrastructure, services and road surfaces, deep ripping of compacted areas, re-contouring, spreading of topsoil, contour ripping and seeding.

2.2.3. High impact disturbance

High impact disturbance areas are defined as those areas that require extensive earthworks to either approximate surrounding natural relief or create a compatible landform consistent with the surrounding natural relief and landforms. Typically, such areas contain concrete footings that require cracking and covering with fill, voids that need to be filled with waste rock, and/or significant reshaping and contouring to create the required relief. All concrete and buried services are required to be removed to at least one metre below final surface. Examples of high disturbance areas include accommodation camps; fuel farm facilities; haul roads; bridges; dams; power stations; and processing plants. Constructed landforms (such as waste dumps and waste fines storage facilities) are also highly disturbed areas that require significant earthworks to achieve stable rehabilitation designs.

2.3. Rehabilitation methodology

Key learnings from the progressive rehabilitation undertaken to date across a range of Rio Tinto operational locations facilitate continual improvement within rehabilitation methodology. Examples relevant to the Brockman Operation Proposal are provided in Table 2.

Table 2 Key learnings from Pilbara mine site progressive rehabilitation

Learning	Operational Control	Further Discussion Within the Summary
Rainfall is integral to the success of rehabilitation. Good results in plant density and spinifex cover are achieved if rainfall is received soon after seeding i.e., soil moisture assists in germination and establishment of seedlings. However, if the quantity of rainfall after seeding is too high, detrimental impacts upon rehabilitation success may occur.	Schedule seeding before the onset of wet season, rather than when the earthworks are completed, regardless of time of year. Planned trials to determine effect of timing of seeding.	2.3.2 Seed management 5 Summary of rehabilitation outcomes 6.1 Eco-engineering solutions to improve mine site rehabilitation outcomes
Ongoing intermittent rainfall is required through time to ensure that revegetation continues to develop on the desired trajectory to achieve closure criteria. In alignment, weed density generally decreases over periods of low rainfall.	Monitoring of reference sites to determine the effect of rainfall on natural systems Weed monitoring and management.	2.3.2 Seed management 5 Summary of rehabilitation outcomes 6.1 Eco-engineering solutions to improve mine site rehabilitation outcomes
The presence of weeds significantly impedes overall rehabilitation outcomes particularly within parameters native perennial species richness / density and native perennial cover.	Regular monitoring of weeds and prompt implementation of weed management actions when required.	5 Summary of rehabilitation outcomes
Generally, the addition of topsoil as a growth medium provides better revegetation results than those achieved at sites where no topsoil was available. However, there has been some successful revegetation at sites where no topsoil was utilised.	Ongoing review of topsoil management and monitoring of trials	2.3.1 Growth mediums 5 Summary of rehabilitation outcomes 6.5 Growth media trials
Current results indicate that waste materials with soil-like properties, collectively termed 'Alternate Growth Media' (AGM) can act as effective germination beds and be used as longer-term growth mediums.	Ongoing characterisation of potential AGM and monitoring of trials.	2.3.1 Growth mediums 6.5 Growth media trials
With the limited trials to date, application of fertiliser did not improve revegetation results.	Ongoing investigation of soil ameliorants to improve success of AGM, and of germination and survivability results for native species	2.3.1 Growth mediums 6.5 Growth media trials
Spinifex cover is closely associated with total plant cover and density values.	Ongoing monitoring to determine if association continues through time and with differing seed mixes.	5 Summary of rehabilitation outcomes

2.3.1. Growth medium

There may also be a shortfall of topsoil and subsoil available for rehabilitation due to topsoil being naturally thin or absent on topography such as hillslopes and ridge lines, or steep underlying topography presenting safety risks preventing the collection of topsoil. Where a topsoil deficit exists at a site, consideration is given to the use of subsoil and alternative growth media in rehabilitation.

Throughout the Pilbara, there is an ongoing opportunity to utilise mineral waste as topsoil substitutes or supplements for rehabilitation activities. The waste materials with soil-like properties are referred to as 'alternative growth media' (AGM). It is anticipated that AGM will provide a suitable growth medium in rehabilitation areas where topsoil is unavailable or limited in quantity. Research trials are underway to determine if the revegetation success in areas rehabilitated with alternative growth media will be acceptable, and early indications are promising (Section 6.5). Waste types which are identified as potentially suitable are laboratory tested for key soil chemical and physical parameters. If the characterisation results are favourable, the material is stockpiled with location recorded on mine site survey records.

Alternative growth media material was identified and tested from several Rio Tinto sites in the Pilbara including: Marandoo; Tom Price; Western Turner Syncline; and Channar (Outback Ecology 2010, Stantec 2017, and Landloch 2018). Stockpiling of suitable material commenced, with additional investigations to incorporate materials into the mine plans for future recovery underway.

Results from ongoing monitoring of these trials will be used to inform future closure strategies. If required, seeding rates may be increased in areas receiving alternative growth media or subsoil material to compensate for the lack of a topsoil seedbank. The application of fertiliser, or other ameliorants, will also be considered for materials that have low nutrient status, although recent evidence suggests the addition of fertiliser is not always beneficial and can promote weed establishment (Stantec 2020).

2.3.2. Seed management

Locally collected seed assists in the revegetation and creation of a self-sustaining ecosystem. Over time, the viability of the seed within stockpiled topsoil may decrease, particularly if stored for long periods or if the stockpile does not become vegetated. In addition, as topsoil is not always used in rehabilitation of areas it was salvaged from, the salvaged topsoil may not contain seeds of all the target species of its new location/habitat.

Seed mixes used during rehabilitation are of local provenance. Specific seed mixes are selected to provide a range of species appropriate to the landscape position and slope. Local colonising species are included in the mix aid to aid in quick vegetation establishment, and to thus compete with weed species that may establish from wind-blown seed. Rio Tinto is working towards ensuring culturally significant species are also considered in the selection of species and determination of proportion of seed numbers for each species in the mix.

Rio Tinto purchases seeds from commercial seed suppliers, with emphasis on ensuring that there are adequate seed of appropriate quantity and local provenance species available for planned rehabilitation at each of the mine sites or other assets. Stringent controls on seed quality, provenance and seed storage are in place and seed pre-treatments are used for a proportion of the seed of some species to maximise the potential of applied seed to germinate under field conditions. Seeds are stored in purpose-built, climate-controlled storage facilities to maximise long-term viability. Viability testing and species-specific pre-treatment occurs before seed are utilised in seed mix preparation and application onto rehabilitated sites. Increasing revegetation success through ongoing improvement projects and research partnerships in seed biology and seeding technologies is a key factor in the ability to successfully rehabilitate across all Pilbara mining operations.

As the opportunity to utilise rare and threatened species in rehabilitation programs is limited by various factors such as availability, the focus of rehabilitation programs is to restore vegetation complexes that include the more common species present in the habitat type, and to achieve a suitable range of strata

considering the desired post-mining land use. Seed mixes may include species of conservation significance if available, but presence of these species in rehabilitation areas is more likely to result from natural recruitment from surrounding areas.

Legislative requirements regarding seed provenance are often included as conditions within Native Vegetation Clearing Permits obtained under the EP Act. A review of all legislative requirements for seed provenance is conducted as part of the planning process for rehabilitation programs to ensure seed provenance conditions are met. All legal obligations related to rehabilitation and seed provenance for the HD2 area are summarised in the Legal Obligations Register appended to the MCP.

3. PROGRESSIVE REHABILITATION OVERVIEW

This progressive rehabilitation Summary provides synopses of Rio Tinto's internal completion reports and of the annual rehabilitation monitoring program results for the BS4, B2N and SGE areas. The objective of the progressive rehabilitation program is to evaluate successional development of the rehabilitation and thereby provide feedback for the improvement of rehabilitation techniques, and to help assess progress towards long-term rehabilitation goals.

3.1. Disturbance areas and progressive rehabilitation

Within the proposed Brockman Operation closure boundary, all disturbed areas that can be accessed safely, with the exception of pit floors (unless backfilled to within 10m of the final surface), will be rehabilitated, either progressively through operations, or at closure.

Figure 1 shows the total area of disturbance within the Brockman Operation closure boundary, illustrating the amount of rehabilitation already undertaken and the area still requiring rehabilitation. At the time of writing this Summary, 826.12 ha of disturbed land at Brockman Operation has been rehabilitated, ranging from low disturbance areas to highly disturbed waste landforms (Table 3).

Implementation of progressive rehabilitation at the Brockman Operation will occur during the operational phase when disturbed areas become available. Completed and planned rehabilitation areas (as of 2021) within the Brockman Operation closure boundary are presented in Figure 2 to Figure 5.

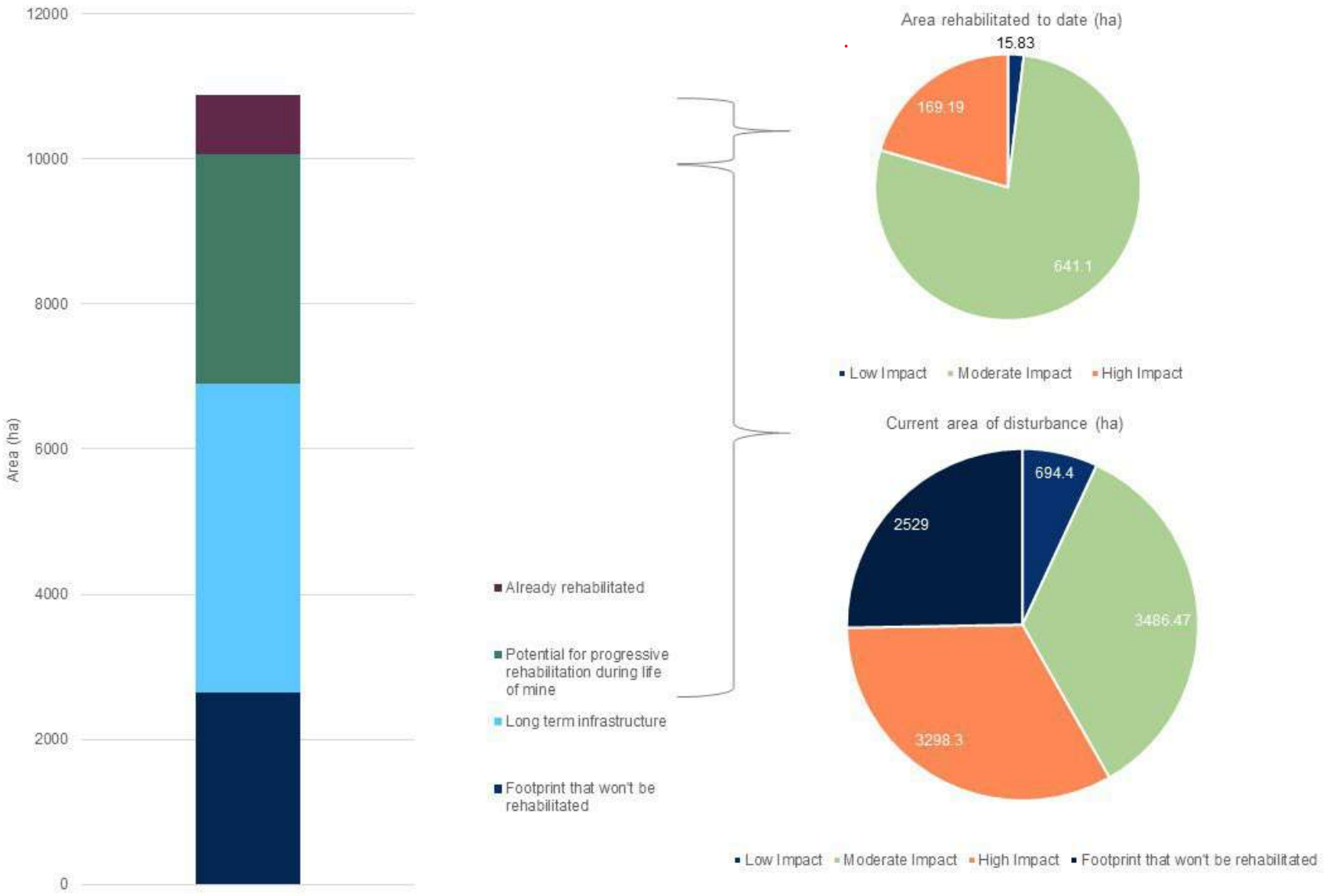


Figure 1: Rehabilitation type and area for Brockman Operations (data captured in December 2021)

Table 3: Completed progressive rehabilitation within the Brockman Operation closure boundary.

Disturbance type	Domain type	Area (ha)[1]	Rehabilitation Sites[2]	Active transects	Summary Section
Low	Topsoil Stockpiles	15.83	Various	None assessed using vegetation quadrat method Low disturbance rehabilitation has been assessed using the RQA method.	Section 5.4
Moderate	Borrow Pits	379.9	B2N 1991 Borrow Pits	BR2_274_Rehab_L_1997 BR2_258_Rehab_L_1997	Section 5.5.3
			B2N 2009 Borrow Pits	BR4_BR2_BP293_T1_ 2014	Section 5.5.4
			BS4 Borrow Pits	BR4_BLE6_2010 BR4_BLE7_2010 BR4_19ABC(2)_ 2010 BR4_BP17B_2010	Section 5.5.6
			B2N to BS4 Access Rd Borrow Pits	BR4_B2B4_Access_ Rd_T1 to T4_2016	Section 5.5.5
			BS4 White Quartz Rd Borrow Pits	BR4_4681Al_ WQRBP37_2010 BR4_4681V_ WQRBP41_2010 BR4_4681AM_ WQRBP06_2010	Section 5.5.7
			Nammuldi ANFO Facility Borrow Pits	No active transects (original transects: BR2_NAM_Anfo_T1 to T3)	Section 5.5.2
			Nammuldi BWT HV Borrow Pits	BR2_Nammuldi_HV_Rd _T1 and T2_2016	Section 5.5.1

[1] Areas included in this column are not reflective of the full amount of rehabilitation undertaken per disturbance type within the closure boundary. Refer to Figure 1 for full values.

[2] Rehabilitation sites are presented as examples of rehabilitation completed within the closure boundary and do not reflect the full area (ha) of disturbance that has been rehabilitated.

Disturbance type	Domain type	Area (ha)[1]	Rehabilitation Sites[2]	Active transects	Summary Section
			Nammuldi Rail Loop Borrow Pits	BR2_Nammuldi_Railloop_T1 to T3_2016	
	Landfill	4.4	Nammuldi BWT Landfill	BR2_NAM_NBWT_ Landfill_T1_2019	Section 5.6.1
	Road	135.6	B2N Old Haul Road	BR2_Old_Haul_Road_2012	Section 5.6.2
	Mine Backfilled Pit	4.6	Brockman 2 Pit 3	BR2_Pit_3_Surrounds_2012	
	Mine Backfilled Pit		Brockman 2 Pit 2 Backfill	BR2_Pit_2_Backfill_2012	
	Airstrip	11.3	Boolgeeda Aerodrome	BR4_Boolgeeda_T1 and T2_2014	Section 5.7
	Infrastructure	51.4	BS4 Fuel Hub	BR4_FuelHub_T1_2014	
	Camps / Villages	4.5	Boolgeeda Camp	2019_BR4_BoolCamp_WD_T1 and T2	Section 5.7.2
High	Waste Dumps	106.6	Nammuldi Lens C Waste Dump	BR2_Lens_C_Transect_1_2008	Section 5.9.1
			B2N Central and Pit 2 Waste Dumps	BR2_Central_WD_T1 and T2_2012 BR2_Pit_2_Waste_Dump_2012	Section 5.9.2
			B2N Pit 6 Waste Dump	No active transects (original transects: Pit 6_WD_T1 and T2)	Section 5.9.3
			B2N South POD Waste Dump	BR2_SouthPod_WD_T1 to T8_2019	Section 5.9.4
			B2N Waste Dump West	BR2_WD_West_1997	Section 5.9.5
			B2N B Dump	BR2_B_Dump_Transect_1 to 3_2012	Section 5.9.6
			BS4 DP1 and DP4	2020_BS4_DP1_WD_T1 and T2 2020_BS4_DP4_WD_T1 to T4	Section 5.9.7

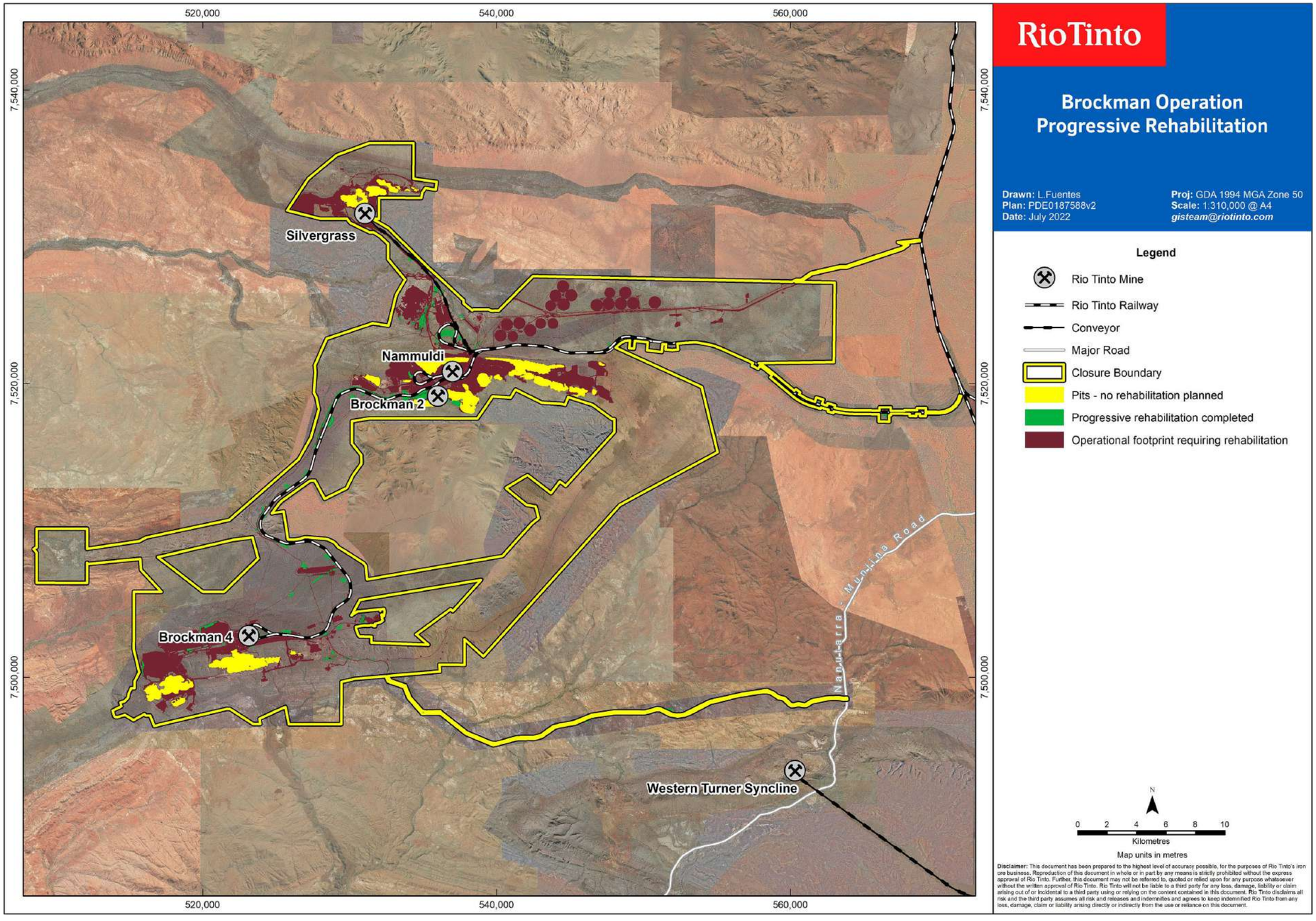


Figure 2: Progressive rehabilitation areas within the Brockman Operation closure boundary.

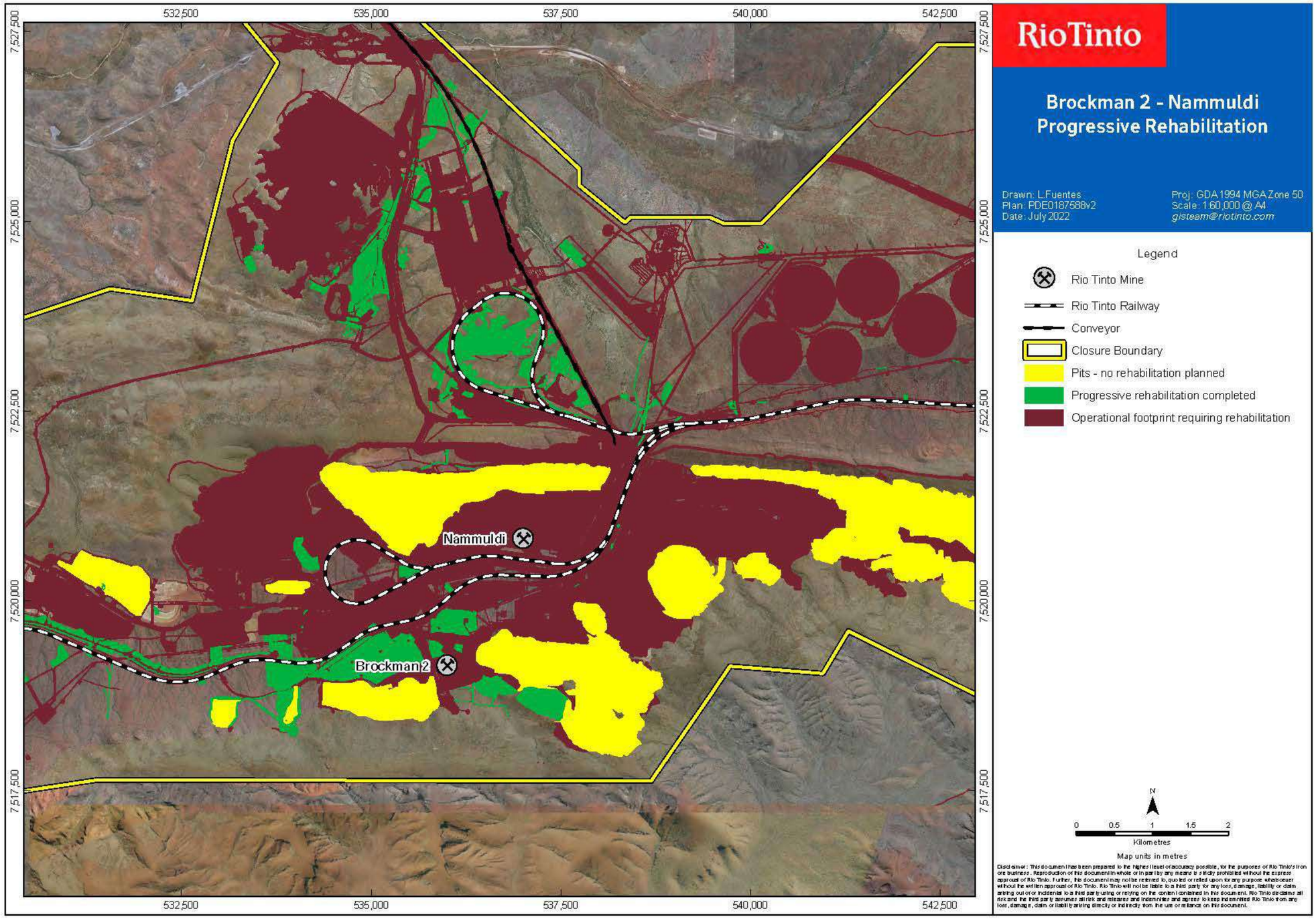


Figure 3: Brockman 2 / Nammuldi completed and required progressive rehabilitation areas.

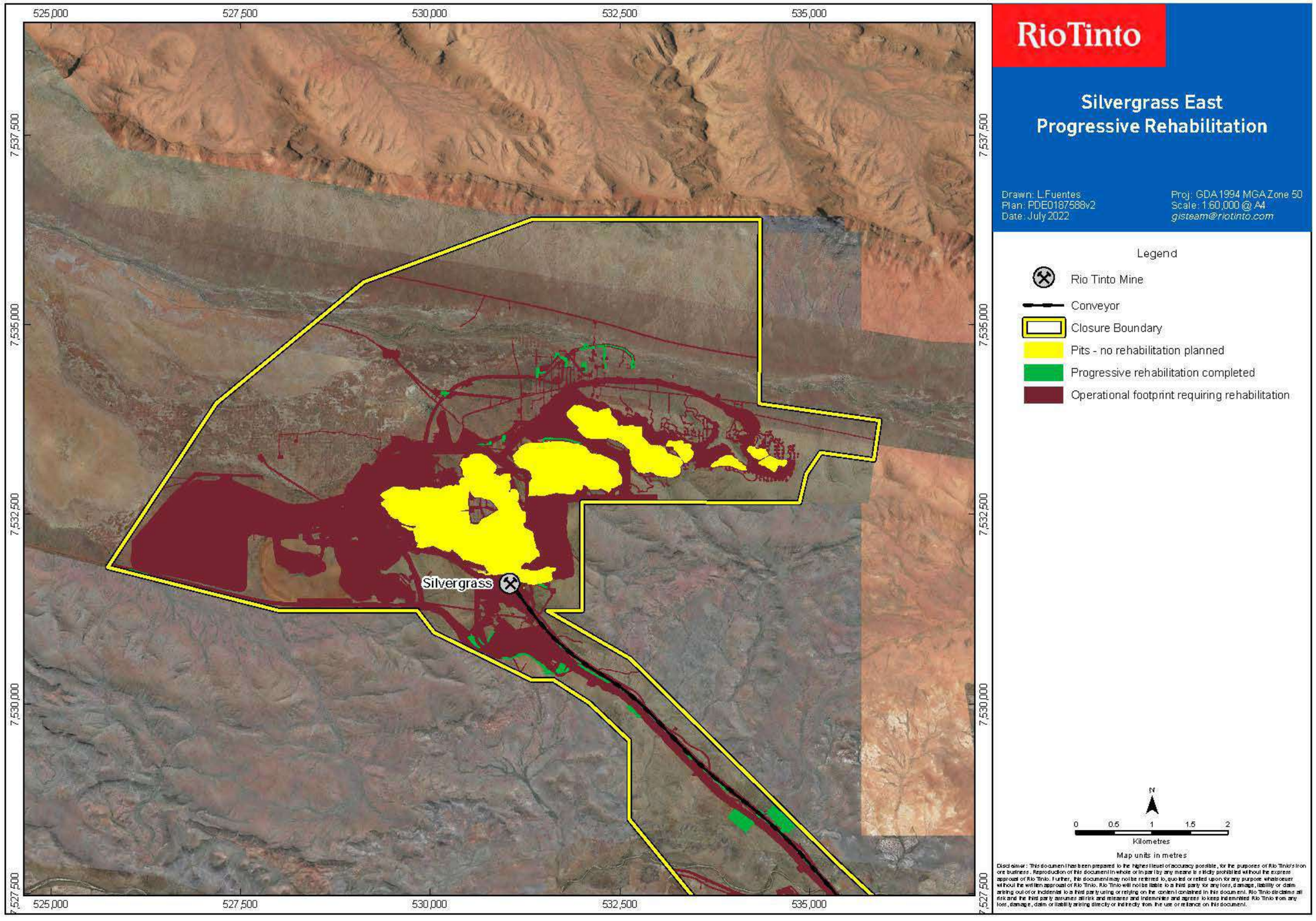


Figure 4: Silvergrass East completed and required progressive rehabilitation areas.

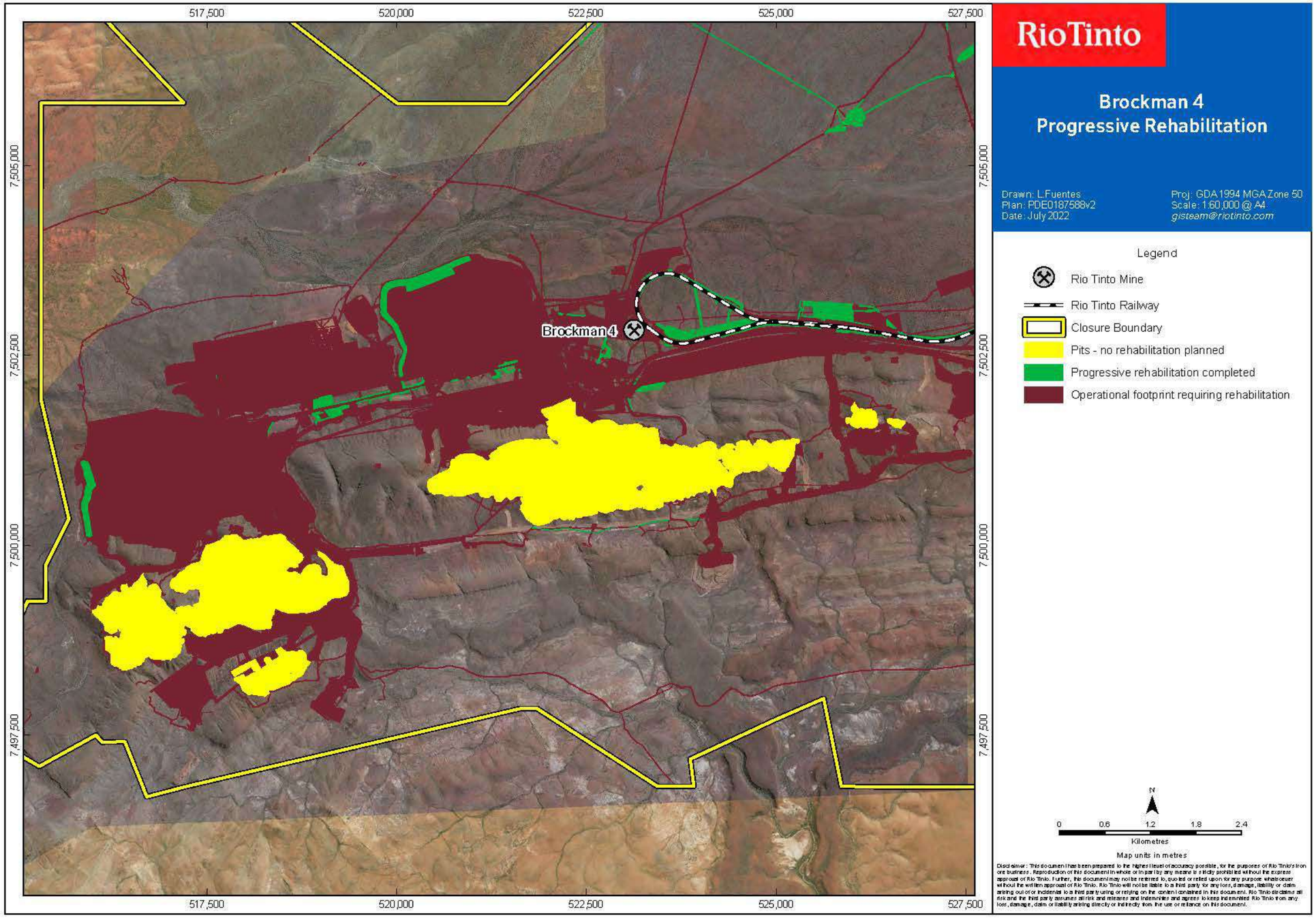


Figure 5: Brockman 4 completed and required progressive rehabilitation areas.

4. MONITORING PROGRAMME

Rio Tinto monitors rehabilitated areas across its Pilbara operations with the objective of obtaining data that will be used to evaluate the success of rehabilitation against biological completion criteria, as well as supporting adaptive management and continuous improvement of rehabilitation techniques as described in the Rio Tinto Rehabilitation Monitoring Procedure (Rio Tinto 2019b).

Analysis of monitoring results provides information to inform the development of realistic and achievable completion criteria, by examining changes in key parameters over time and comparing results from the rehabilitation with those from corresponding reference sites in undisturbed areas. Such analysis of monitoring results will also be used to indicate the likely success of progressive rehabilitation in achieving completion criteria and whether any areas of rehabilitation require rework due to poor performance.

4.1. Monitoring schedule and design factors

Rehabilitation monitoring is scheduled using a risk-based approach to determine the appropriate monitoring technique and frequency. Where possible, monitoring is completed annually for the first three years following rehabilitation, then in years 5, 7, 9, 12 and 15, and then every third year thereafter. Frequency of monitoring may be altered depending on the condition of the rehabilitated site and the availability of resources.

Rehabilitation monitoring is completed in the cooler months (June to September) of each year, noting that COVID restrictions modified the program in 2020 and 2021. The monitoring program design (i.e., monitoring technique and frequency) for each rehabilitated site considers the following factors:

- the level of complexity of the rehabilitation and subsequent risk to rehabilitation quality outcomes (e.g. generally waste dumps are a high risk due to their complexity whilst a lower risk for achieving desired rehabilitation outcomes exists for low disturbance areas);
- the regulatory requirements for rehabilitation monitoring;
- the age of the rehabilitation;
- the overall area of the rehabilitation (i.e., the larger the size, the higher the number of monitoring locations required);
- if there is a trial implemented on some of the rehabilitation (e.g., the ability to detect germination of seeded species requires early monitoring in the first year is especially important in analysis of trial results);
- natural disturbance such as fire or cyclonic rainfall (may reset the timing of monitoring to year 1); and
- safe access for monitoring personnel.

Monitoring schedules for the rehabilitation sites are provided in Appendix A:. In general, the rehabilitation monitoring schedules comply with the requirements of the Rio Tinto Rehabilitation Monitoring Procedure.

4.2. Rehabilitation monitoring methods

Monitoring methods utilised by Rio Tinto include:

- **Rehabilitation Quality Assessments (RQAs) and photo point monitoring**: These observational assessments are used on low to moderate disturbance areas, historical rehabilitation with no monitoring history, or on areas too small for transects. They can also be used in combination with the above transect methods on large rehabilitation areas to manage monitoring resources efficiently. The purpose is to gain an overview of the rehabilitation quality

including erosion, growth medium, vegetation cover, species richness, vegetation structure, plant density, weed presence and general condition. Each characteristic is compared between the rehabilitation and local undisturbed native vegetation and given a score according to the RQA field book guidelines. A representative photograph is taken of both the rehabilitation and reference areas.

- **Vegetation, fauna habitat and erosion monitoring**: Vegetation monitoring involves establishing quadrats (2 m x 2 m) at 5 m intervals along a 50 m or 100 m transect. Within each quadrat, numbers of all native perennial plant species and weeds are counted, and individual percent cover estimated. The number of bare areas is assessed by dividing the edge of each quadrat on the transect baseline into eight x 25 cm sections and recording the number that has no perennial plant species cover. A subjective assessment of total native perennial plant cover (%) is also recorded for each quadrat. Notes are taken of the general condition of the rehabilitation, including new disturbance and fire damage. The term 'spinifex' in this report refers to *Triodia* species.

  Fauna and habitat monitoring comprises estimating litter cover, noting rocks and logs in each quadrat, and a whole-of-transect assessment of grazing extent, native animal scats, ant numbers, and other indicators of animal activity.

  Erosion monitoring entails an examination of a permanent vegetation transect to identify the presence and number of gullies that are greater than 30 cm in depth. Gully locations and associated measurements of total width and depth at the deepest point are recorded. Comparisons of data collected over time can determine if a landform has stabilised or if it is exhibiting rates of erosion which require intervention. Eroded areas that may require intervention are then investigated for potential rework opportunities.

4.2.1. Revegetation completion criteria

Vegetation on rehabilitated land has been identified as a key outcome in evaluating the site condition at closure and compatibility with the post-mining land use. All progressive rehabilitation undertaken during operations is required to meet the closure outcomes / completion criteria described within the associated MCP. Broadly, the desired closure outcomes help align the rehabilitation methodology with the objectives of establishing a safe, stable, and non-polluting landscape vegetated with native species of local provenance, and ensuring the site is compatible with proposed post-mining land use.

Based on recent work undertaken by Rio Tinto and Stantec (Stantec 2020) on potential biological completion criteria for the Channar mine site, the following key parameters were selected to develop quantitative targets which are applicable across all rehabilitation areas and reference sites:

- **Native perennial species richness and species density**: Species richness is the total number of species in a defined area. This differs from the more comprehensive measurement of species diversity which incorporates relative abundances.

  Species density was calculated as the mean number of species per quadrat and is a valuable measure for monitoring vegetation changes over the long-term. Although not significantly different to species richness, species density can better detect plant responses to a given management action, and unlike species richness, comparative analyses can still be made when transect lengths differ.

- **Native perennial plant density**: Plant density refers to the mean number of plants per unit area. Total counts of native plants were documented for each quadrat and averaged for entire transect values.

- **Native perennial plant cover**: Values for this parameter were obtained with visual assessments for each quadrat of the percentage of surface area with vegetation (i.e. percentage that is not bare). Final values were calculated for each transect as the mean percentage of cover across all

quadrats. Due to the subjectivity involved in visually assessing percentage cover, final values are considered estimates only.

The analysis of these parameters is standardised across all Rio Tinto operational sites and is considered appropriate in the development of a consistent approach to determining success of rehabilitation over time. Rio Tinto is undertaking further work on this approach and will also incorporate feedback when received from stakeholders on the preliminary Channar monitoring strategy present in the MCP (2020). Further refinements of completion criteria will be presented in future updates to closure plans and progressive rehabilitation performance summaries.

The preliminary completion criteria for the Brockman Operation are presented in Table 4 below, with the associated monitoring methods and means of verification (vegetation parameters). These will be refined further as mining progresses to ensure they are Specific, Measurable, Achievable, Relevant and Time-Bound (SMART) (as defined by Young et al (2019)). Application of the SMART principle facilitates a systematic and comprehensive framework for goal formation.

Table 4: Brockman Operation preliminary completion criteria.

CLOSURE OUTCOME	PRELIMINARY COMPLETION CRITERIA	UNIT AND METHOD(S) OF VERIFICATION
Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use	• Seed used in rehabilitation works is of local[1] provenance.	• Seed management plan • Analysis of historical monitoring data
	• Recruitment of native perennial plants is observed.	• Rehabilitation monitoring/site inspections • Number of native perennial plants per m^2
	• Native plants within rehabilitated areas are observed to flower and/or fruit.	• Rehabilitation monitoring/site inspections • Reproductive activity • Species flowering/fruiting
	• Species richness of native perennial plants within rehabilitated areas is not less than reference sites.	• Rehabilitation monitoring/site inspections • Number of perennial plants species per m^2
	• Diversity and abundance of weed species recorded within rehabilitation areas will be no higher than within established reference sites.	• Rehabilitation monitoring/site inspections • Weed cover (%) • Proportion of weed cover to total perennial cover • Weed species count
The final landform is stable, and its design considers hydrological factors.	• No erosion features that compromise landform integrity or stability are present. • Erosion from landforms does not threaten the health of surrounding natural ecosystems.	• Depth and width and length of rills/gullies. • Erosion monitoring to quantitatively evaluate behaviour of rills and gullies over time (increasing depth width or length may indicate need for further management).

[1] Local is defined as Pilbara IBRA and/or as defined in NVCPs

CLOSURE OUTCOME	PRELIMINARY COMPLETION CRITERIA	UNIT AND METHOD(S) OF VERIFICATION
	• The final landform has been designed and constructed with consideration given to its stability during intense rainfall and large flood events. • Final landforms are outside pit crest zones of instability.	• Post-construction review by competent person to ensure landforms were built in accordance with plan, including QA/QC checks. • Analysis of aerial imagery to provide qualitative analysis of landform stability.

4.2.2. Rehabilitation monitoring reference sites

To obtain meaningful information on rehabilitation outcomes, suitable reference sites are required for comparative purposes. The location, topography and vegetative structure of the rehabilitated area are the key considerations when selecting a reference site, which will ideally represent the natural landscape surrounding the operational area. Additional factors and potential limitations that are also considered during reference site selection include approval boundaries, exclusion areas, final landform designs, mine planning, accessibility and safety factors. Consequently, the distance between rehabilitation and reference sites can vary.

Reference sites are positioned within undisturbed native vegetation representative of the local area where the rehabilitation is to be conducted. Appropriately positioned monitoring reference sites will encompass the target vegetation community to provide the baseline vegetation criteria used for assessing rehabilitation progress and outcomes and, where possible, enable a comparison to similar undisturbed areas. Reference sites are located on different topography types (upper slopes / hilltops, mid-slopes and lower slopes and flats) to account for spatial variations of mined landforms and their influencing factors.

The monitoring of reference sites provides a temporal record of natural variations in established vegetation through time which can offer valuable insights into the influence of non-mining related variables such as climate or fire events. Monitoring data obtained from reference sites also assists in the planning of rehabilitation by informing methodology, such as the development of seed lists. Using a range of reference sites is endorsed to better facilitate a comprehensive assessment of rehabilitation progress.

A total of four active reference sites have been established at the BS4 operations (Figure 8). As all four are located on flat ground, monitoring of rehabilitation may also be compared to reference sites at B2N / SGE. A total of 21 active reference sites have been established at the B2N / SGE operations and are shown in Figure 6 and Figure 7. Further details on the reference sites utilised for BS4 and B2N / SGE rehabilitation are provided Appendix B:

There were some cases across the BS4 and B2N rehabilitation areas where initial reference site selection was adjusted either due to access issues, site destruction or monitoring inconsistencies. Rehabilitation data is compared, where possible, to reference sites monitored in the same year to account for environmental changes that may influence vegetation parameters (e.g. rainfall). However, several reference sites historically used for comparison with rehabilitation areas within the Brockman Operation closure boundary were either not monitored frequently enough to act as an appropriate analogue or were skipped during recent assessments. Some rehabilitation areas were therefore compared to different reference sites during the last assessment and other areas required inclusion of additional reference sites to account for deficiencies in the initial reference site selection. Reference site selection and establishment is currently under review to develop an appropriate methodology which ensures such issues are avoided.

4.2.3. Climate data

Rainfall and temperature

The Brockman Operation exists in Kurrama country within Western Australia's Pilbara region which has an arid climate and experiences regular cyclonic activity during November to March. Characteristic climatic features of the region include seasonally low rainfall with high temperatures, high evaporation rates and high daily temperature range.

Rainfall occurs predominantly in the summer months as low- pressure troughs descend into the region, resulting in frequent summer thunderstorm activity, and occasionally protracted rainfall, characteristic to the region. The low-pressure systems are responsible for tropical cyclones which bring heavy rain to inland parts of the Pilbara, and protracted rainfall is occasionally observed.

Annual temperature trends observed in the Pilbara region show the most range between maximum and minimum values during winter months, with the highest summer maximum usually recorded in November. Summer temperatures regularly exceed 35°C, with maximums above 40°C often recorded.

Rainfall and temperature data utilised for the progressive rehabilitation monitoring program is sourced from nearby Bureau of Meteorology (BOM) certified weather stations and stations established within the relevant Rio mine site closure boundary. Rio Tinto weather stations are used to provide monthly localised data, with long-term averages sourced from BOM weather stations.

The nearest certified meteorological station to Brockman Operations is Paraburdoo Aero (BOM Station 007185) located approximately 80 km to the south-east of the closure boundary. Climatic data gathered from Station 007185 has been captured since 1974 and is comparable to an automatic weather station located at B2N (installed in 1998). As such, climatic data obtained from Paraburdoo Aero is considered representative of that experienced across B2N, BS4 and SGE.

A weather station also exists at BS4, providing local monthly climatic data for progressive rehabilitation sites within the area. In addition to Paraburdoo Aero, long-term data utilised for BS4 sites is sourced from the Hamersley weather station (BOM station 005005), located approximately 112 km south-east of the closure boundary.

Climate change

Climate change is a complex issue, with inherent uncertainty about the timing, pace, and severity of possible impacts. Risks from climate change to the stability of landforms, mobilisation of contaminants and revegetation are some of the identified vulnerabilities that have been considered in closure planning.

Based on climate change projections rainfall reduction will be relatively small in the Pilbara. However, the sensitivity of hydrological processes to small changes in rainfall coupled with the expected rise in temperatures (particularly during winter months, which may impact monitoring schedule and design) and potential evaporation will have a large impact on the hydrology of the Pilbara region (Charles et al., 2015). The materialisation of these climate projections is likely to make successful rehabilitation in the Pilbara more challenging.

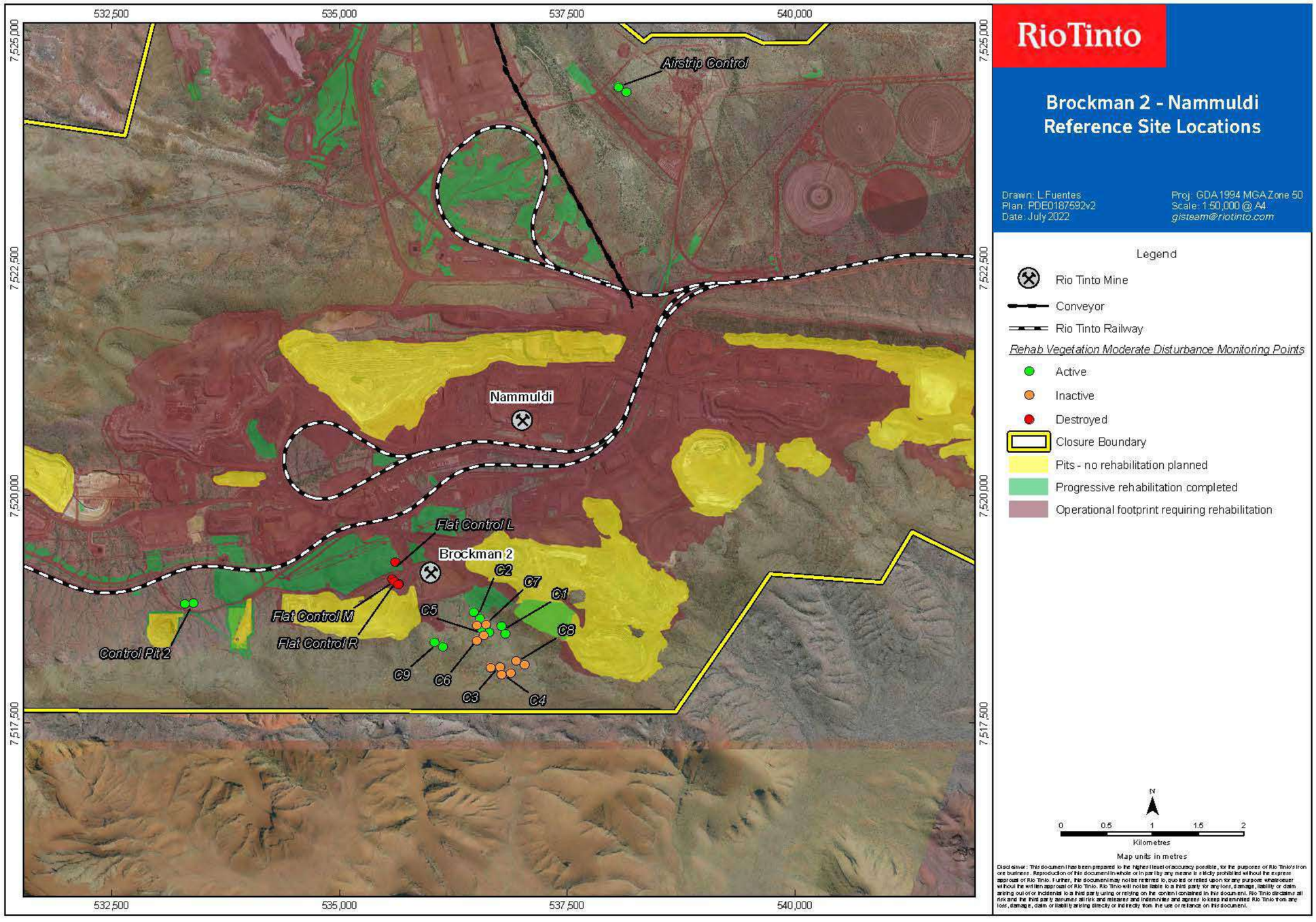


Figure 6: B2N reference sites locations.

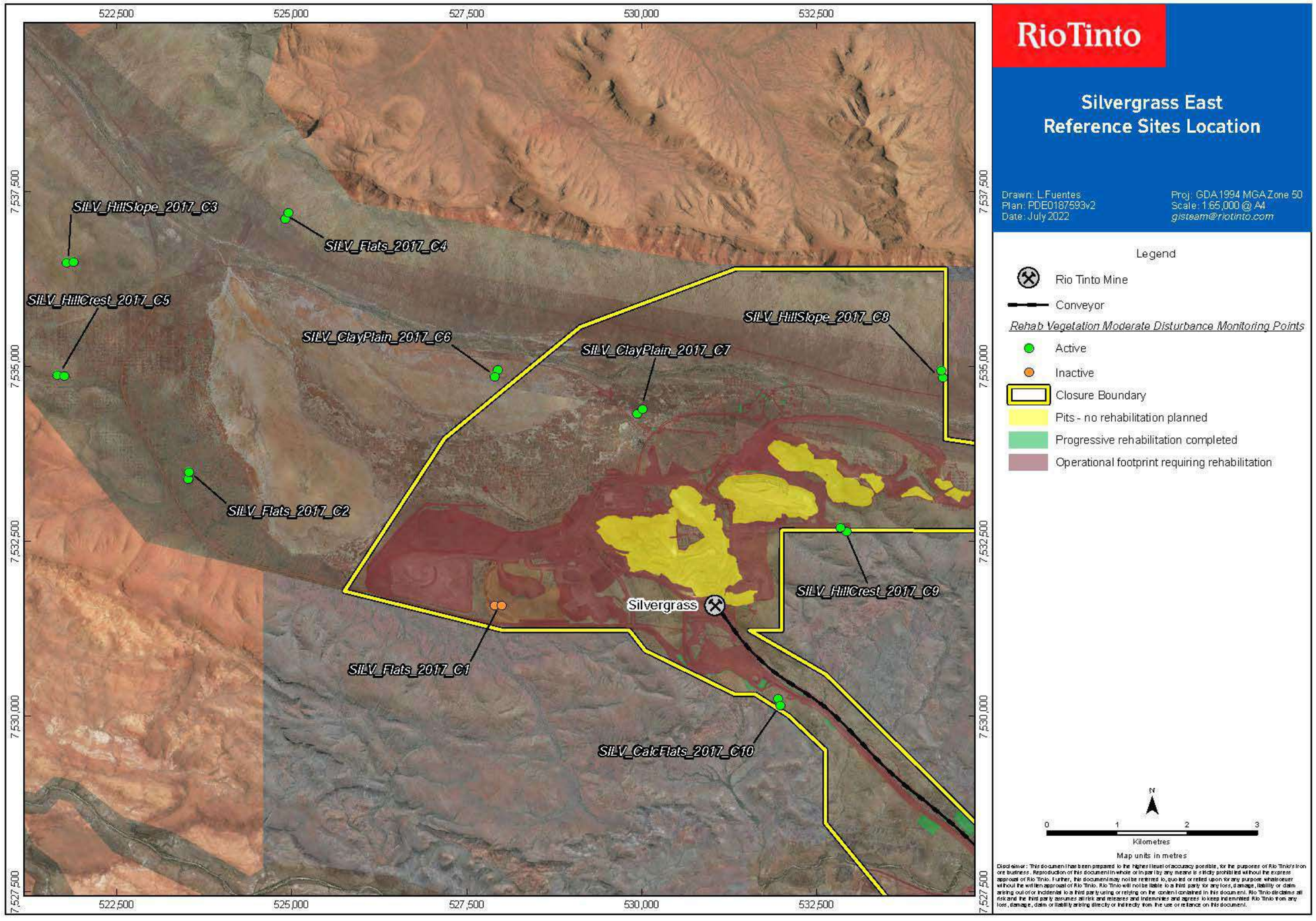


Figure 7: SGE reference sites locations.

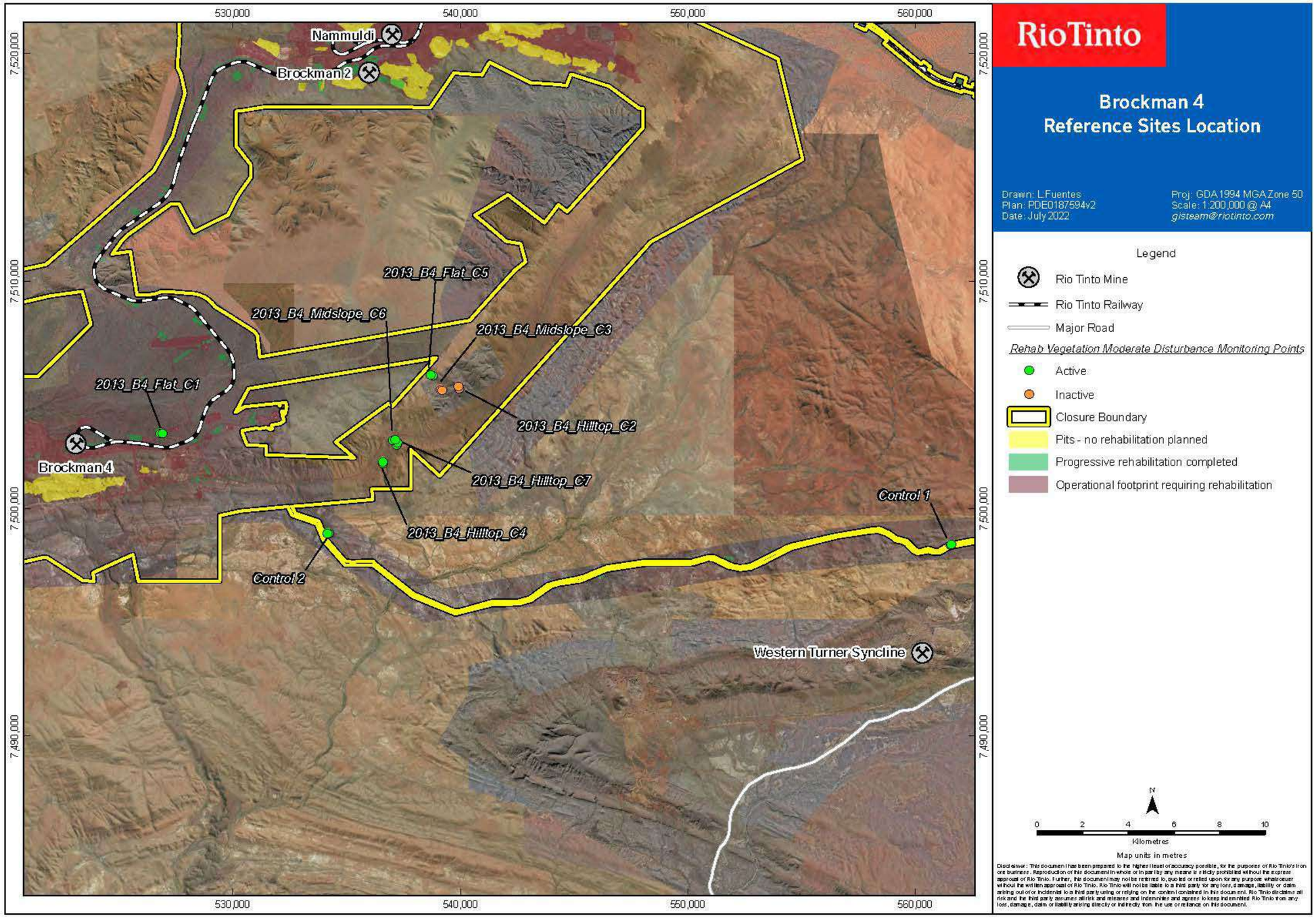


Figure 8: BS4 reference sites locations.

5. SUMMARY OF REHABILITATION PERFORMANCE

Examples of monitoring outcomes of key rehabilitation areas at within the Brockman Operation closure boundary provide contemporary scientific evidence of the success of rehabilitation undertaken to date in the area. Summaries of key rehabilitation areas within the Brockman Operation closure boundary are outlined in the Brockman Operation 2022 MCP.

Interpretations and analyses of rehabilitation monitoring results were limited to a moderate extent by deficiencies in pre-2010 records of rehabilitation methodology. For example, the use of ameliorant was rarely documented so any potential correlation with successful rehabilitation outcomes will not be evident. Data and document management is currently undergoing a significant upgrade to alleviate the issue. Detailed close-out reports will be completed for all future rehabilitation works, following a standardised approach which utilises up-to-date databases and document control methods.

5.1. Rainfall

The rainfall distribution typically experienced across Brockman Operations is bimodal, peaking in December to February and May to June, resulting from the influence by two main climatic systems:

1. The northern rainfall system of tropical origin.
2. The southern winter rainfall associated with low-pressure frontal systems.

This is demonstrated in Figure 9 which shows that the highest average monthly rainfall recorded at BOM station 007185 (from 1974 to 2020) was received in January and February. The long-term annual average rainfall during this period was 323 mm/year, with the least rainfall received in September and October. Monthly rainfall during December to February ranged from 27-75 mm whilst monthly rainfall during September to November ranged between four and ten mm.

The monthly rainfall (mm) for B2N and BS4 is presented in Figure 10. The rainfall data was sourced from the B2N and BS4 weather stations, with long-term data sourced from the Hamersley weather station (005005) (BOM 2021).

Rainfall in 2009 and 2010 was well below average, with the B2N weather station recording less than one fifth and less than one third of the long-term annual average respectively. The prolonged dry conditions may have hindered initial germination and plant establishment at BP293, where rehabilitation works were conducted in 2009. Rainfall received following the 2014 rehabilitation of Nammuldi ANFO, BWT HV and Rail Loop borrow pits was close to the annual average of 385 mm (005005 BOM 2021), so it is unlikely that initial germination and establishment were adversely affected at these sites.

Monthly rainfall across BS4 was close to or above average between January 2015 and March 2017, likely resulting in good conditions for seed germination and plant growth at BS4 Fuel Hub and Boolgeeda Aerodrome rehabilitation sites where works were completed in 2012 / 2013.

Rainfall was generally below average between 2017 and 2020, with particularly low levels recorded at BS4 throughout 2018 and 2019. The lack of wet season rainfall during both the 2017/2018 and 2018/2019 wet seasons may have inhibited initial seed germination and survival on newer rehabilitation areas such as the B2N to BS4 Access Road and the Boolgeeda Camp (rehabilitated in 2015 and 2018 respectively).

The unfavourably dry conditions throughout 2018 (only 150 mm rainfall received) may have impacted seed germination and plant establishment at the Pit 6 waste dump site which was rehabilitated the previous year. The South POD waste dumps may have also been adversely affected by low rainfall which was recorded from the time of rehabilitation completion (December 2018) to the time of the 2020 assessment.

Substantial rainfall, significantly above the monthly average, was recorded in February 2020, with over 200 mm received. This was likely to have created favourable conditions for seed germination and plant

growth on sites where rehabilitation was completed in 2019 and 2020, such as BS4 DP1 and DP4 waste dumps. However, the atypically high rainfall may also have led to increased erosion on the newly rehabilitated waste dumps, resulting in a substantial number of gullies recorded.

5.2. Temperature

Areas within the Brockman Operation closure boundary generally experience maximum average temperatures from November to March, with the Paraburdoo Aero station (007185) recording maximums between 35°C and 41°C and minimums of 20°C to 26°C during these months (Figure 9). The coolest temperatures were recorded between June and August, with an average maximum of 25°C and an average minimum of 10°C.

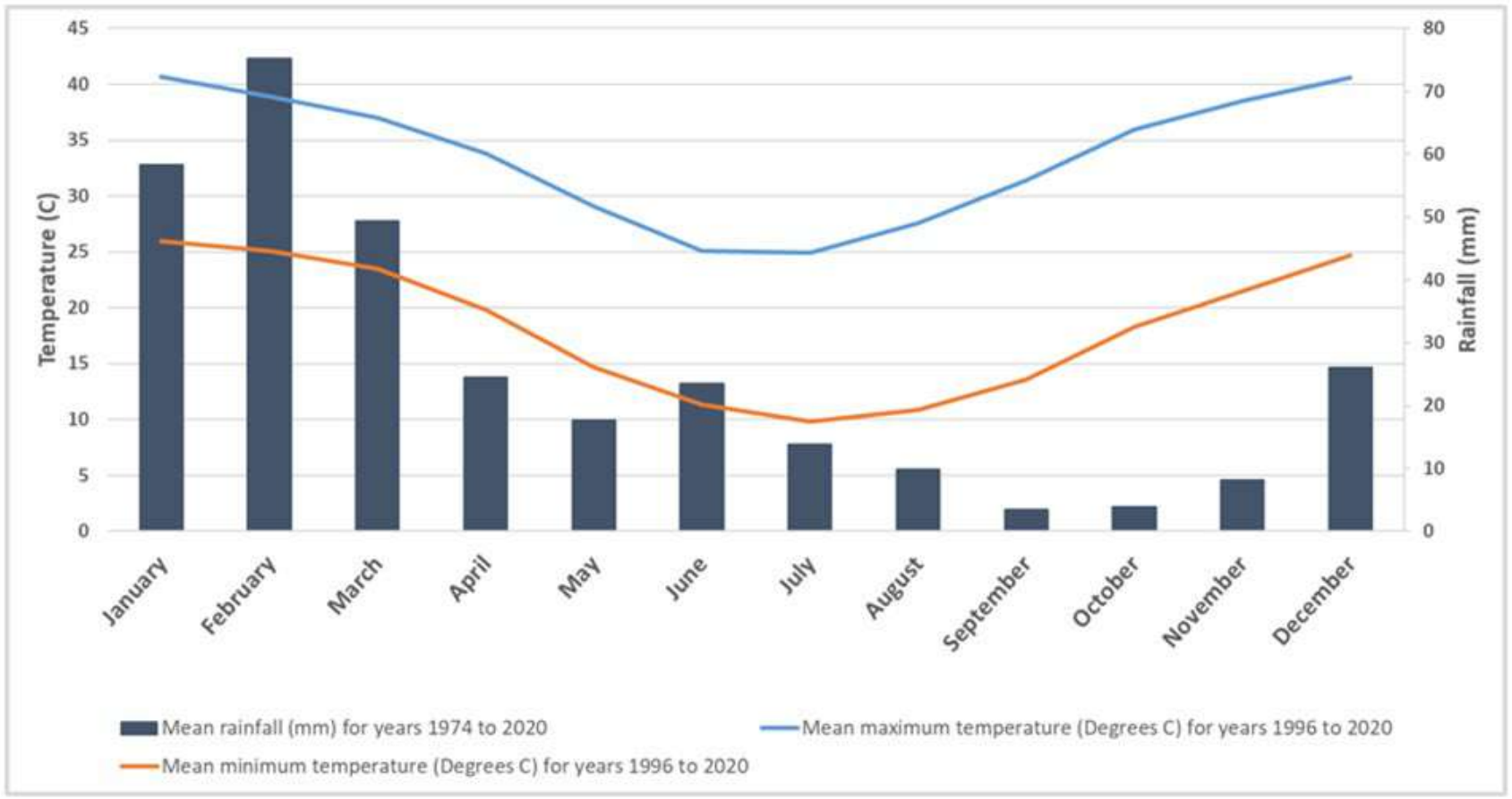


Figure 9: Long-term average monthly rainfall and maximum and minimum temperatures for Paraburdoo Aero station 007185.

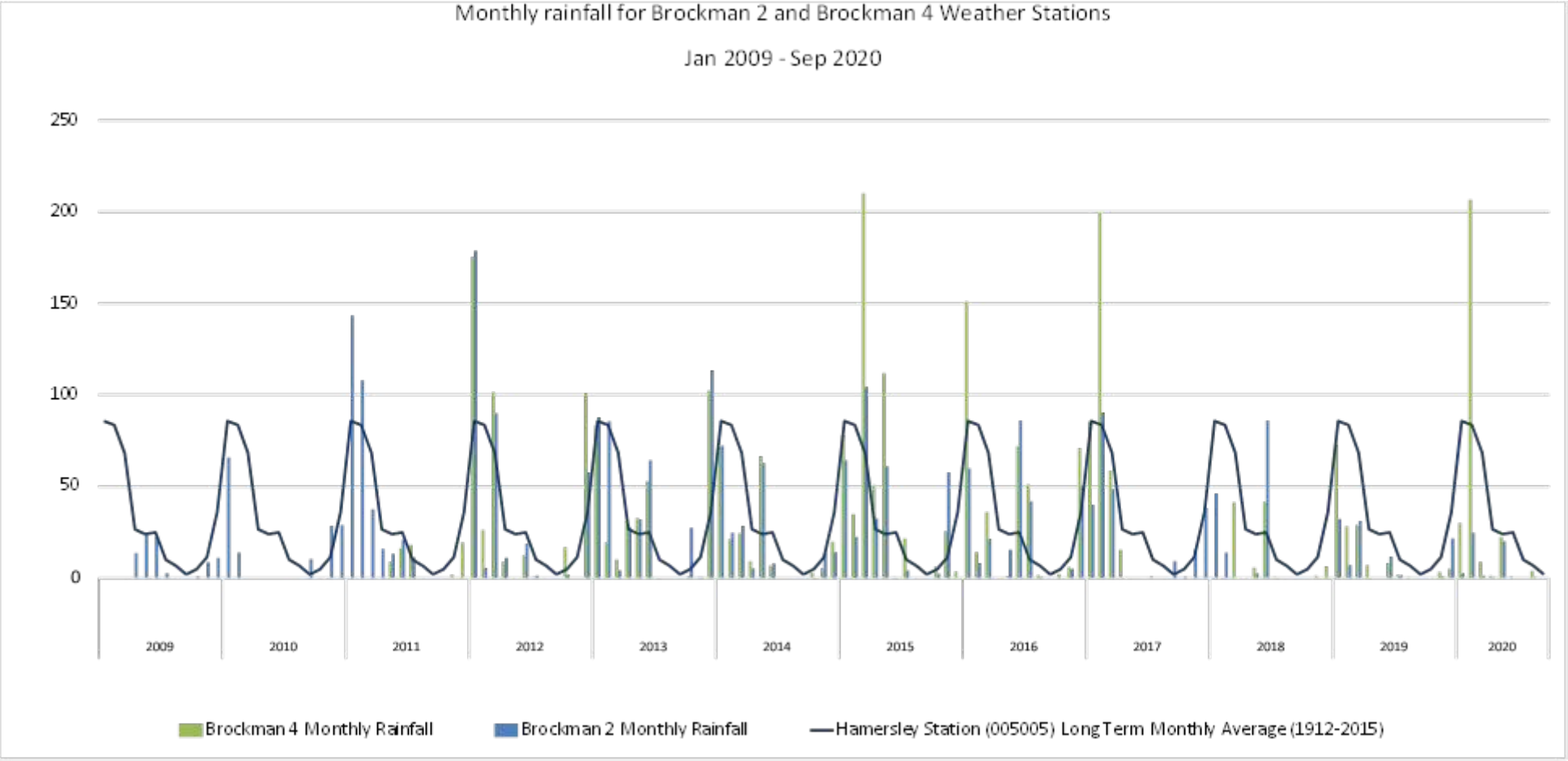


Figure 10: Brockman 4 and Brockman 2 monthly rainfall from January 2009 to September 2020, with long-term monthly average from Hamersley Station (1912-2015).

5.3. Fire

Obtaining a comprehensive understanding of vegetation parameter dynamics in post-fire communities is highly valuable for rehabilitation in Western Australia due to the climate-induced, increasing prevalence of fire. The parallels observed between vegetation parameter trends at early rehabilitation sites and at burnt sites are also cause for furthering the current knowledge base on fire-affected communities, and to facilitate this, exploring the potential for undertaking additional monitoring at burnt sites.

As fire is a natural and common occurrence in Pilbara ecosystems, vegetation quadrat data obtained from burnt reference sites can still facilitate meaningful comparisons on the premise that the trends observed reflect a vegetation community in post-fire recovery, and do not represent the target community for rehabilitation. An overview of reference sites impacted by fire within the Brockman Operation closure boundary is provided in Table 5. Transect 274_Rehab_L was the only rehabilitation transect to be affected by fire.

Table 5: Overview of burnt rehabilitation and reference sites.

REFERENCE SITE	MONITORING YEARS BETWEEN WHICH BURNING OCCURRED	PERCENTAGE OF QUADRATS BURNT
BR4_Flat_C5	2018 and 2020	30%
BR4 *Control 1*	2017 and2018	100%
274_Control_R	2002 and 2003	Unknown
274_Control_M	2002 and 2003	Unknown
C1	2012 and 2014	100%
C2	2012 and 2014	30%
C5	2012 and 2014	100%
C9	2012 and 2013	100%

5.4. Low impact disturbance areas

Rehabilitation works were undertaken at a small number of sites categorised as low impact disturbance at B2N and SGE. Low impact disturbance areas designated for rehabilitation are monitored with the RQA method. This Summary focuses on vegetation quadrat monitoring data (typically used for moderate and high disturbance) as it provides greater analytic value for informing rehabilitation methodology. For this reason, no low impact disturbance areas have been included in this Summary.

5.5. Moderate impact disturbance areas – borrow pits

Available rehabilitation and monitoring data for Brockman Operation borrow pits is summarised in Table 7 - Table 9 to provide a general indication of borrow pit rehabilitation performance to date. Ultimately, this will help inform methodology for future rehabilitation efforts, facilitate an increasing assurance in successful outcomes for rehabilitation, for example, through an enhanced risk management process resulting in less requirements for rework. Strategies and design parameters can be refined through the continual input of new data, facilitating a continually growing confidence in the chosen methodology for borrow pit rehabilitation.

Table 6: Brockman Operation borrow pits rehabilitation overview.

REHABILITATION PARAMETER	SITE							TOTAL
	Nammuldi Rail Loop and BWT HV Borrow Pits	Nammuldi ANFO Facility Borrow Pits	B2N 1991 Borrow Pits	B2N Borrow Pit 293	B2N to BS4 Access Rd Borrow Pits	BS4 Borrow Pits	White Quartz Rd Borrow Pits	
# Active transects (monitored)	5	3	2	1	4	4	3	27
Year of rehab	2014	2014	1991	2009	2015	2009	2009	-
Growth medium	Topsoil	Topsoil	Unknown	Topsoil	Topsoil	Topsoil	Topsoil	-
Depth of growth medium application (mm)	200 mm	Unknown	Unknown	Unknown	100-150 mm	Unknown	Unknown	-
Time of storage of growth medium (yr)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	-
Seeding mix	N/A	N/A	Unknown	N/A	Some borrow pits seeded but not assessed in 2020	N/a	N/A	-
Seeding rate (kg/ha)	0	0	Unknown	0	Unknown	0	0	-
Soil ameliorant (type)	N/A	Unknown	Unknown	Unknown	Unknown	N/A	N/A	-
Rate of application of ameliorant (kg/ha)	0	Unknown	Unknown	Unknown	Unknown	0	0	-
Contour ripping (depth)	Yes (unknown)	Yes (unknown)	Unknown	Yes (unknown)	Yes (200 mm)	Yes (unknown)	Yes (unknown)	-
Ripping (width)	Unknown	Yes (unknown)	Unknown	Unknown	Unknown	Unknown	Unknown	-

Table 7: Brockman Operation borrow pit rehabilitation and reference sites monitoring overview.

MONITORING	SITE							TOTAL / RANGE
	Nammuldi Rail Loop and Nammuldi BWT HV Borrow Pits	**Nammuldi ANFO Facility Borrow Pits**	**BR2 258 Control L BR2 274 Control M BR2 Airstrip Control**	**B2N 1991 Borrow Pits**	**BR2 258 Control L, M and R BR2 258 Control M and R**	**B2 Borrow Pit 293**	**BR4 Flat C1 and Flat C5 2013 BR2 C1 and C2**	
Year rehabilitation completed / year reference site established	2014	2014	1997 / 2012 (Airstrip Control)	1991	1997	2009	2013 (BR4 controls) / 2009	-
Year of latest available monitoring summary	2020	2020	2020	2019	2019	2020	2020 (BR4 controls) / 2019	
Number of transects monitored	5	3	3	2	5	1	4	24 transects
Range of species richness values	4 to 9 species	1 to 4 species	4 to 12 species	7 to 11 species	6 to 8 species	9 species	3 to 10 species	1 to 19 species
Range of species density values	0.3 to 2.0 species per quadrat	0.1 to 0.5 species per quadrat	1.1 to 2.0 species per quadrat	1.2 to 1.8 species per quadrat	1.4 to 1.5 species per quadrat	1.2 species per quadrat	1.1 to 3 species per quadrat	0.1 to 3.7 species per quadrat
Range of plant density values	0.3 to 6.5 plants per quadrat	0.2 to 0.6 plants per quadrat	6.2 to 9.7 plants per quadrat	3.5 to 6.4 plants per quadrat	3.3 to 4.4 plants per quadrat	4.7 plants per quadrat	4.5 to 12.0 plants per quadrat	0.2 to 20.1 plants per quadrat
Range of spinifex density values	0 to 0.5 *Triodia* plants per quadrat	0 to 0.5 *Triodia* plants per quadrat	2.2 to 6.3 *Triodia* plants per quadrat	2.7 to 5.4 *Triodia* plants per quadrat	2.5 to 2.9 *Triodia* plants per quadrat	3.9 *Triodia* plants per quadrat	4.4 to 10.0 *Triodia* plants per quadrat	0 to 18.5 *Triodia* plants per quadrat
Range of total cover values (%)	4-38%	5 to 18%	13 to 36%	38 to 39%	41 to 48%	36%	38 to 64%	4 to 46%

MONITORING	SITE							TOTAL / RANGE
	Nammuldi Rail Loop and Nammuldi BWT HV Borrow Pits	Nammuldi ANFO Facility Borrow Pits	BR2 258 Control L BR2 274 Control M BR2 Airstrip Control	B2N 1991 Borrow Pits	BR2 258 Control L, M and R BR2 258 Control M and R	B2 Borrow Pit 293	BR4 Flat C1 and Flat C5 2013 BR2 C1 and C2	
Range of spinifex cover values (%)	0 to 5.9%	0 to 5.4%	7.8 to 30%	29.7 to 30.0%	27.9 to 41.9	20%	31.0 to 55.3%	0 to 43%
Range of weed cover values (%)	0	0	0 to 0.1%	0 to 1.2%	0 to 0.8%	0	0.2 to 0.4	0.1 to 3%
Range of weed density values	0	0	0 to 0.1	0 to 0.55	0 to 0.15	0	0.1 to 0.2	0.2 to 0.5
Range of percentages of quadrats with weeds present	0	0	0 to 5%	0 to 35	0 to 5%	0	0 to 5%	0 to 50%
Range of percentages of quadrats with annuals present	5 to 80%	0 to 55%	5 to 50%	0**	0	10%	0 to 55%	0 to 100%
Range of # of species flowering / fruiting (inc. walk-around assessment)	3 to 4 flowering / fruiting species	3 to 6 flowering / fruiting species	1 to 4 flowering / fruiting species*	1 to 2 flowering / fruiting species**	0 to 3 flowering / fruiting species*	6 flowering / fruiting species	0 to 5 flowering / fruiting species*	0 to 11 flowering / fruiting species
Erosion (number of gullies)	0 gullies	0 gullies	0 gullies	0 gullies	0 gullies	0 gullies	1 gully (stable, at C2)	0 to 1 gully

***significantly higher values recorded during previous assessment*

(85% quadrats with annuals; 21 to 22 flowering / fruiting species)

Table 8: Brockman Operation borrow pit rehabilitation and reference sites monitoring overview (continued).

MONITORING	SITE				TOTAL / RANGE
	B2N to-BS4 Access Rd Borrow Pits	**BS4 Borrow Pits**	**White Quartz Rd Borrow Pits**	**BR4 Control 1* and 2 BR4 Flat C1 and C5**	
Year rehabilitation completed / year reference site established	2015	2009	2009	2011 (Control 1 and 2) / 2013	-
Year of latest available monitoring summary	2020	2020	2020	2020	
Number of transects monitored	4	4	3	4	19 transects
Range of species richness values	6 to 15 species	4 to 16 species	5 to 9 species	3 to 10	1 to 16 species
Range of species density values	1.4 to 2.3 species per quadrat	0.4 to 3.7 species per quadrat	1.1 to 1.5 species per quadrat	1.1 to 5.0	0.1 to 5.0 species per quadrat
Range of plant density values	2.3 to 6.2 plants per quadrat	0.9 to 20.1 plants per quadrat	1.6 to 4.5 plants per quadrat	4.5 to 39.8	0.2 to 39.8 plants per quadrat
Range of spinifex density values	1.1 to 5.8 *Triodia* plants per quadrat	0.2 to 18.5 *Triodia* plants per quadrat	0.2 to 3.7 *Triodia* plants per quadrat	4.3 to 26.0	0 to 26 *Triodia* plants per quadrat
Range of total cover values (%)	25 to 38%	12 to 39%	13 to 46%	40 to 64%	4 to 64%
Range of spinifex cover values (%)	11 to 28%	3 to 20%	3 to 43%	31 to 43%	0 to 43%
Range of weed cover values (%)	0	0	0 to 3%	0 to 0.4%	0 to 3%
Range of weed density values	0	0	0 to 2.4	0 to 0.2	0 to 0.5

MONITORING	SITE				TOTAL / RANGE
	B2N to-BS4 Access Rd Borrow Pits	BS4 Borrow Pits	White Quartz Rd Borrow Pits	BR4 Control 1* and 2 BR4 Flat C1 and C5	
Range of percentages of quadrats with weeds present	0	0	0 to 50%	0 to 5%	0 to 50%
Range of percentages of quadrats with annuals present	0 to 55%	60 to 100%	10 to 60%	5 to 55%	0 to 100%
Range of # of species flowering / fruiting (inc. walk-around assessment)	0 to 10 flowering / fruiting species	2 to 9 flowering / fruiting species	3 to 11 flowering / fruiting species	0 to 5 flowering / fruiting species	0 to 11 flowering / fruiting species
Erosion (number of gullies)	0 gullies	0 gullies	0 gullies	0 gullies	0 gullies

**Control 1 omitted for Access Road borrow pits as they were rehabilitated just prior to the site being burnt, and because only two monitoring events were conducted at Control 1 during the monitoring period for the Access Rd borrow pits (between 2016 and 2020).*

5.5.1. Nammuldi Rail Loop and BWT HV borrow pits

Rehabilitation of the Nammuldi Rail Loop and BWT HV borrow pits was undertaken in 2014, with monitoring first conducted in 2016. Methodology details of the Nammuldi BWT HV rehabilitation are unavailable but field observations suggest that the area was scarified. It is also presumed that the site received topsoil, applied to a minimum depth of 200 mm as documented for the Rail Loop borrow pits. Seeding was not performed at either site.

Monitoring results for the Nammuldi borrow pits indicate the variability of rehabilitation outcomes that can occur across a single site, advocating the importance of installing multiple rehabilitation transects. Four years post-rehabilitation Rail Loop transects T1 and T3 achieved similar values to the reference sites in all three parameters, with higher values recorded at T1. However, spinifex density was markedly lower at all three Rail Loop transects than the reference sites, with the latest assessment recording no spinifex at T2 or T3. Low plant density values were also recorded at these two transects in 2020, having declined from the previous monitoring assessment, contrast to the inclining trend observed at T1.

Vegetation parameter values recorded at Rail loop_T2 were not approaching those of the reference sites, and no improvement was recorded in any parameter over the four years. However, Figure 11 and Figure 12 indicate that two years after rehabilitation some vegetation had established at T2. Considering the promising results observed at T1 and T3, the rehabilitation performance of T2 is not representative of the overall outcome of the Nammuldi Rail Loop borrow pits rehabilitation.

Areas where monitoring results indicate poor outcomes should be inspected to determine if further works, such as ripping and seeding, are required in the future. A rehabilitation performance framework is to be developed to improve facilitation of inclusion of remedial works into the annual rehabilitation planning (Section 6.1).

The Nammuldi BWT HV borrow pit rehabilitation sites followed similar unsatisfactory trajectories (below reference site values) to Rail Loop T2 in plant and species density but achieved similar or higher values to the reference sites in species richness and plant cover. Although total plant cover between the rehabilitation and reference sites was similar, the vegetation at the rehabilitation transects consisted of a higher proportion of shrub cover and lower proportion of *Triodia* cover. In addition to species density and plant density, substantially lower spinifex density values were documented across the BWT HV rehabilitation compared to the reference sites, with little change recorded over the duration of monitoring. Given the relatively mature age of the rehabilitation, further improvement in these parameters is unlikely.



Figure 11: BR2_Nammuldi_Railloop_T2_2016 (start) 2016.



Figure 12: BR2_Nammuldi_Railloop_T2_2016 (start) 2018.

Native perennial species density and richness

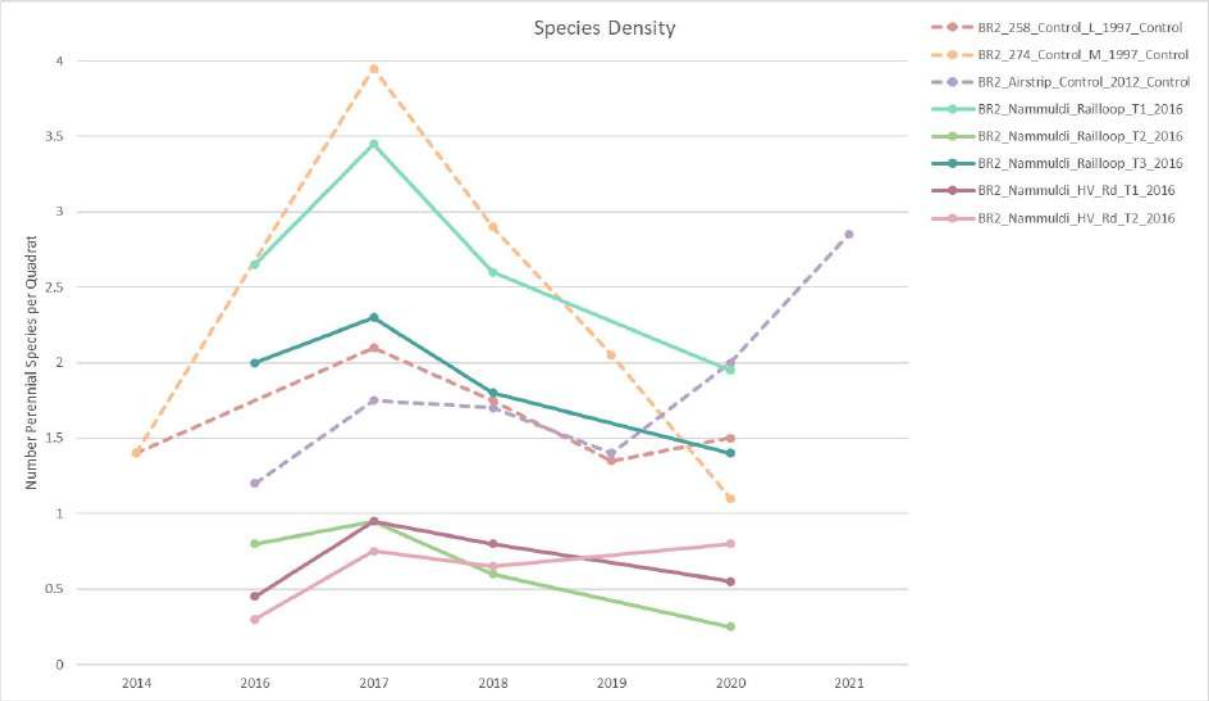


Figure 13: Native perennial species density (species / quadrat) for the Nammuldi Rail Loop and BWT HV Road borrow pit rehabilitation and reference sites over time.

In 2020, the number of native perennial species observed across the Rail Loop and BWT HV Road rehabilitation sites ranged from four to nine, compared to four to 12 at the reference sites (Table 7). Species richness decreased at all five rehabilitation transects between the last two monitoring assessments, with a loss of four recorded at all three Rail Loop transects and HV_Rd_T2. Variable changes in species richness occurred over this period at the reference transects.

Declining trends were also recorded for species density between 2018 and 2020 at the Rail Loop transects and HV_Rd_T1 (Figure 13). The number of perennial species per quadrat at Railloop_T1 and T3 in 2020 was within the reference site range, whilst Railloop_T2 and the two HV_Rd transects had less than one species per quadrat. Multivariate analysis found a significant difference between species density at Rail Loop T2 and the reference sites. The lowest reference value was recorded at 274_Control_M which can be attributed to the site being in post-fire recovery. Below average rainfall may also account for decreases in species density observed between 2018 and 2020.

When walk-around assessment results are included, the total species count across the rehabilitation in 2020 ranged from 10 to 16 compared to the 19 to 20 observed at the reference sites. Species recorded on the rehabilitation that were also present on at least one reference site included *Acacia ancistrocarpa*, *Acacia bivenosa*, *Corchorus lasiocarpus* subsp. *parvus*, *Indigofera monophyla* and *Triodia epactia*.

Native perennial plant density

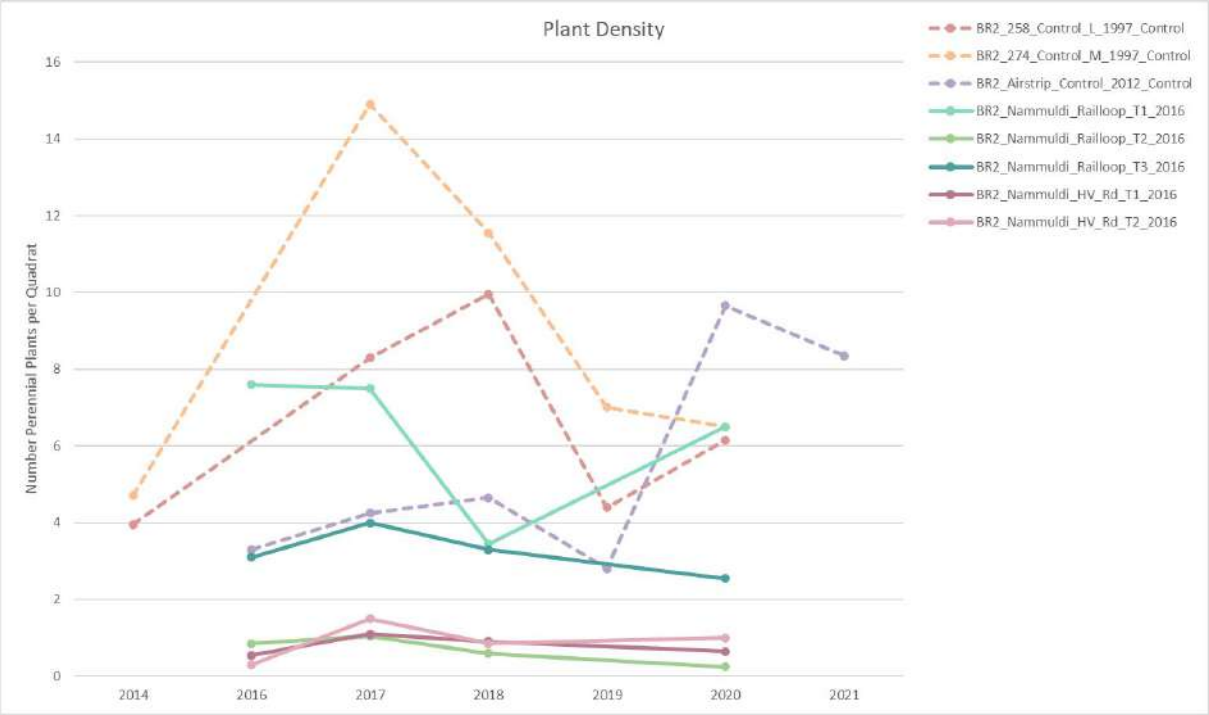


Figure 14: Native perennial plant density (plants / quadrat) for the Nammuldi Rail Loop and HV Road borrow pit rehabilitation and reference sites over time.

Rail Loop rehabilitation transects 1 and 3 followed plant density trajectories of a more satisfactory quality than T2 and both HV Road transects which all remained under two plants per quadrat for the entire monitoring period (Figure 14). Rail Loop T1 maintained highest similarity with to plant density at the reference sites in all monitoring years, with Rail Loop T3 having similar similarity in 2018.

All five rehabilitation sites recorded their highest number of plants per quadrat in 2017, with an even higher values recorded at 274 Control M and 258 Control L. Plant density at these two reference sites declined substantially the over the next two years, which may have been a result of the below average rainfall received in 2018 and 2019 (Figure 10). This is maintained by the moderate declines observed at four rehabilitation transects between the 2018 and 2020 assessments. Rail Loop T1 was the only rehabilitation transect to increase in plant density during these years, with the resulting value for plant density being the only rehabilitation parameter to fall within the range of reference site values.

Native perennial plant cover

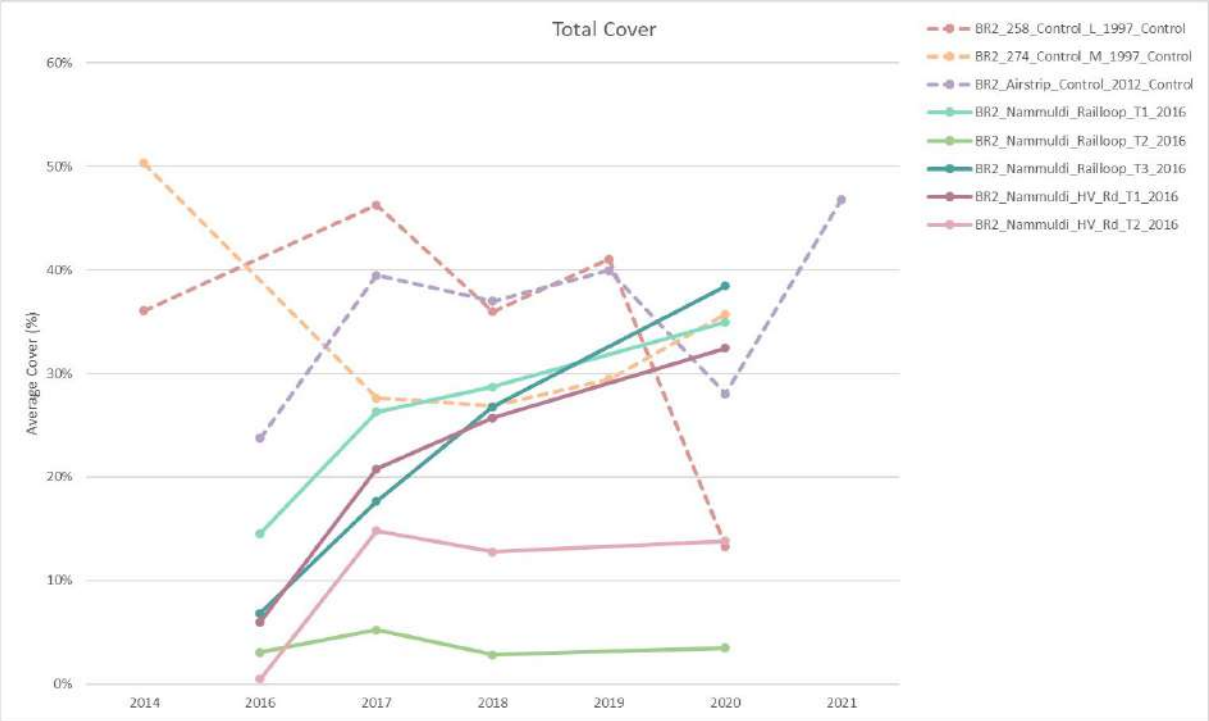


Figure 15: Native perennial plant cover (%) for the Nammuldi Rail Loop and HV Road borrow pit rehabilitation and reference sites over time.

Plant cover at three rehabilitation transects (Railloop T1 and T3, HV Rd T1) follow encouraging trajectories over the duration of monitoring, with Railloop_T3 achieving almost 40% plant cover by 2020. All three transects exhibit similar or higher cover than the 13% to 36% observed at the reference sites in 2020 (Figure 15). The least amount of cover observed during the 2020 monitoring assessment was approximately 4%, seen at Railloop_T2. The sharp decline observed at reference site 258 Control L between 2019 and 2020 was largely attributed to a decline in cover of *Acacia aptaneura* and senescence of *Triodia epactia*. Declining cover of *A. aptaneura* also contributed to the less severe decrease in plant cover at Airstrip Control. It is most likely that losses in cover / senescence of these species was a result of below average rainfall received in 2018 and 2019.

5.5.2. Nammuldi ANFO Facility borrow pits

The Nammuldi ANFO rehabilitation was completed in 2014, and included topsoil application and ripping, although no seed was applied (Table 6). The area is represented by three flat 100 m transects, all of which have not been burnt since monitoring began in 2018.

Six years after rehabilitation, the ANFO Facility borrow pits were performing poorly, with the last assessment documenting values below the corresponding reference sites for most vegetation parameters. Plant cover was the only vegetation parameter which had shown some improvement at all rehabilitation transects. Spinifex density had not improved since monitoring began and was less than one plant per quadrat at all rehabilitation sites, which was substantially lower than the range of the reference sites.

Native perennial species density and richness

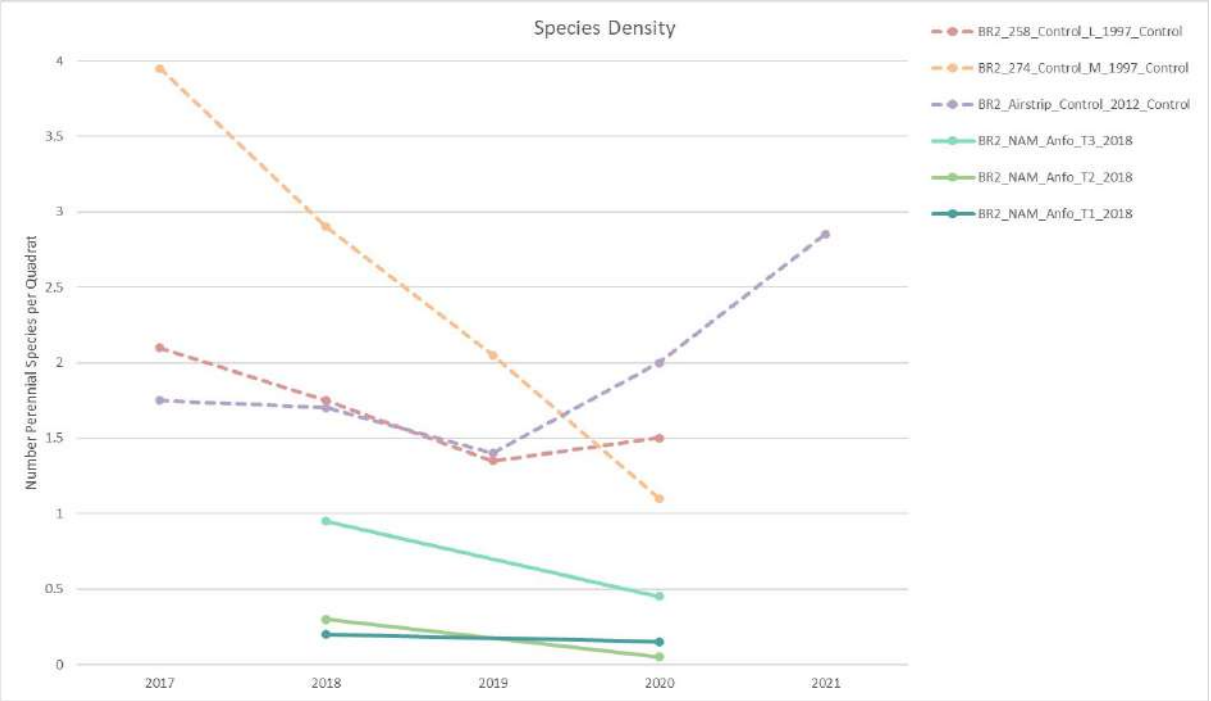


Figure 16: Native perennial species density (species / quadrat) for the Nammuldi ANFO Facility borrow pit rehabilitation and reference sites over time.

Species richness observed across the rehabilitation sites ranged from one at ANFO_T2 to four at ANFO_T3, whilst reference sites ranged from nine to 12 species (Table 6). Slightly higher species counts were documented when results from the walk-around assessments are included (seven to 10 across rehabilitation compared to 19 to 20 at reference sites). Several species were present on at least one reference site and one rehabilitation site, including *Acacia bivenosa*, *Acacia pruinocarpa* and *Triodia epactia*.

Species density declined at two of the ANFO rehabilitation transects (T2 and T3) between the two monitored assessments, whilst remaining constant at the other (T1) (Figure 16). Reference sites 258 Control L and Airstrip Control show both declining and increasing trends during this time as they were monitored during all three years. 274 Control M lost the greatest number of species per quadrat, declining from 2.9 in 2018 to 1.1 in 2020. The rehabilitation transects had significantly lower species density than each reference site, except ANFO_T3, which achieved comparability to reference site 274 Control M.

Native perennial plant density

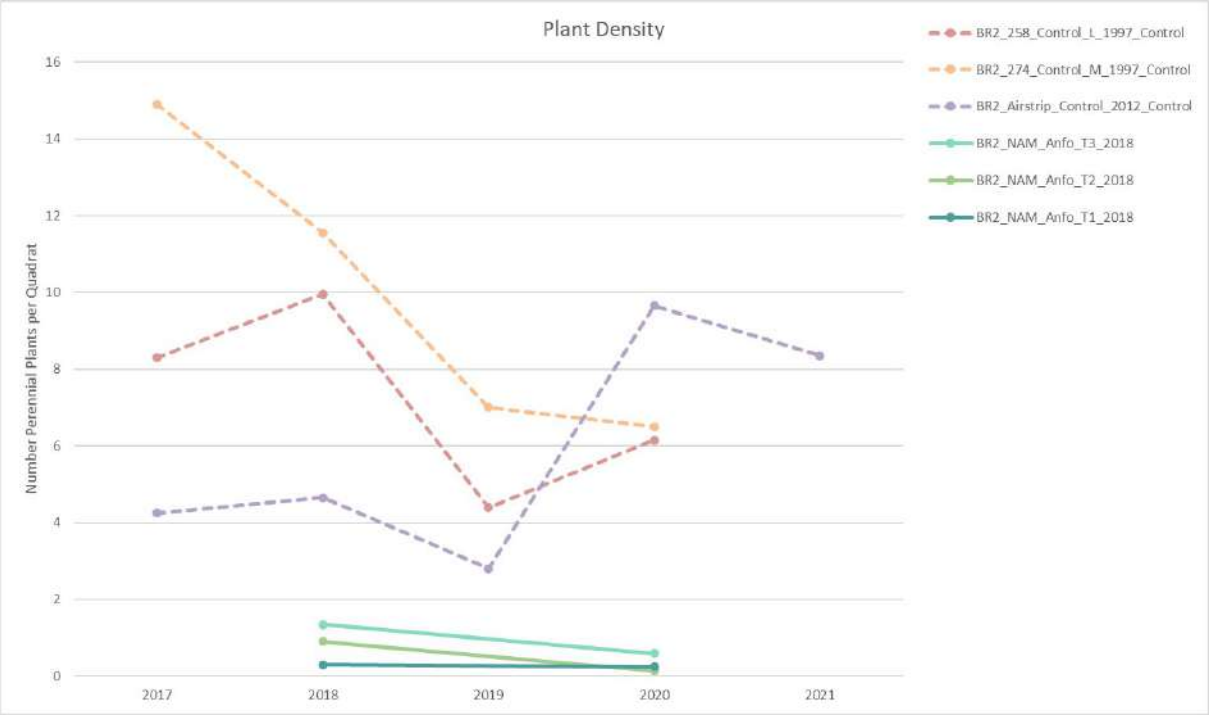


Figure 17: Native perennial species density (species / quadrat) for the Nammuldi ANFO Facility Road borrow pit rehabilitation and reference sites over time.

Plant density trajectories for the rehabilitation sites reflect those observed for species density, with declining trends observed at ANFO_T2 and T3 and no change occurring at T1 (Figure 17). In 2020, plant density at all three rehabilitation transects was significantly lower than the reference sites. Over the monitoring period, plant density decreased substantially at the two 1997 controls, whilst an equally substantial increase (of five plants per quadrat) occurred at the Airstrip Control. Below average rainfall may account for some of the declining trends observed, particularly at the reference sites where senescence of long-established herbaceous species results in a more prominent decline.

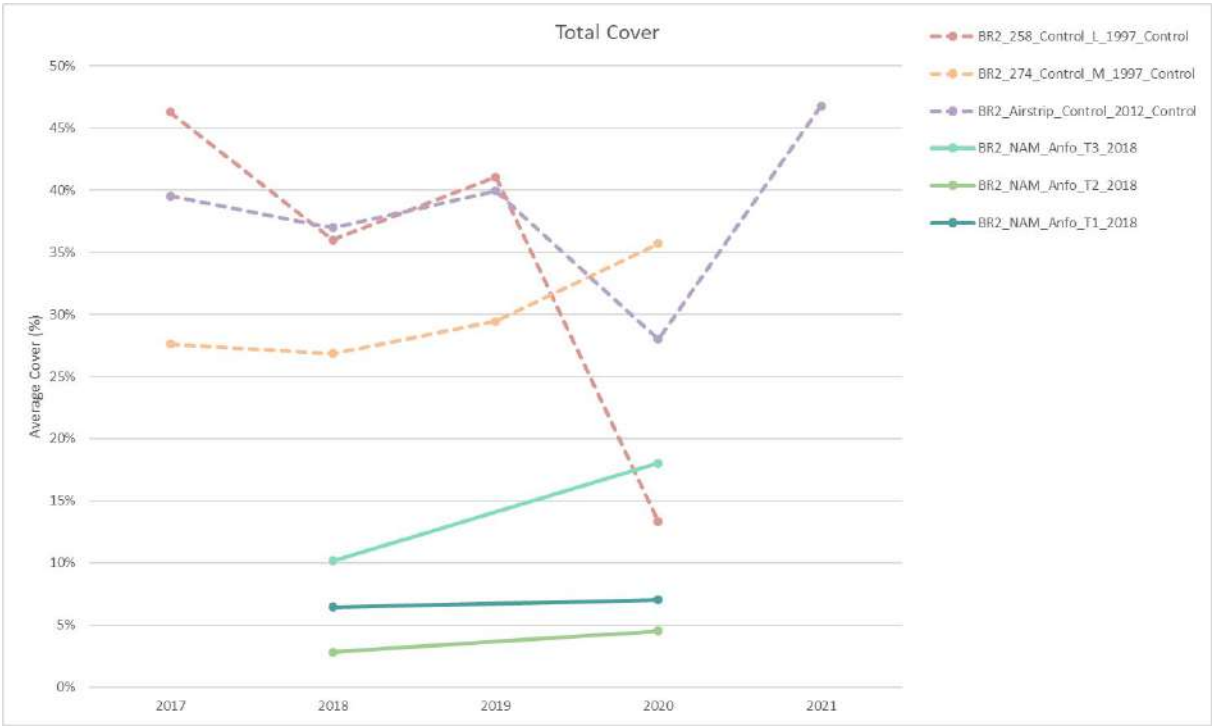


Figure 18: Native perennial plant cover (%) for the Nammuldi ANFO Facility borrow pit rehabilitation and reference sites over time.

Plant cover on rehabilitation transect ANFO_T3 improved substantially over the duration of monitoring, whilst there were no notable changes in cover at ANFO_T1 and ANFO_T2 (Figure 18). Cover increased slightly at reference site 274 Control M and decreased substantially at reference sites, 258 Control L and Airstrip Control. As previously noted, the declining trends observed at the reference sites was mostly attributed to below average rainfall recorded in 2018 and 2019. The increase in cover at 274 Control M may be attributed to a very gradual post-fire recovery, as although it was over a decade since the site was burnt, cover had still not returned to pre-fire values. No significant differences in plant cover values were found between the rehabilitation transects and reference sites 258 Control L and Airstrip Control in 2020, whilst ANFO T1 and T2 had significantly lower values than 258 Control L.

5.5.3. B2N 1991 borrow pits

Two borrow pit sites at BS2 (258 Rehab and 274 Rehab) were rehabilitated in 1991. Given the age of the rehabilitation, records containing methodology parameters are unknown (Table 6). Visual observation indicates contour ripping was conducted and topsoil was applied at each site. Three transects (L, M, R) were delineated at each site and first monitored in 1997, with the latest monitoring assessment only performed for one transect (L) at each site. Considering the last monitoring assessments of the M and R rehabilitation transects were conducted in 2011 / 2012, they have been omitted from further analysis.

Satisfactory results were observed at both 258 Rehab L and 274 Rehab L, with no significant differences found between each transect and their corresponding reference sites for all three vegetation parameters. This was further confirmed by observations during monitoring, which confirmed a high proportion of *Triodia* sp, reminiscent of the target ecological community during the assessment (Rio Tinto 2019). Better outcomes in the two density parameters were observed at 274 Rehab L, most likely due to the presence of weeds at 258 Rehab L (three weed species were present in 2019). The transect is located close to a creek and station fence which is likely to have resulted in an increased exposure to weeds.

Rehabilitation outcomes at 258 Rehab L and 274 Rehab L are further discussed below, with inferences based on comparative analyses of rehabilitation and reference site vegetation quadrat data. Data interpretations have taken the following items into consideration:

- The trajectories of reference sites 258_M and 258_L observed from 2011 onwards in Figures 5 6 to 5 8 are not true representations of how vegetation parameters change over time due to the eight-year gap between monitoring assessments;
- 274_Rehab_L was patchily burnt prior to the 2017 assessment, with 35% of the quadrats affected; and
- 274_Control_M and R were burnt between the 2002 and 2003 assessments.

Native perennial species density and richness

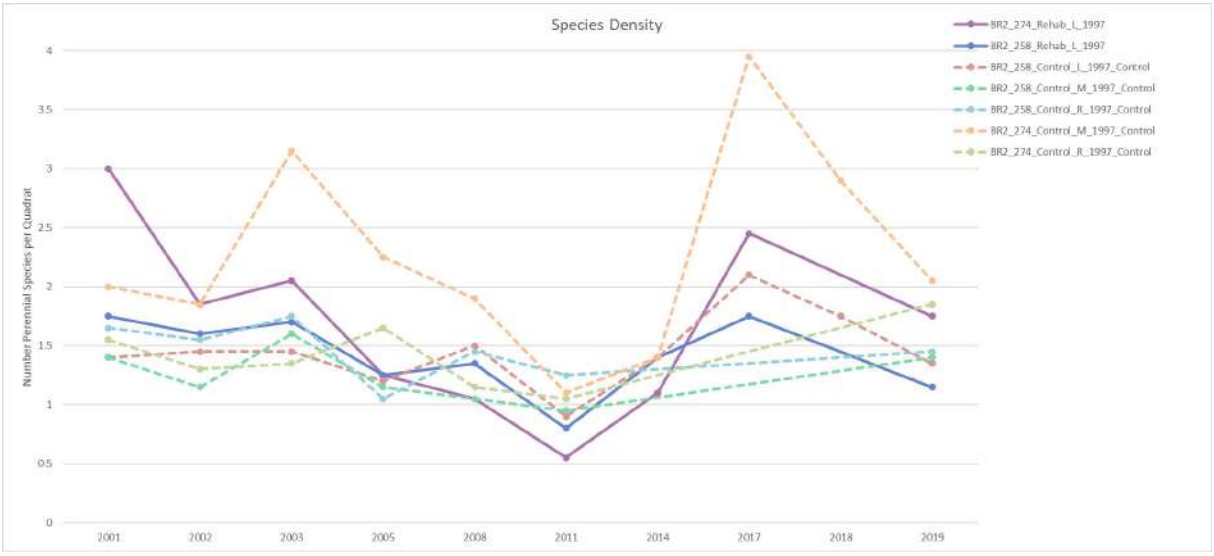


Figure 19: Native perennial species density (species / quadrat) for the B2N 1991 borrow pit rehabilitation and reference sites over time.

No statistically significant differences in species density were found between the rehabilitation and reference sites in 2019, with rehabilitation outcomes in this parameter considered highly satisfactory. The rehabilitation sites follow similar trajectories over the duration of monitoring, with a general declining trend observed from 2001 to 2011, followed by a steep incline until 2017 and final decline over the final two years (Figure 19). Corresponding increasing and declining trends occur at most reference sites, signifying that species density at the rehabilitation is comparable to the target vegetation community.

Seven native perennial species were recorded at Rehab_258_L in 2019, whilst 11 were present at Rehab_274_L. Although both values were less than the previous assessment, they maintain comparability (multivariate analysis found a significant similarity) to species richness at the reference sites, which ranged from six to 12 species in 2019. Comparable declining trends in species richness were observed between 2017 and 2019 at each rehabilitation transect and at reference sites 258_Control_L and 274_Control_M, indicating an influence of environmental factors on species establishment during this time. This is further supported by climatic data which reveals that annual rainfall was below average during this period. Corresponding declines may have occurred at the other reference sites, but this is not evident within the recorded data as they had not been monitored since 2014 or 2011.

A total of 19 species were recorded across the rehabilitation in 2019, with nine of these species present at one or more reference sites. Three species, *Acacia aptaneura*, *Sclerolaena cornishiana* and *Triodia epactia* were common across all sites. Species unique to the rehabilitation included a range of *Acacia* sp, *Corymbia hamersleyana*, *Eragrostis eriopoda*, and *Eremophila fraseri* subsp. *fraseri* (among others), all of which are long-lived perennials.

Native perennial plant density

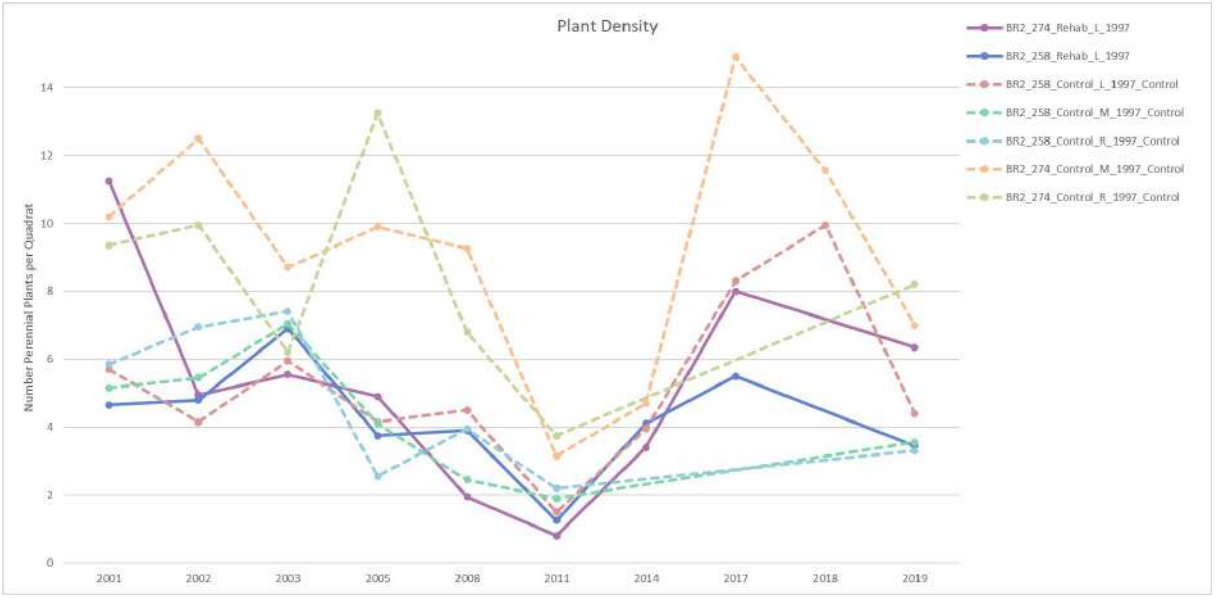


Figure 20: Native perennial plant density (plants / quadrat) for the B2N 1991 borrow pit rehabilitation and reference sites over time.

There was no significant difference in native perennial plant density between the rehabilitation and reference sites in 2019, indicating considerable development of the rehabilitation towards reference site attributes (Figure 20). Consistent with species density, declining trends in plant density were observed between 2017 and 2019 at each rehabilitation transects and at reference sits 258_Control_L and 274_Control_M, providing further evidence for the influence of low rainfall on vegetation density parameters. Although less plants per quadrat were recorded at 274 Rehab L than at the corresponding reference sites (274 Control M and R), the difference was not significant.

Native perennial plant cover

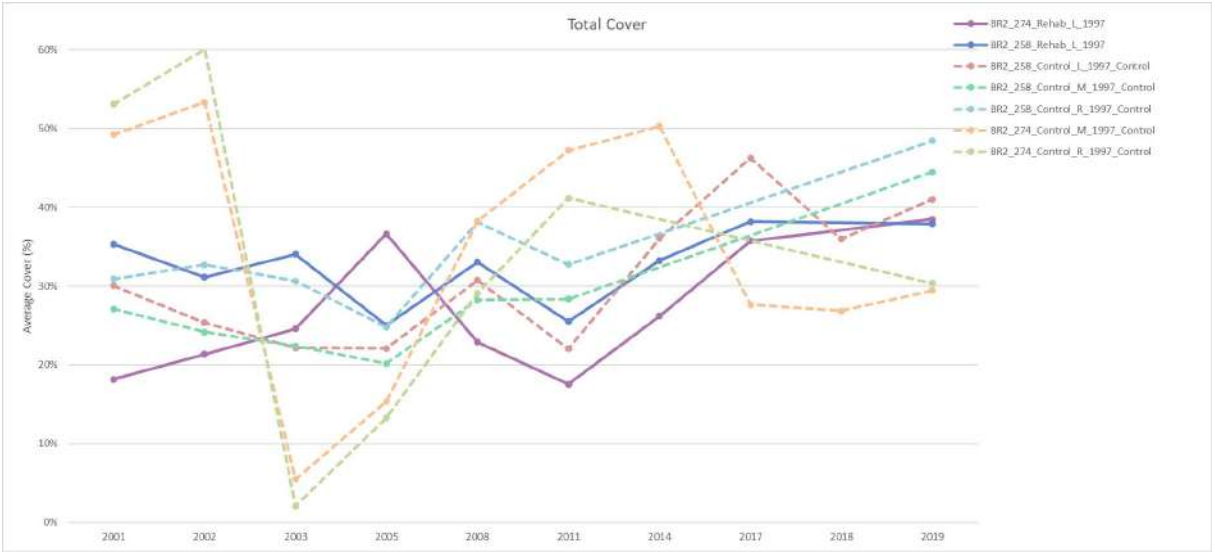


Figure 21: Native perennial total plant cover (%) for the B2N 1991 borrow pit rehabilitation and reference sites over time.

Native perennial plant cover was the only parameter to increase (albeit minimally) at 274 Rehab L between 2017 and 2019, whilst no change occurred during this time at 258 Rehab L (Figure 21). Cover values documented in 2019 at the two rehabilitation sites differed by an insignificant one percent, with lower values recorded at each 274 Control site. Higher cover was observed at all three 258 Control

sites in 2019 (compared to the 38 and 39% recorded at the rehabilitation) however the variations were not significant.

5.5.4. B2N 2009 borrow pit

Rehabilitation of the Brockman 2 Borrow Pit 293 was completed in 2009, with implemented works including contour ripping and topsoil application. No seeding was conducted at the borrow pit site, which is represented by one 100 m long transect, first monitored in 2014.

Native perennial species density and richness

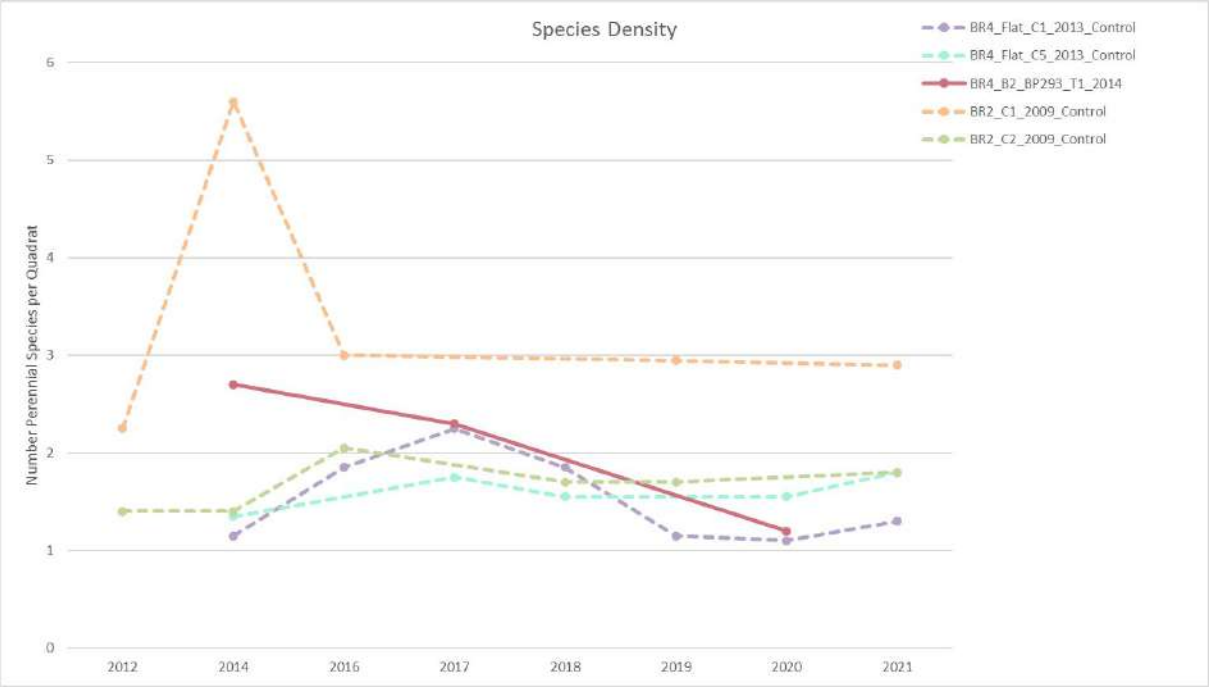


Figure 22: Native perennial species density (species / quadrat) for the B2N 2009 borrow pit rehabilitation and reference sites over time.

Species density at the rehabilitation declined at a relatively consistent rate over the entire monitoring period (Figure 22). The last monitoring assessment found no significant differences in species density between the rehabilitation and reference sites.

The number of native perennial species recorded at BP293 decreased from 13 in 2017 to nine in 2020, which was within the two reference site values recorded. The addition of walk-around assessment observations results in a total species count of 20 at the rehabilitation site. In comparison, Flat_C1 and Flat_C5 had a total of 13 and 21 species respectively. Of the 20 species recorded on the rehabilitation, 11 were present on at least one of the reference sites. These species included *Acacia ancistrocarpa*, *Codonocarpus cotinifolius*, *Themeda triandra* and *Triodia epactia*.

Native perennial plant density

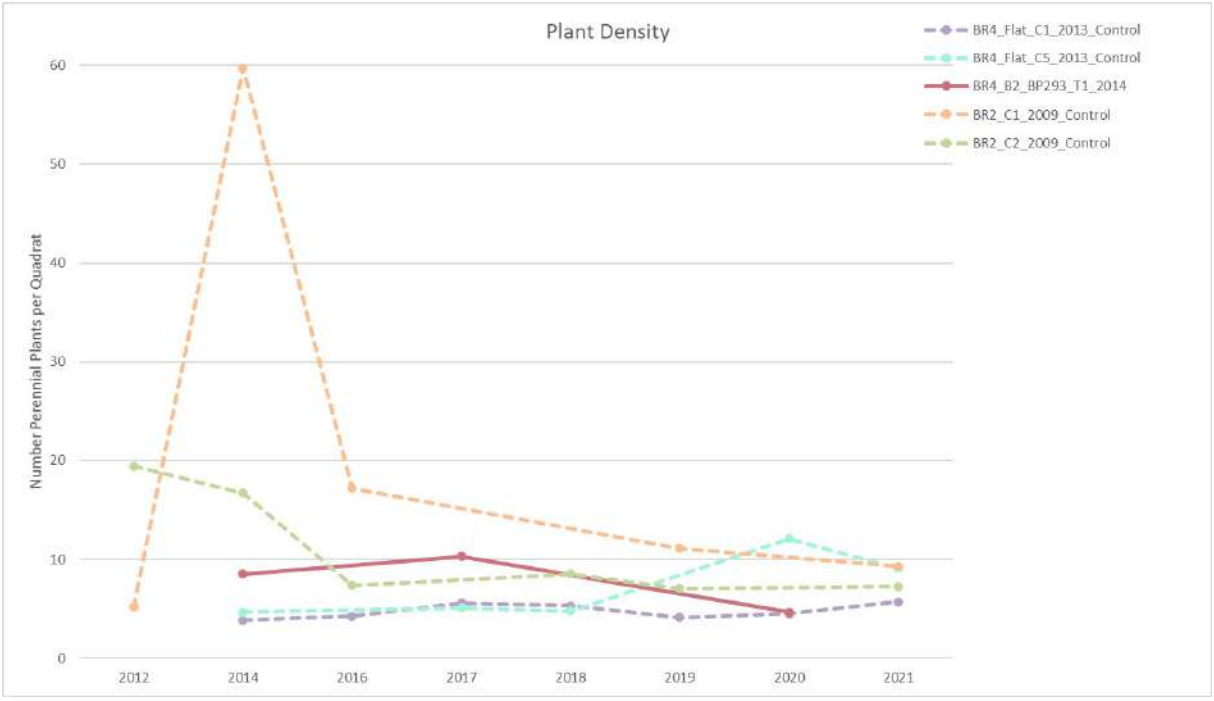


Figure 23: Native perennial plant density (plants / quadrat) for the B2N 2009 borrow pit rehabilitation and reference sites over time.

Over the duration of monitoring the number of native perennial plants per quadrat at the rehabilitation decreased from 8.5 to 4.7, which was within the reference site range (Figure 23). An increase in plant density was observed at Flat_C5 between 2018 and 2020, mostly attributed to germination of *Triodia* sp. following fire disturbance and was significantly higher than the rehabilitation site.

Native perennial plant cover

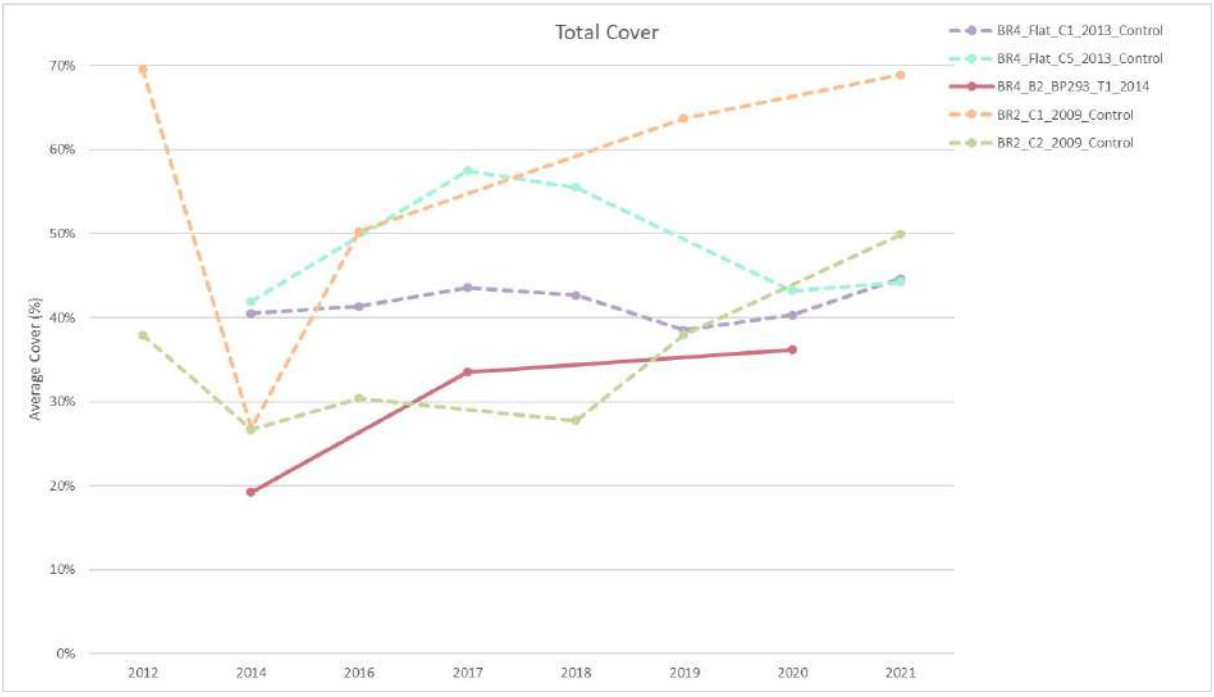


Figure 24: Native perennial total plant cover (%) for the B2N 2009 borrow pit rehabilitation and reference sites over time.

Native perennial plant cover at the BP293 rehabilitation follows an increasing trajectory from 2014 to 2017 which plateaus in subsequent years (Figure 24). Total plant cover recorded at the rehabilitation during the latest monitoring assessment was only marginally less than the reference sites. Overall, there were no significant differences between the rehabilitation and reference sites.

5.5.5. B2N to B4 Access Road borrow pits

The borrow pits adjacent to the Brockman 2 to Brockman 4 Access Road were rehabilitated in 2015 and four 100 m transects were first monitored in 2016. Rehabilitation works included the application of topsoil and contour ripping to a depth of 200 mm (Table 6). None of the rehabilitation sites have been burnt since monitoring began, whilst 30% of the quadrats at reference site BR4_Flat_C5 were burnt between the 2018 and 2020 monitoring assessments. The resulting impacts to vegetation at the site were most evident within the plant density parameter. Although less cover was recorded at all four rehabilitation transects than the reference sites, the overall trajectories observed at the rehabilitation transects are satisfactory.

Native perennial species density and richness

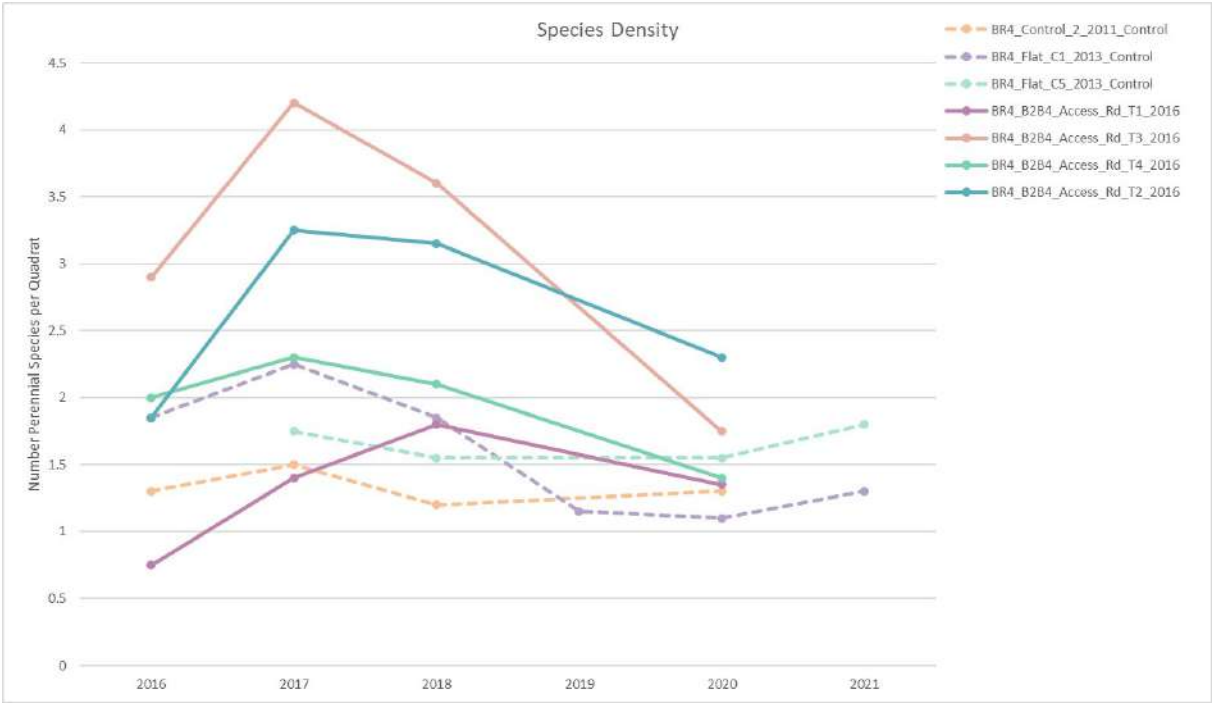


Figure 25: Native perennial species density (species / quadrat) for the B2N to B4 Access Road borrow pit rehabilitation and reference sites over time.

Six to 15 native perennial species were recorded across the rehabilitation in 2020, compared to the reference site range of three to 10 species (Table 7). Species richness increased at two rehabilitation transects over the full monitoring period and decreased at the other two.

Decreasing trends in species density were recorded from 2017 onwards at Access_Rd_T2, Access_Rd_T3, and Access_Rd_T4, with Access_Rd_T1 also showing a decline after 2018 (Figure 25). Despite the declines, all sites had a species density in 2020 that was within or above the reference site range, with no significant differences found.

There were 15 to 23 species present at each rehabilitation site, including the quadrat and walk-around assessments, compared to the 16 and 21 species observed across the reference sites. Species present at both the reference and rehabilitation site included *Acacia ancistrocarpa*, *Codonocarpus cotinifolius* and *Triodia epactia*.

Native perennial plant density

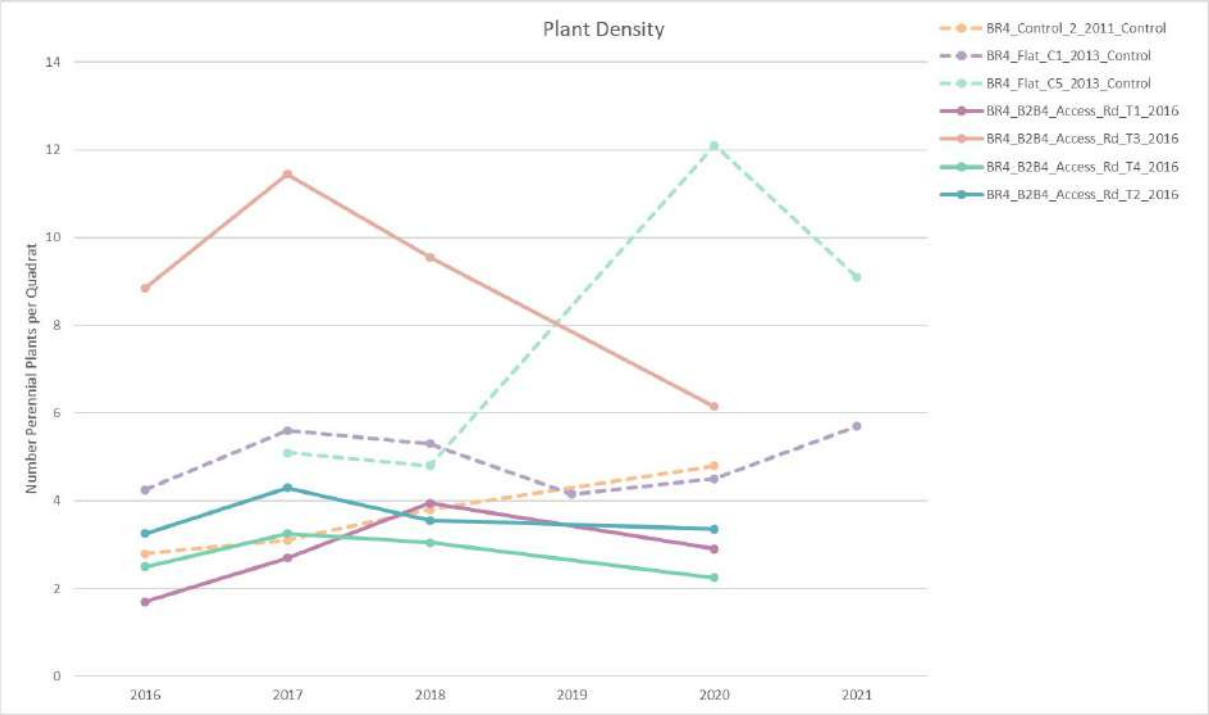


Figure 26: Native perennial plant density (plants / quadrat) for the B2N to B4 Access Road borrow pit rehabilitation and reference sites over time.

Plant density values recorded during the last monitoring assessment ranged from approximately two to six plants per quadrat at the rehabilitation sites, and between five and 12 plants per quadrat at the reference sites (Figure 26). Access_Rd_T3 was the only rehabilitation transect exhibiting similar plant density to the reference sites in 2020, recording a higher value than Control_2 and Flat_C1. The highest 2020 value was observed at Flat_C5, however this can be largely attributed to the post-fire condition of the site.

Native perennial plant cover

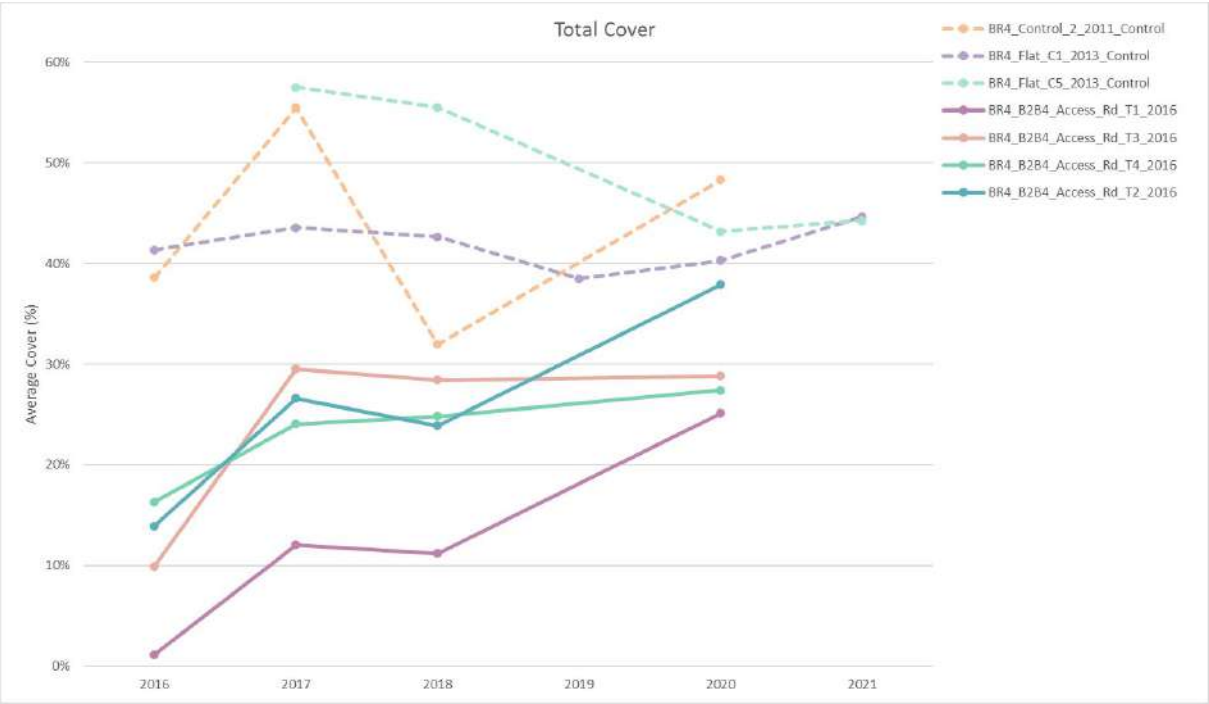


Figure 27: Native perennial total plant cover (%) for the B2N to B4 Access Road borrow pit rehabilitation and reference sites over time.

Native perennial plant cover between the rehabilitation and reference sites was not significantly different in 2020, with 25% to 38% cover at the rehabilitation sites, compared to 43% to 48% at the reference sites (Figure 27). Increasing trends in plant cover occurred post-2018 at Access_Rd_T1, Access_Rd_T4 and Control 2. The increases can be primarily attributed to shrub species such as *Acacia atkinsiana* and *Acacia bivenosa.*

5.5.6. BS4 borrow pits

Rehabilitation works on the Brockman 4 borrow pits were completed in 2009, with ripping and topsoil application included but seeding excluded. Monitoring of four 50 m long transects commenced in 2010 / 2011, with each borrow pit represented by one transect. None of the rehabilitation areas have been burnt since monitoring began.

Eleven years post-rehabilitation three of the four BS4 borrow pit sites were performing well, exhibiting species richness and density, plant density and spinifex density values which were either within or higher than the reference site range (Table 7). Vegetation parameter values recorded across the rehabilitation in 2020 were all below BR4_Control_1 which was to be expected considering fire had impacted the entire site between the previous two assessments. Rehabilitation performance was least satisfactory at transect BP17B where the values recorded in 2020 for the three key vegetation parameters were below all reference sites.

Native perennial species density and richness

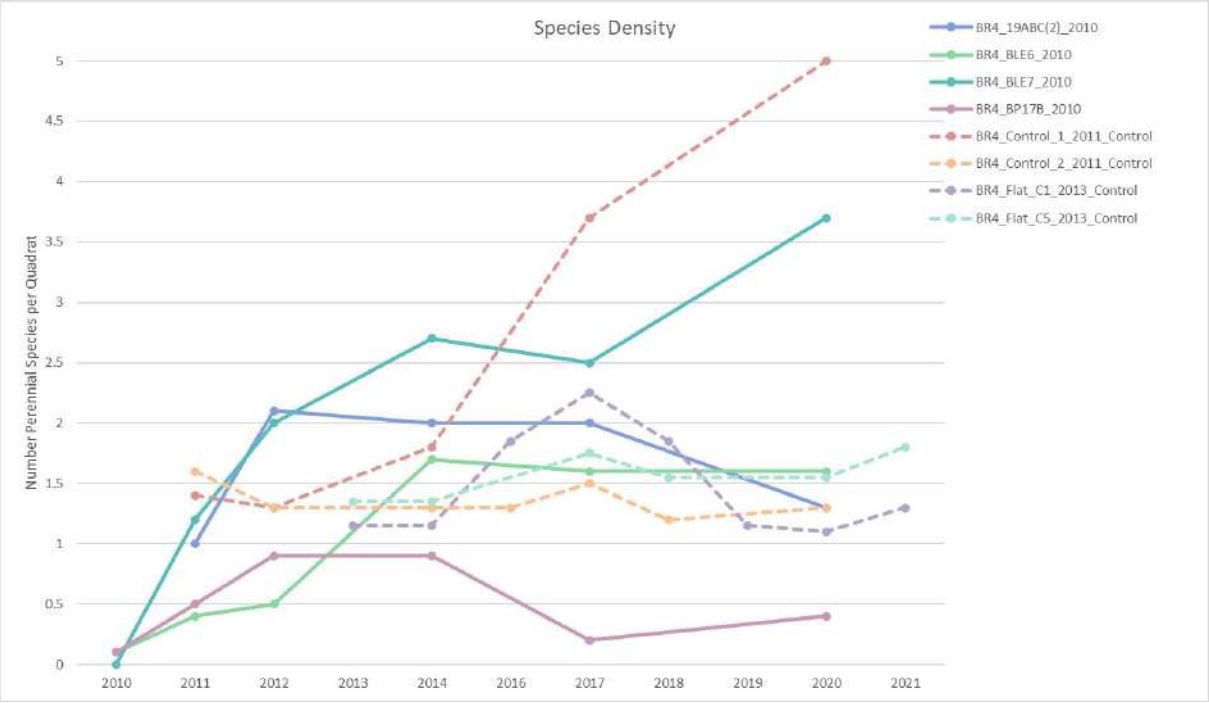


Figure 28: Native perennial species density (species / quadrat) for the BS4 borrow pit rehabilitation and reference sites over time.

Species density increased over the full monitoring period at three out of the four rehabilitation transects, with the greatest success in this parameter observed at BLE7, and least at BP17B (Figure 28). Although the trajectory of transect 19ABC (2) was of an overall declining nature, the most recent species density value recorded was still within the reference site range. The number of species per quadrat recorded at BP17B remained under one throughout the duration of monitoring and it was the only transect not within the reference site range in 2020.

Four to 16 native perennial species were recorded at the rehabilitation sites in 2020, with all values within or above the reference site range (three to 10) (Table 7). Total species counts which include the walk-around were also similar between rehabilitation and reference sites, with respective ranges of 14 to 24, and 13 to 21. Several native perennial species such as *Acacia atkinsiana*, *Acacia bivenosa*, *Indigofera monophylla*, *Triodia epactia* and *Triodia wiseana* were present on all rehabilitation sites. A total of 22 species that were present on at least one rehabilitation area were also present on at least one reference site.

Native perennial plant density

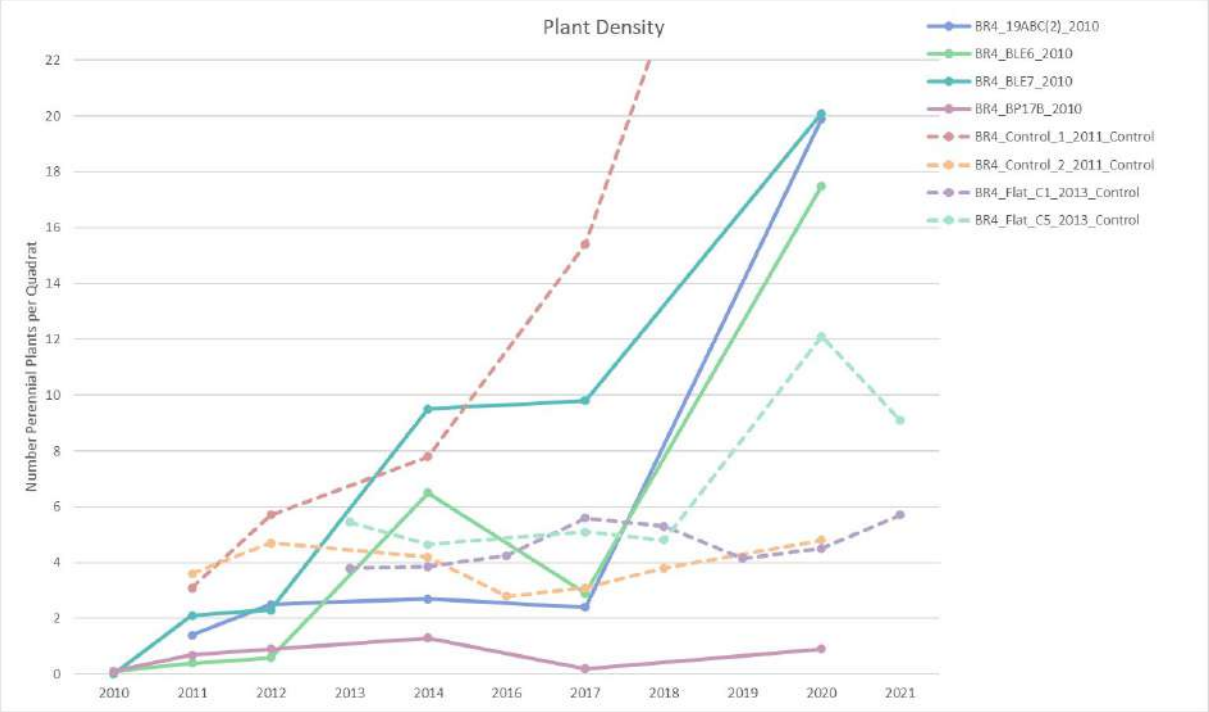


Figure 29: Native perennial plant density (plants / quadrat) for the BS4 borrow pit rehabilitation and reference sites over time.

A significant increase in plant density were observed between 2017 and 2020 at three rehabilitation transects, gaining ten to 17 more plants per quadrat (Figure 29). The inclining trends observed at these sites were mostly attributed to an increase in the density of *Triodia* plants. As with outcomes observed in species density, rehabilitation transect BP17B performed poorly within this parameter, remaining under two plants per quadrat throughout monitoring.

Plant density recorded at the reference sites in 2020 ranged from five to 40, with all but BP17B achieving values within this range. The 40 plants per quadrat were documented at reference transect Control 1 and were most likely a result of post-fire succession (site was burnt after 2017). If Control 1 data is not considered, the 2020 plant densities of BLE6, BLE7 and 19ABC(2) were above all reference site values. Plant density also increased substantially between 2018 and 2020 at Flat_C5 in response to fire disturbance.

Native perennial plant cover

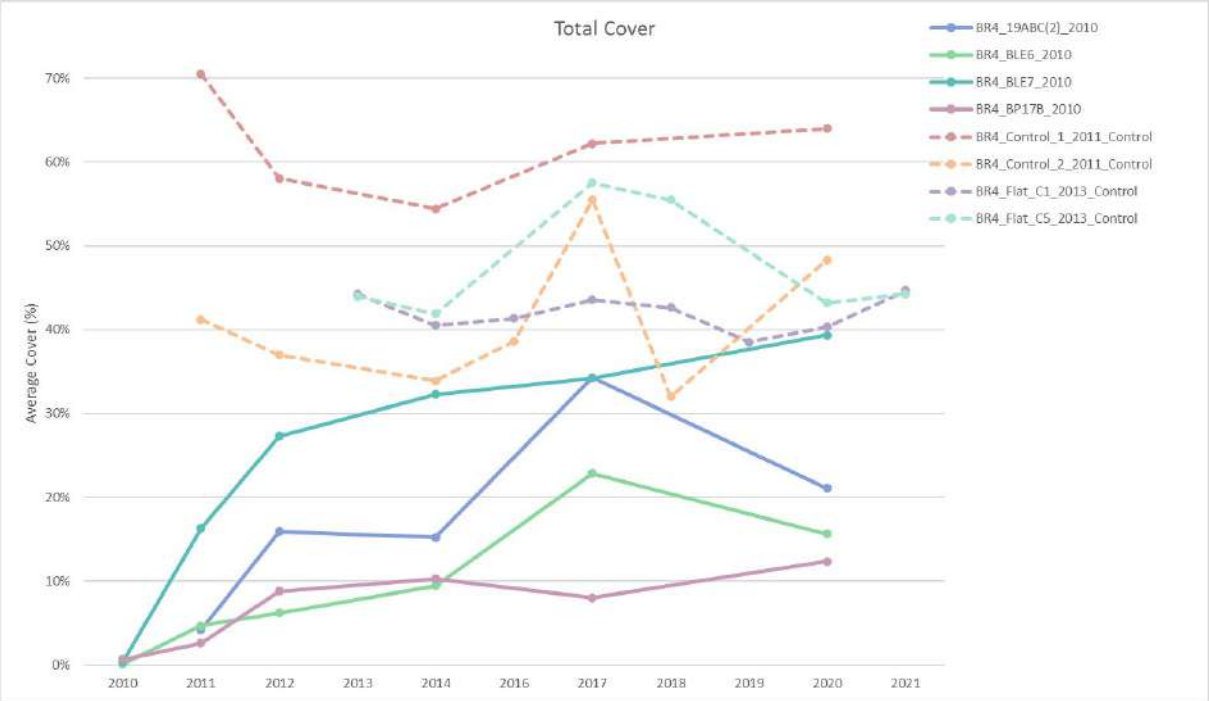


Figure 30: Native perennial total plant cover (%) for the BS4 borrow pit rehabilitation and reference sites over time.

Native perennial plant cover was lower at the rehabilitation transects compared to the reference sites in all monitoring years, with the latest assessment recording 12% to 39% cover across the rehabilitation sites, compared to a reference site range of 40% to 64% (Table 8 and Figure 30). Cover increased slightly at BLE7 and BP17B between 2017 and 2020, whilst declining trends were observed at 19ABC(2) and BLE6. The decrease in cover at these sites was mostly attributed to losses in cover of several shrub species, as well as the perennial tree *Codonocarpus cotinifolius*. Due to the age of the rehabilitation (approximately 10 years old at the time of assessment), it is possible that some species had reached the end of their natural lifespan and declines may be a result of natural senescence of these species. Similarity to reference site values in 2020 was only obtained at transect BLE7, whilst cover values at the remaining rehabilitation sites were below the reference site range.

5.5.7. BS4 White Quartz Road borrow pits

Nine years since monitoring commenced, the three 50m White Quartz Road rehabilitation transects achieved species density and species richness values within or above the range of the reference sites (excluding Control 1 as fire disturbance resulted in significantly high values). Trajectories in the three key vegetation parameters peak in 2017 at several sites, possibly reflecting the substantial rainfall received in November / December the previous year (Figure 10).

Native perennial species density and richness

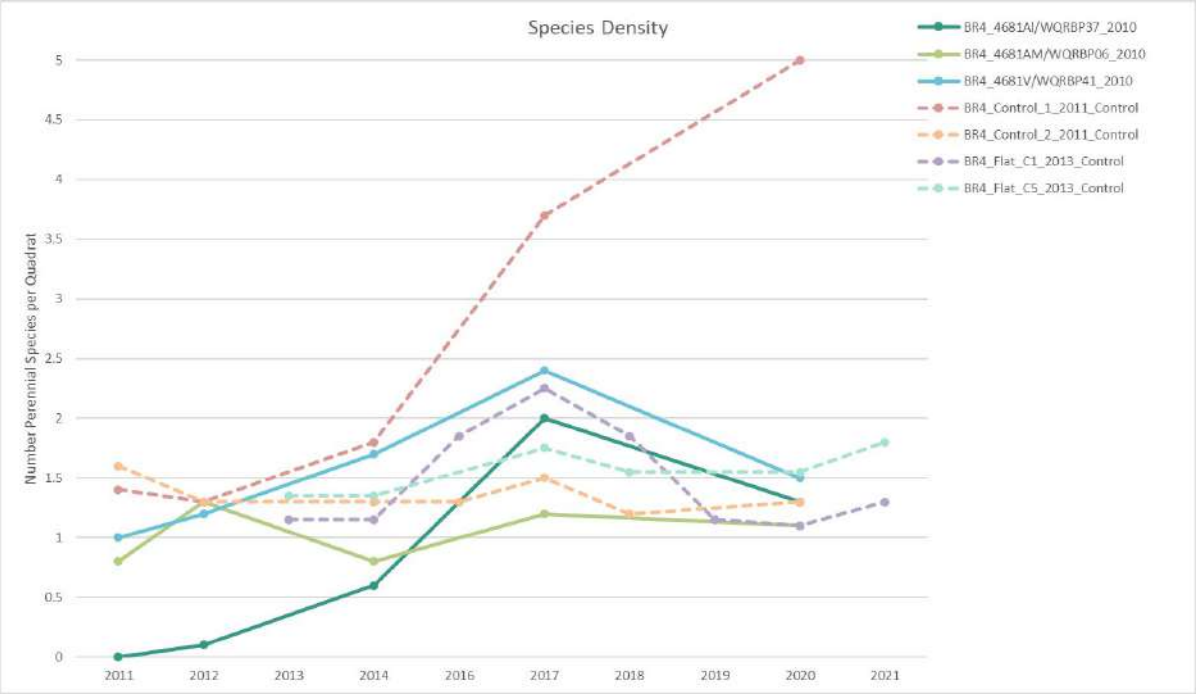


Figure 31: Native perennial species density (species / quadrat) for the BS4 White Quartz Road borrow pit rehabilitation and reference sites over time.

Rehabilitation transects WQRBP37 and WQRBP41 follow increasing trajectories in species density until 2017, with the last monitoring assessment recorded declines at both transects. Variation between rehabilitation and reference sites was only significant for Control 1 comparisons, where the substantially high value recorded in 2020 was mostly attributed to an increase in *Triodia* density following fire disturbance in approximately November 2017.

The number of native perennial species (species richness) recorded at the rehabilitated borrow pits ranged from five to nine in 2020, and 15 to 19 upon inclusion of the walk-around assessments, compared to the reference site ranges of three to 10, and 13 to 21 (Table 8). Species richness decreased at WQRBP37 and WQRBP41 between 2017 and 2020; as well as reference site Flat_C1. Several *Triodia* and shrub species were recorded on at least two of the three rehabilitation areas, such as *Acacia bivenosa*, *Acacia synchronicia*, *Senna glutinosa* subsp. x *luerssenii*, *Triodia angusta* and *Triodia epactia*. A total of 18 species present on the rehabilitation areas were also present on at least one reference site.

Native perennial plant density

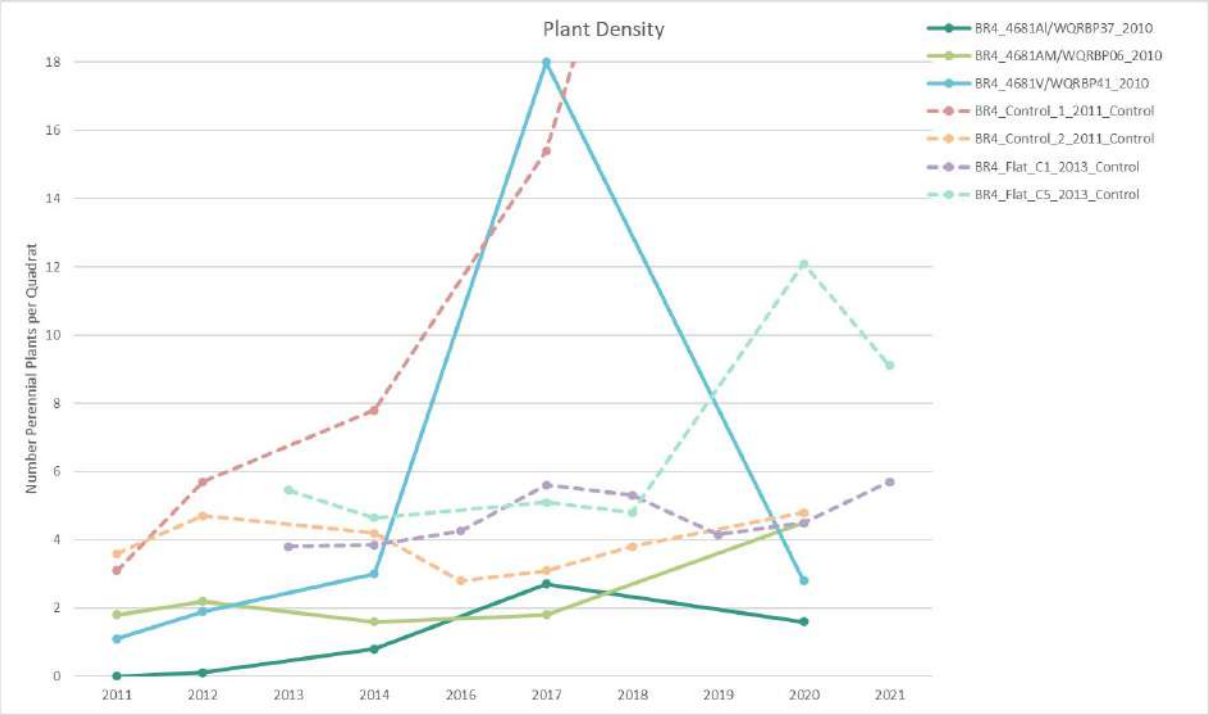


Figure 32: Native perennial plant density (plants / quadrat) for the BS4 White Quartz Road borrow pit rehabilitation and reference sites over time.

Approximately two to five plants per quadrat were across the rehabilitation sites in 2020, with no value differing significantly to three of the reference sites (Figure 32). In alignment with species density, inclining plant density trends were observed from 2011 to 2017 at WQRBP37 and WQRBP41, although a substantially larger increase occurred at WQRBP41 between the 2014 and 2017 monitoring assessments. A proportionate decrease was recorded at the transect during the following assessment and was mostly attributed to a decrease in the abundance of *Sclerolaena cuneata*.

Plant density at Control 1 increased substantially and in 2020 was significantly higher all other sites due to high rates of *Triodia* germination following fire disturbance. The increase in plant density observed at Flat_C5 from 2018 to 2020 was also attributed to fire disturbance, with the observed increase (compared to Control 1) consistent with less of the site being impacted.

Native perennial plant cover

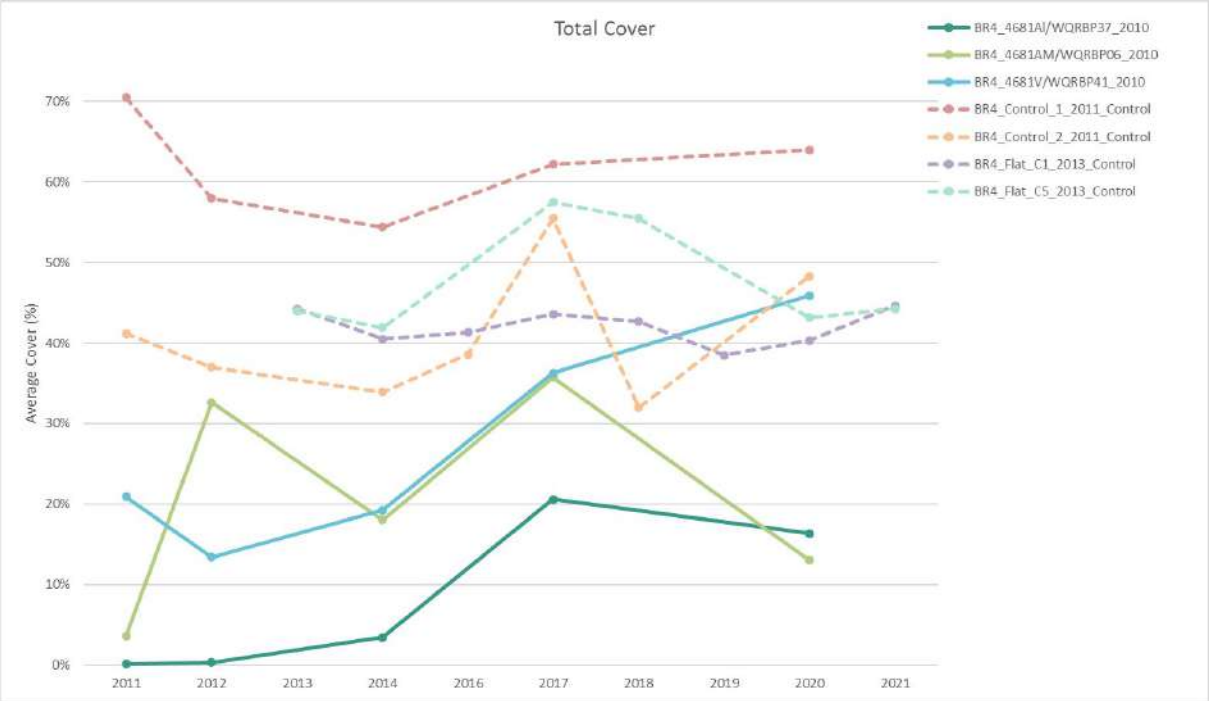


Figure 33: Native perennial total plant cover (%) for the BS4 White Quartz Road borrow pit rehabilitation and reference sites over time.

Native perennial plant cover ranged from 13% to 46% across the rehabilitation areas in 2020, compared to the reference site range of 40% to 64% (Table 8). Trends in plant cover on the rehabilitation were variable throughout the monitoring period, although all three transects recorded higher cover in 2020 than when first assessed. The substantial decrease observed at WQRBP06 between 2017 and 2020 was attributed to losses of *Triodia epactia* and *Triodia angusta*. During this period, plant cover increased at WQRBP41 and remained relatively stable at WQRBP37. Both WQRBP37 and WQRBP06 had less cover in 2020 than all four reference sites, however the variation was only statistically significant for WQRBP06.

5.6. Moderate impact disturbance areas – landfill, haul road and pit backfill

The Nammuldi Below Water Table (BWT) landfill rehabilitation was estimated to have been completed between the end of 2018 and the beginning of 2019. Methodology details are unavailable, but an observational site assessment indicated that works included topsoil application and scarifying (Table 9). Monitoring of one 100 m transect commenced in 2019.

B2N sites Old Haul Road, Pit 2 Backfill, and Pit 3 Surrounds were rehabilitated in 1998 / 1999 (Table 9). Rehabilitation works included contouring and ripping, with topsoil spread to a minimum depth of 200 mm, although seeding was not performed. A single 50 m transect was established at each rehabilitation site, with monitoring first undertaken in 2012. The Pit 3 Surrounds site was very narrow, located between the access road and a bund.

Fire had not impacted the rehabilitation at Nammuldi BWT Landfill, Old Haul Road, Pit 2 Backfill, and Pit 3 Surrounds over the duration of monitoring.

Table 9: B2N Landfill, Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds rehabilitation overview.

REHABILITATION PARAMETER	SITE			
	Nammuldi BWT Landfill	**B2N Old Haul Road**	**Pit 2 Backfill**	**Pit 3 Surrounds**
# Active transects (monitored)	1	1	1	1
Closure domain	Landfill	Road - haul	Mine backfilled pit	Excavation / disturbance
Year of rehab	2018 / 2019	1998 / 1999	1998 / 1999	1998 / 1999
Growth medium	Topsoil presumed from visual assessment	Topsoil	Topsoil	Topsoil
Depth of growth medium application (mm)	Unknown	200 mm	200 mm	200 mm
Time of storage of growth medium (yr)	Unknown	Unknown	Unknown	Unknown
Seeding mix ((Appendix ?)	Unknown	N/a	N/a	N/a
Seeding rate (kg/ha)	Unknown	0	0	0
Soil ameliorant (type)	Unknown	Unknown	Unknown	Unknown
Rate of application of ameliorant (kg/ha)	Unknown	Unknown	Unknown	Unknown
Contour ripping (depth)	Unknown	Yes (unknown)	Yes (unknown)	Yes (unknown)
Ripping (width)	Unknown	Unknown	Unknown	Unknown

Table 10: B2N Landfill, Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds rehabilitation and reference sites monitoring overview.

MONITORING	SITE				TOTAL / RANGE
	Nammuldi BWT Landfill	**Airstrip Control**	**B2N Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds**	**Control Pit 2 Airstrip Control**	
Year rehabilitation completed / year reference sites established	2018 / 2019	2012	1998 / 1999	2012	
Year of latest available monitoring summary	2020	2020	2019	-2019	
Number of transects monitored	1	1	3	2	7
Range of species richness values	10 species	12 species	4 to 8 species	3 to 6 species	4 to 12 species
Range of species density values	1.5 species per quadrat	2.0 species per quadrat	1.7 to 1.8 species per quadrat	1.3 to 1.4 species per quadrat	1.3 to 2.0 species per quadrat
Range of plant density values	2.7 plants per quadrat	9.7 plants per quadrat	3.9 to 4.8 plants per quadrat	2.8 to 5.9 plants per quadrat	2.8 to 9.7 plants per quadrat
Range of spinifex density values	1.6 *Triodia* plants per quadrat	2.2 *Triodia* plants per quadrat	3.1 to 3.7 *Triodia* plants per quadrat	2.2 to 5.6 *Triodia* plants per quadrat	1.6 to 5.6 *Triodia* plants per quadrat
Range of total cover values (%)	2.1%	28%	28 to 37%	40%	2.1 to 40%
Range of spinifex cover values (%)	1.7%	12%	27.3 to 32.1%	24% to 36.6%	1.7 to 36.6%
Range of weed cover values (%)	0% *	0%	0%	0%	0%
Range of weed density values	0 *	0	0	0	0
Range of percentages of quadrats with weeds present	0% *	0%	0%	0%	0%

MONITORING	SITE				TOTAL / RANGE
	Nammuldi BWT Landfill	Airstrip Control	B2N Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds	Control Pit 2 Airstrip Control	
Range of percentages of quadrats with annuals present	35%	50%	0 to 10%	0%	0 to 50%
Range of # of species flowering / fruiting (inc. walk-around assessment)	4 flowering / fruiting species	1 flowering / fruiting species	3 flowering / fruiting species	1 to 3 flowering / fruiting species	1 to 4 flowering / fruiting species
Erosion (number of gullies)	0 gullies	0 gullies	0 gullies	0 gullies	0 gullies

5.6.1. Nammuldi BWT Landfill

Overall, the Nammuldi landfill rehabilitation is progressing positively, with comparable outcomes to reference sites evident in three parameters – species richness, species density and spinifex density. Values recorded for these parameters in 2020 were only marginally below the corresponding reference value (Table 10), indicating a strong potential for the rehabilitation to develop a vegetation structure that resembles the reference site over time.

Weeds were present early on at the site, with two species recorded in 2019, and 15% of quadrats affected. Only one of these species (*Cenchrus ciliaris*) was observed the following year during the walk-around assessment. Early weed control was recommended to mitigate weed dominance at the site, which may explain the reduction in weed cover, although it is unclear whether any measures were implemented.

Native perennial species density and richness

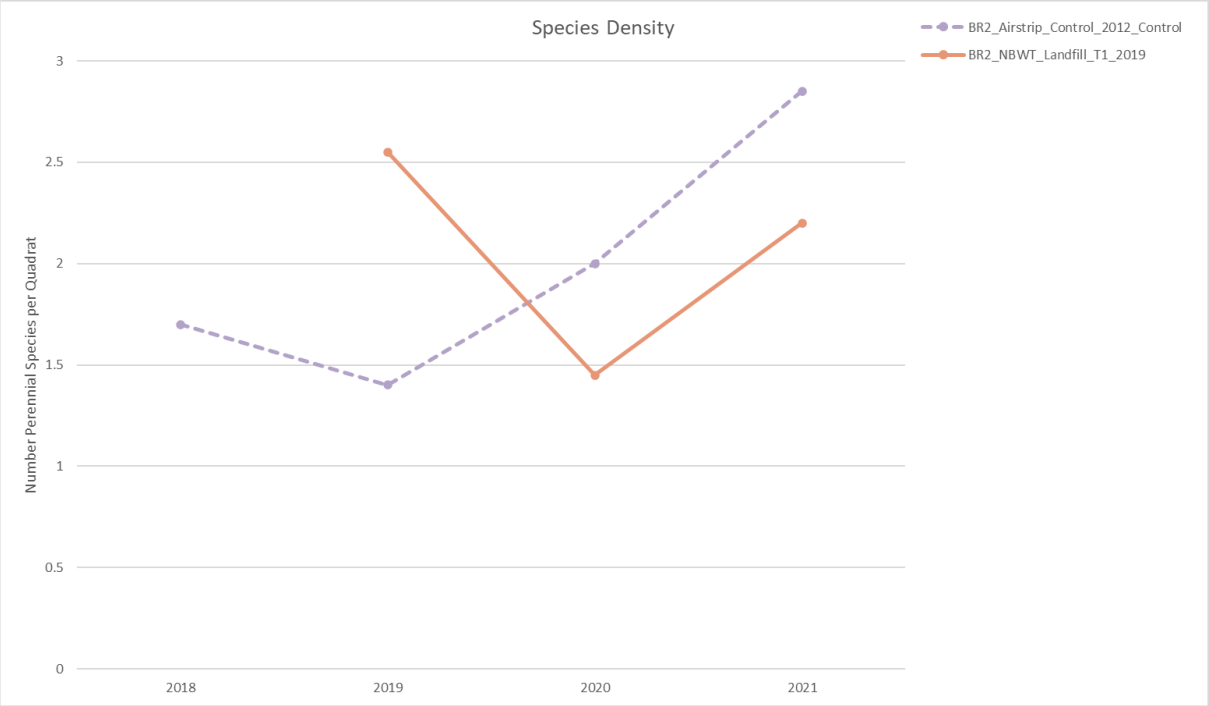


Figure 34: Native perennial species density (species / quadrat) for Nammuldi BWT Landfill rehabilitation and reference sites over time.

The first monitoring assessment recorded higher species density at NWBT_Landfill_T1 than Airstrip_Control, with the two succeeding assessments documenting the opposite (Figure 34). Despite this, no significant difference between the rehabilitation and reference site was found in any year. The number of species per quadrat at the rehabilitation decreased by approximately 42% between 2019 and 2020, with a proportionate inverse trend observed at the reference site. An increasing trend is observed at both sites from 2020 to 2021, indicating a promising result in species establishment at the rehabilitation.

Ten native perennial species were recorded at the NBWT Landfill rehabilitation in 2020, slightly below that observed at the reference site (Table 10), where species richness had doubled since the previous year. Species richness showed increasing trends between 2020 and 2021 at both sites, with NWBT_Landfill_T1 increasing by 60% and Airstrip_Control by approximately 42%.

The total species count at the rehabilitation when both quadrat and walk-around assessments are considered, was 16 in 2020, four less than the reference site. Eight species were common between the two sites including key species of the target community such as *Acacia ancistrocarpa*, *Acacia bivenosa* and *Triodia epactia*.

Native perennial plant density

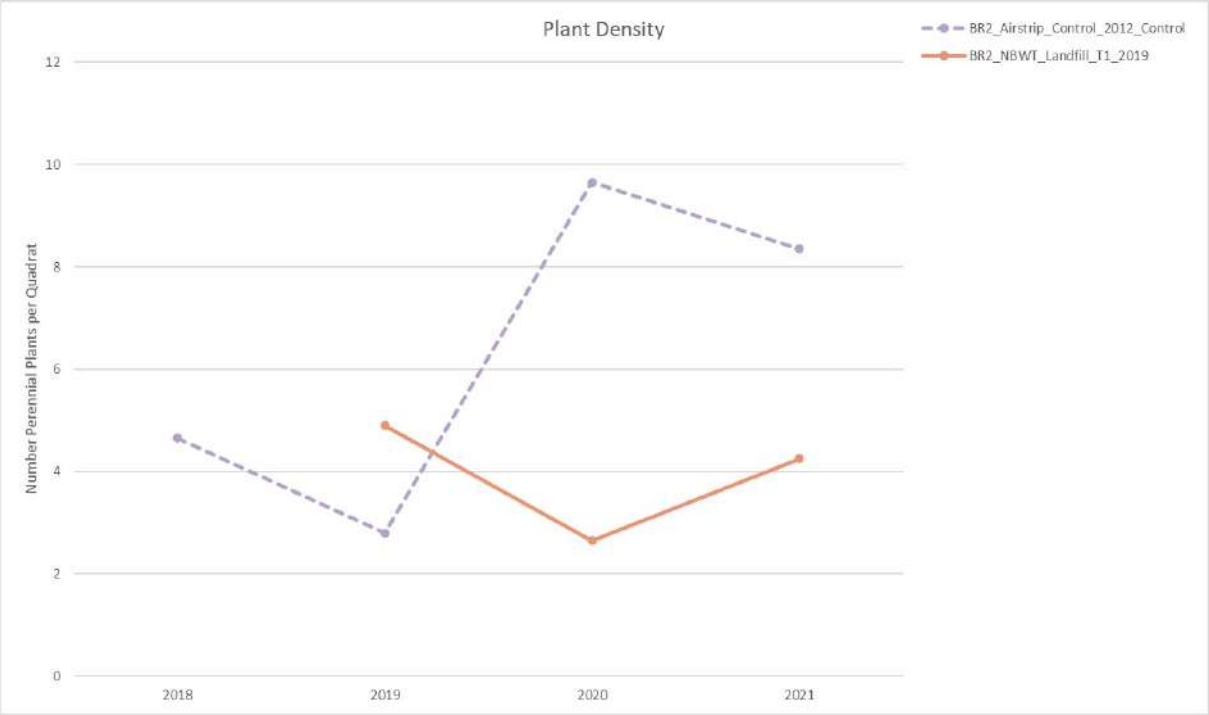


Figure 35: Native perennial plant density (plants / quadrat) for Nammuldi BWT Landfill rehabilitation and reference sites over time.

Contrasting trends in plant density were observed at the rehabilitation and reference site from 2019 to 2020, with the number of plants per quadrat at the landfill decreasing by just under 45% (from 4.9 to 2.7) yet increasing substantially (by approximately seven plants per quadrat) at the Airstrip Control (Figure 35). The increase in plant density on the reference site was attributed mostly to a high establishment of several shrub species.

Native perennial plant cover

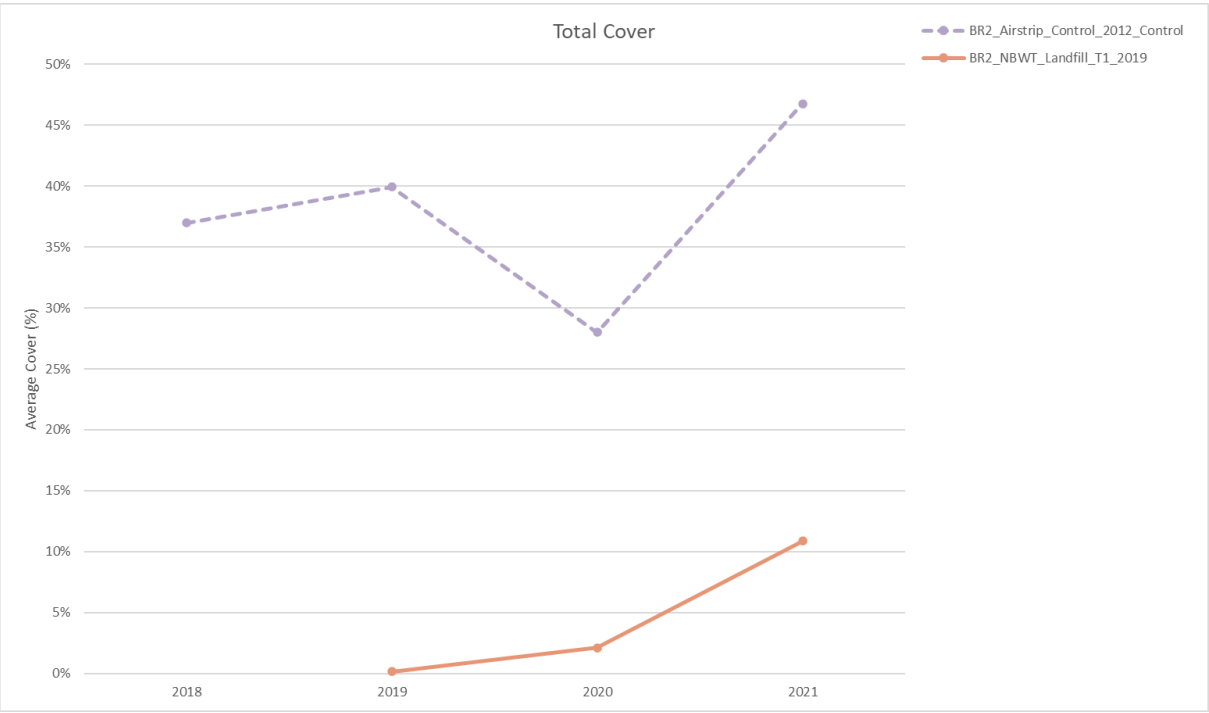


Figure 36: Native perennial total plant cover (%) for Nammuldi BWT Landfill rehabilitation and reference sites over time.

Native perennial plant cover at the rehabilitation follows an inclining trajectory over the three-year monitoring period, however, the values recorded were significantly lower than all reference site values (Figure 36). The lowest reference cover value of 28% was recorded in 2020, contrasting with the meagre 2% exhibited by the landfill rehabilitation. However, this was not unexpected considering the young age of the rehabilitation, and the below average rainfall that was received in the years succeeding completion.

The only declining trend was observed between 2019 and 2020 at Airstrip_Control, with the number of plants per quadrat decreasing by over one-third. The trend was the result of a notable loss of *Acacia aptaneura* plants following below average rainfall. Despite the below average rainfall, plant cover at the rehabilitation had improved slightly, and overall follows an increasing trajectory which has the potential to achieve reference site values over time.

5.6.2. Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds

Two decades after rehabilitation was completed, the Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds sites had achieved satisfactory outcomes, with the 2019 monitoring assessment concluding minimal variation between rehabilitation and reference vegetation parameter values (Table 10). The assessment noted a significant similarity between rehabilitation and reference sites in terms of plant density, determined via multivariate analysis. Lower spinifex density was recorded at the rehabilitation compared to Pit 2 Control; however, the values were comparable to the Airstrip Control.

As expected of 20-year-old rehabilitation, vegetation parameters show plateauing trends from 2016 to 2019, with subsequent increases observed in most parameters at the two sites monitored in 2021. To date, no weeds or erosion gullies have been recorded at the rehabilitation.

Control Pit 2 was the only reference site used in last monitoring assessment, however it has only been assessed twice over the rehabilitation monitoring period, so the change over time for each parameter is represented by a linear trajectory, unreflective of the target community. To account for this, the Nammuldi BWT Landfill reference site, Airstrip Control, was also used for comparison.

Native perennial species density and richness

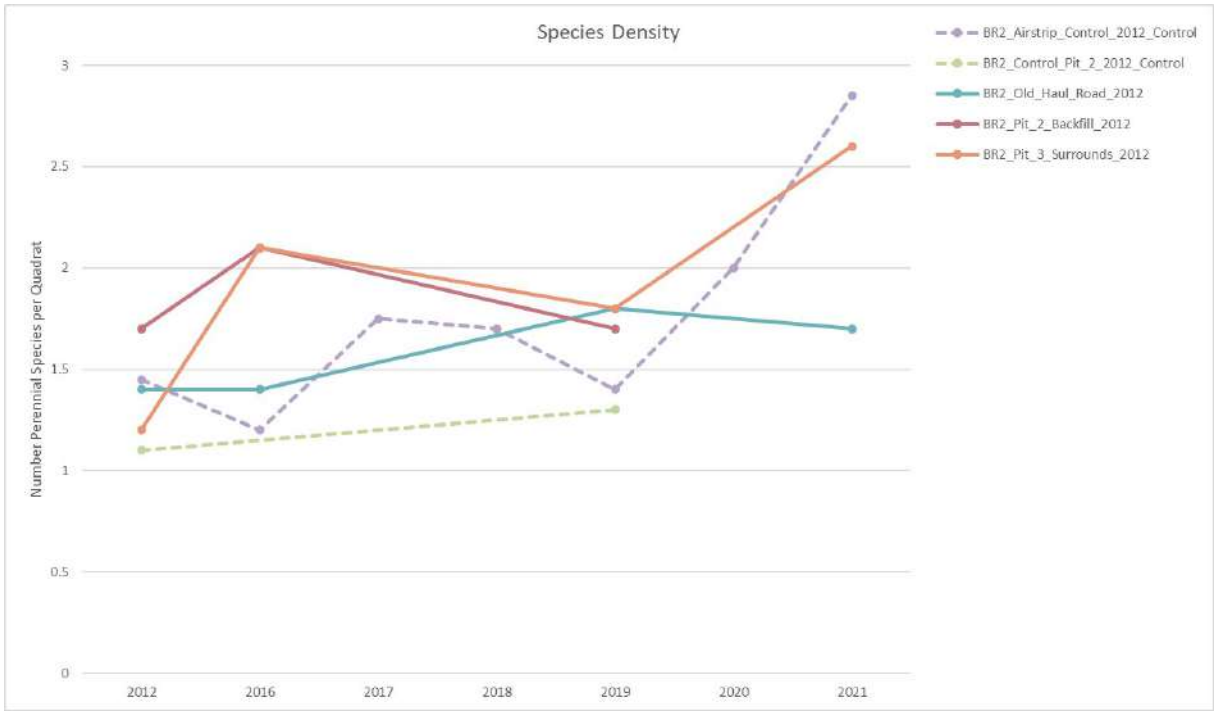


Figure 37: Native perennial species density (species / quadrat) for B2N Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds rehabilitation and reference sites over time.

The number of species per quadrat was not significantly different between the four sites in 2019, indicating that the rehabilitation was performing well in this parameter (Figure 37). Declining trends in species density were observed from 2016 to 2019 at Pit 2 Backfill and Pit 3 Surrounds, however only minor losses in numbers of species per quadrat were recorded.

The three rehabilitation sites had four to eight species present, with three and six observed at the two reference sites (Table 10). The total species count, including walk-around assessments, across both the rehabilitation and reference sites was 34. Ten of these species were common to the rehabilitation references, with *Acacia atkinsiana* and *Triodia wiseana* present at all four sites.

Native perennial plant density

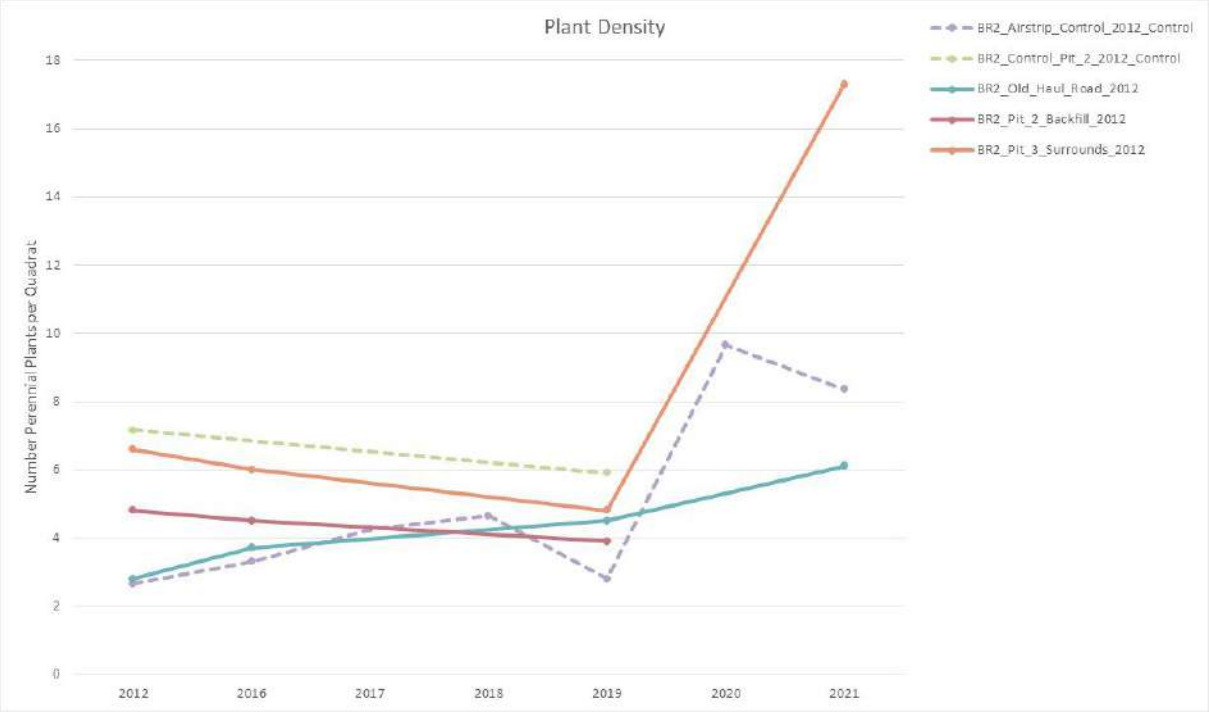


Figure 38: Native perennial plant density (plants / quadrat) for B2N Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds rehabilitation and reference sites over time.

Relatively minimal change in plant density was observed between 2012 and 2019, after which steep increases were recorded at the Airstrip Control and Pit 3 Surrounds (Figure 38). Plant density values at the rehabilitation in 2019 were all within the two reference sites, with the most plants per quadrat recorded at Control Pit 2 (5.9 plants / quadrat). Plant density follows a steady increasing trajectory at the Old Haul Road rehabilitation, increasing by 3.3 plants per quadrat over the duration of monitoring. The Old Haul Road and Pit 2 backfill is observed to be making positive progress towards plant density target values based on the most recent monitoring assessment.

Native perennial plant cover

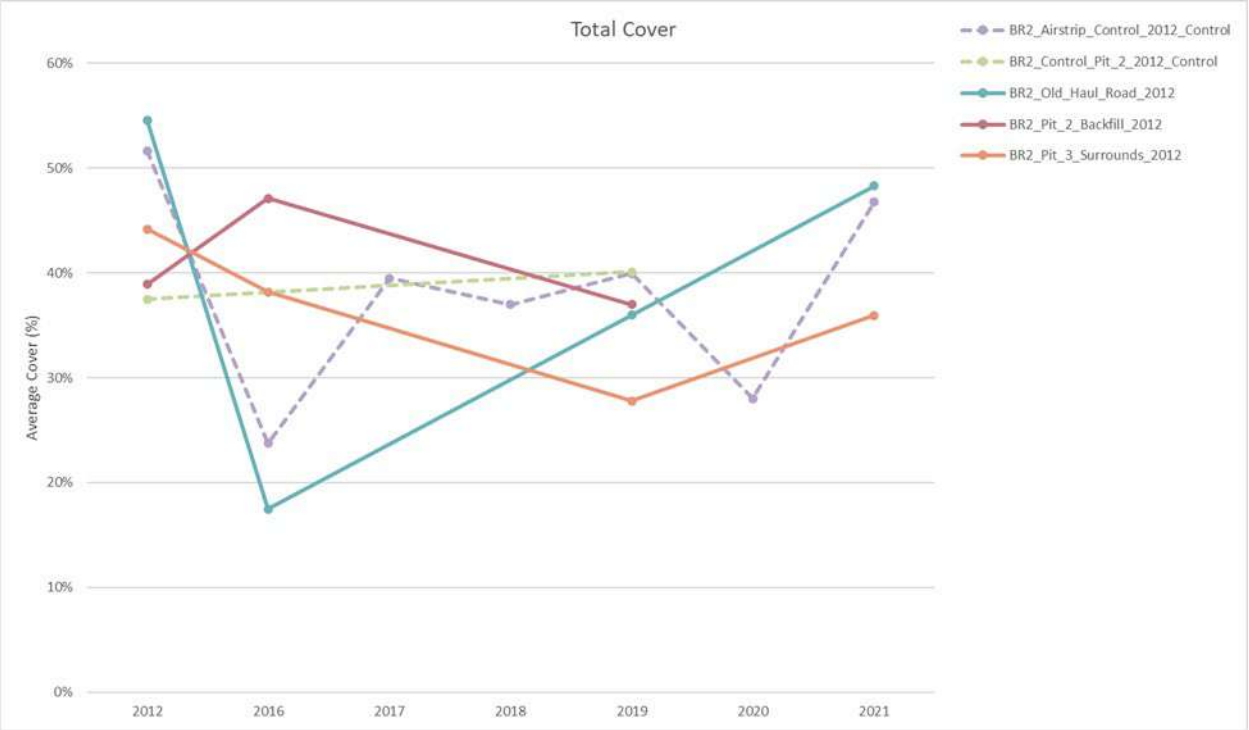


Figure 39: Native perennial total plant cover (%) for B2N Old Haul Road, Pit 2 Backfill and Pit 3 Surrounds rehabilitation and reference sites over time.

Plant cover at Pit 2 Backfill and Pit 3 Surrounds declined over the corresponding monitoring periods, although Pit 2 maintained comparability to the reference sites and the 2021 assessment at Pit 3 Surrounds recorded an increase in cover. A sharp decline in cover occurred at the Old Haul Road rehabilitation between 2012 and 2016, with a similar trend observed at Airstrip Control. At the time of the 2021 monitoring assessment, cover at these two sites had increased back from this low point to almost 50%. Considerably high values were recorded during the first monitoring assessment as it had been over ten years since rehabilitation was completed. The last assessment encompassing all five sites (2019) found no significant difference in total plant cover between sites.

5.7. BS4 Fuel Hub, Boolgeeda Aerodrome and Boolgeeda Camp

Rehabilitation activities for the BS4 Fuel Hub and the Boolgeeda Aerodrome were undertaken in 2013 and 2012 respectively, with monitoring commencing in 2014. The two sites were ripped, with topsoil application documented for the Boolgeeda Aerodrome rehabilitation and presumed, based on visual assessment, for the Fuel Hub rehabilitation (Table 11). Each site is represented by one 100 m long transect.

Rehabilitation works undertaken in 2018 at the Boolgeeda Camp site included re-profiling to create smooth surface, respreading of topsoil to a depth of 200 mm and contour ripping to approximately 500 mm (Table 11). Hand seeding was also conducted in the week following ripping and existing trees were kept in-situ throughout rehabilitation works. Two 100 m transects were established at the site, with the first monitoring assessment conducted in 2019.

Table 11: BS4 Fuel Hub, Boolgeeda Aerodrome and Camp rehabilitation overview.

REHABILITATION PARAMETER	SITE			TOTAL
	Brockman 4 Fuel Hub	**Boolgeeda Aerodrome**	**Boolgeeda Camp**	
# Active transects (monitored)	1	1	2	4
Area (ha)	-	-	-	-
Closure domain	Infrastructure	Airstrip	Camp facilities	-
Year of rehab	2013	2012	2018	-
Growth medium	Topsoil (assumed)	Topsoil	Topsoil	-
Depth of growth medium application (mm)	Unknown	Unknown	200 mm	-
Time of storage of growth medium (yr)	Unknown	Unknown	Less than 3 years. Sourced from Boolgeeda airport stockpile.	-
Seeding mix ((Appendix ?)	N/A	Unknown	Mix of nine native species of local provenance	-
Seeding rate (kg/ha)	0	Unknown	Hand seeded (rate unknown)	-
Soil ameliorant (type)	Unknown	Unknown	Unknown	-
Rate of application of ameliorant (kg/ha)	Unknown	Unknown	Unknown	-
Contour ripping (depth)	Unknown	Yes (unknown)	Contour ripped to depth of 500 mm	-
Ripping (width)	Unknown	Unknown	Unknown	-

Table 12: BS4 Fuel Hub, Boolgeeda Aerodrome and Camp rehabilitation and reference sites monitoring overview.

MONITORING	SITE					TOTAL / RANGE
	Brockman 4 Fuel Hub	Boolgeeda Aerodrome	Flat_C1 Control 2	Boolgeeda Camp	Flat C1	
Year rehabilitation completed / year reference sites established	2013	2012	2011	2018	2013	-
Year of latest available monitoring summary	2020	2020	2020	2020	2020	
Number of transects monitored	1	1 (2 monitored prior to 2020)	2	2	1	7
Range of species richness values	4	12	3	10	3	3 to 12
Range of species density values	1.7	2.8	1.1 to 1.3	0.8 to 1.3	1.1	0.8 to 2.8
Range of plant density values	4.4	19	4.5 to 4.8	1.5 to 3.0	4.5	1.5 to 19
Range of spinifex density values	4.2	11	4.3 to 4.4	0.9 to 2.0	4.4	0.9 to 11
Range of total cover values (%)	55%	41%	40 to 48%	0.5 to 3.0%	40%	0.5 to 55%
Range of spinifex cover values (%)	49%	29%	35 to 42%	0.1	35	0.1 to 49%
Range of weed cover values (%)	0	0.7%	0	0	0	0 to 0.7%
Range of weed density values	0	1.4	0	0	0	0 to 1.4
Range of percentages of quadrats with weeds present	0	20%	0	0	0	0 to 20%
Range of percentages of quadrats with annuals present	15%	75%	5 to 20%	55 to 75%	5%	5 to 75%

MONITORING	SITE					TOTAL / RANGE
	Brockman 4 Fuel Hub	Boolgeeda Aerodrome	Flat_C1 Control 2	Boolgeeda Camp	Flat C1	
Range of # of species flowering / fruiting (inc. walk-around assessment)	3 flowering / fruiting species	flowering / fruiting species	0 to 5 flowering / fruiting species	0 to 2 flowering / fruiting species	0 flowering / fruiting species	0 to 5
Erosion (number of gullies)	0	0	0	0	0	0

5.7.1. Fuel hub and aerodrome

The BS4 Fuel Hub and Boolgeeda Aerodrome rehabilitation sites demonstrated positive outcomes in total plant cover, with the values recorded in 2019 being within or above the two reference sites (Table 12). Outcomes associated with *Triodia* were also of satisfactory quality, with the Aerodrome transect exhibiting more than double the density of the reference sites, and a greater extent of cover was observed at the Fuel Hub compared to both reference sites.

Native perennial species density and richness

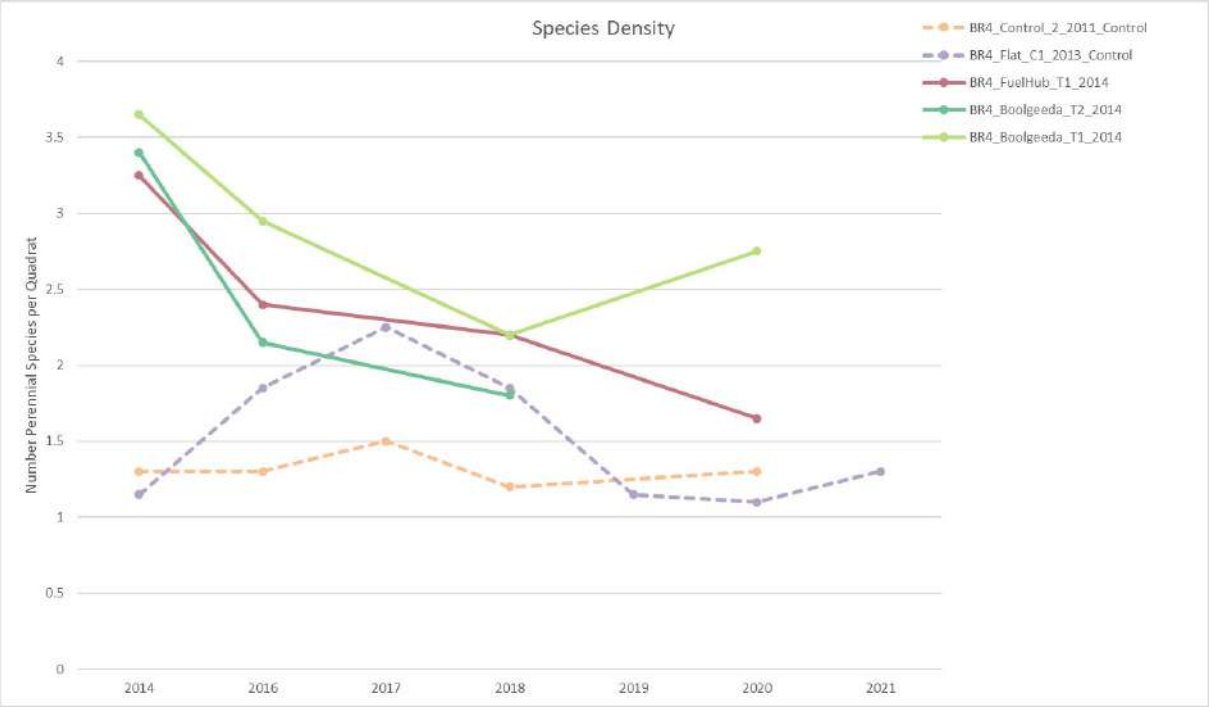


Figure 40: Native perennial species density (species / quadrat) for BS4 Fuel Hub and the Boolgeeda Aerodrome rehabilitation and reference sites over time.

The three rehabilitation transects follow declining trajectories in species density over the duration of monitoring, with the only inclining trend observed at Boolgeeda T1 between 2019 and 2020 (Figure 40). Despite the declines, species density across the rehabilitation was higher than or within the range of values recorded at the reference sites.

Similar to species density results, species richness at the rehabilitation sites have recorded declining trends since monitoring began in 2014. However, higher values were recorded at each rehabilitation transect compared to the three species documented at each reference site during vegetation quadrat monitoring (Table 12). The declining trends observed across these two parameters were likely influenced by the low rainfall received between assessments, which is supported by decreasing species density at the reference sites between 2018 and 2019.

Total numbers of native perennial species recorded during both the walk-around and quadrat assessments were 11 at the Brockman 4 Fuel Hub and 20 at the Boolgeeda Aerodrome, whilst reference sites Control 2 and Flat_C1 had 16 and 13 species present respectively. Species recorded on the rehabilitation included *Acacia atkinsiana*, *Acacia exigua*, *Triodia epactia* and *Triodia pungens*. The reference sites consisted mostly of *Triodia epactia*, although *Acacia pruinocarpa*, *Eucalyptus leucophloia* and several *Ptilotus* spp. were also observed. Six of the species recorded at the Boolgeeda Aerodrome rehabilitation were also found at one or more reference site, including *Acacia bivenosa*, *Corymbia hamersleyana* and *Triodia epactia*.

Native perennial plant density

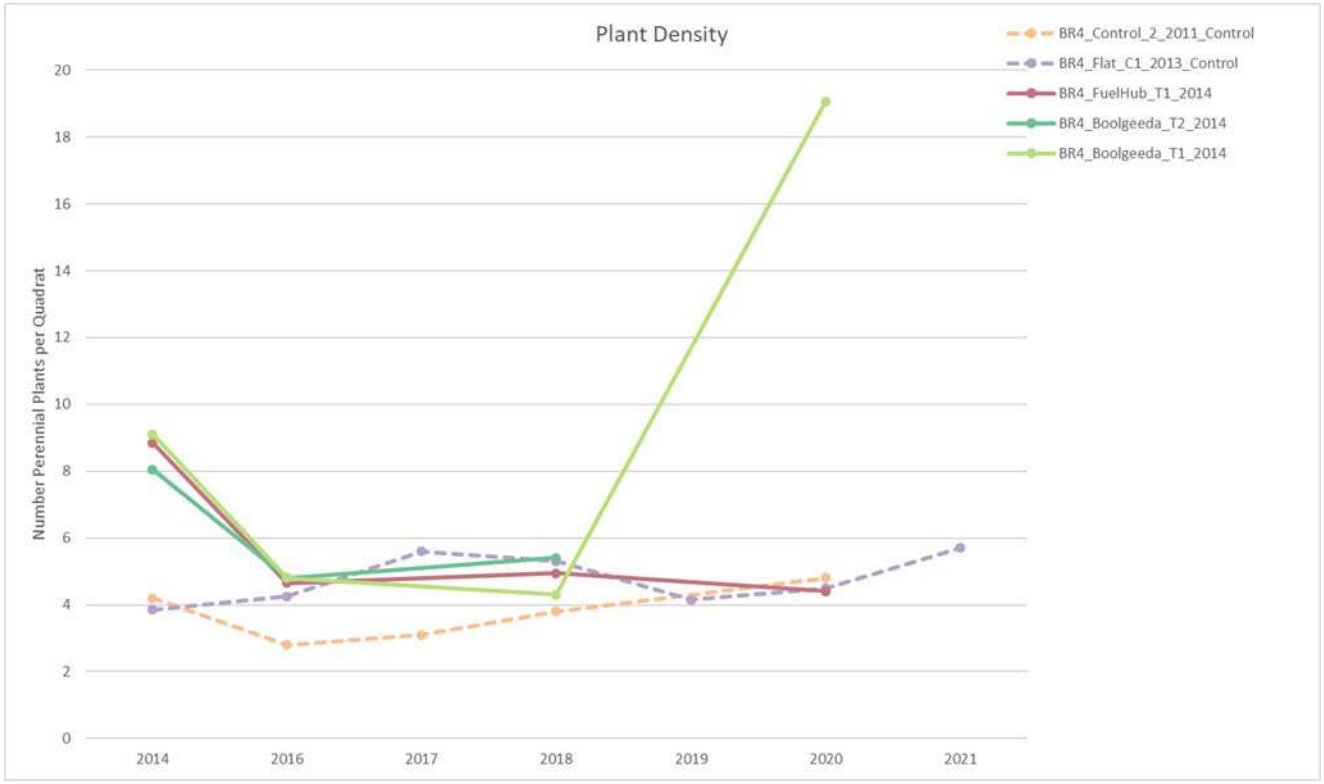


Figure 41: Native perennial plant density (plants / quadrat) for BS4 Fuel Hub and the Boolgeeda Aerodrome rehabilitation and reference sites over time.

Plant density follows similar trajectories from 2014 to 2018, whereby a steep decline occurred over the first two years followed by plateauing trends reflecting minimal change in the number of plants per quadrat between 2016 and 2018 (Figure 41).

The number of plants per quadrat at Boolgeeda_T1 increased slightly between 2016 and 2018 (4.7 to 5), and substantially between 2018 and 2020 (five to 19). The increasing trends were correlated to higher numbers of spinifex, with the drought-tolerant species better able to endure below average rainfall which was received in 2017 and 2018. Spinifex density increased substantially over the monitoring period at both the rehabilitated and reference sites, with the highest value recorded in 2020 (11 *Triodia* species per quadrat) observed at Boolgeeda_T1.

Native perennial plant cover

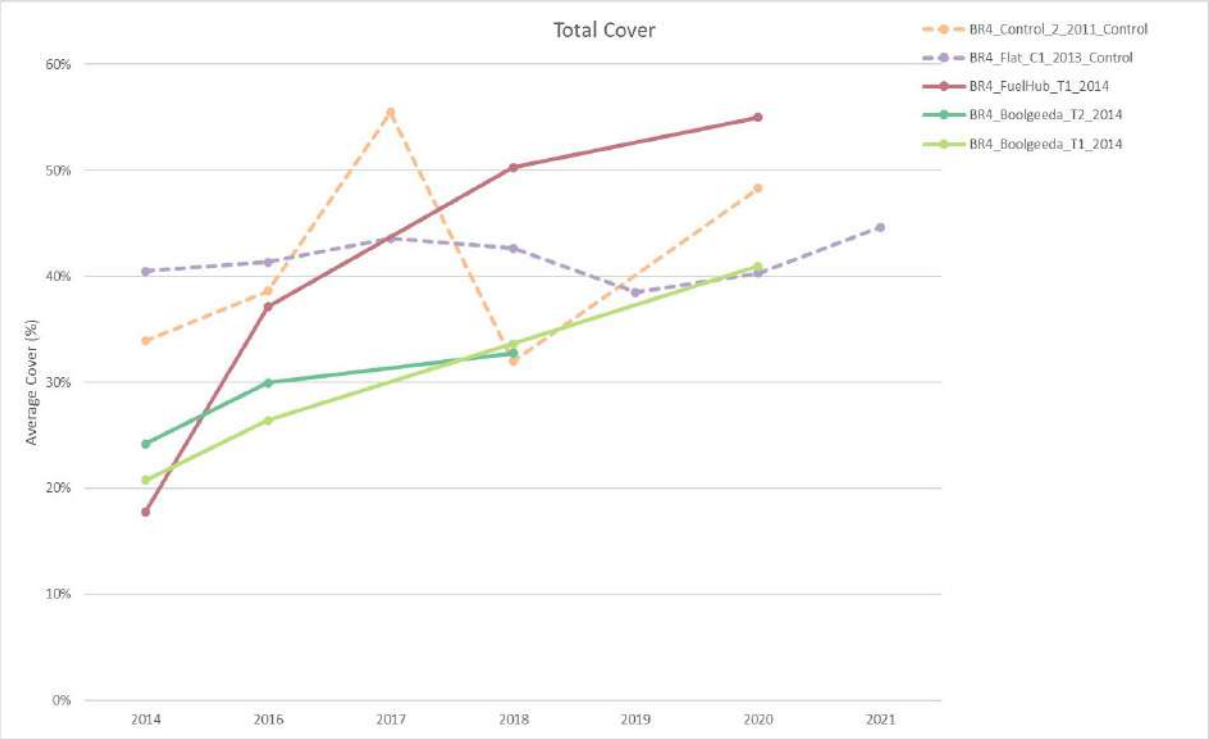


Figure 42: Native perennial plant density (plants / quadrat) for BS4 Fuel Hub and the Boolgeeda Aerodrome rehabilitation and reference sites over time.

Increasing trajectories of native perennial plant cover were exhibited by all three rehabilitation transects over the duration of monitoring, with the largest increase in cover observed at FuelHub_T1 (Figure 42). A substantial 55% of cover was recorded at the Fuel Hub site in 2020, higher than both reference sites, whilst the 41% documented for Boolgeeda_T1 was within the reference site range (Table 12). Plant cover at the reference site Control 2 increased between the last two assessment, with little change recorded at reference site Flat_C1.

5.7.2. Boolgeda Camp

Rehabilitation works at the Brockman 4 Boolgeeda Camp were completed in 2018, with monitoring of two 100 m transects first conducted in 2019. The site was hand seeded one week after ripping was completed, and existing trees were kept in-situ during rehabilitation works (which are summarised in Table 11). The area has not been burnt since monitoring began.

Native perennial species density and richness

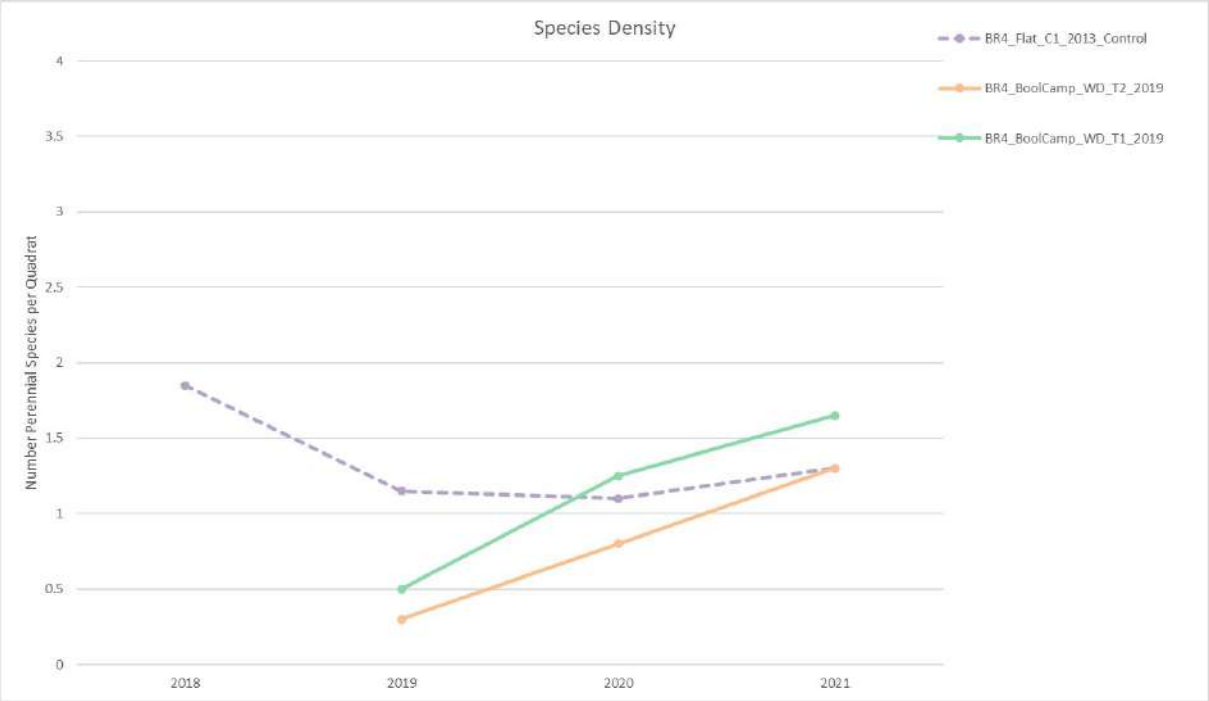


Figure 43: Native perennial species density (species / quadrat) for the Boolgeeda Camp rehabilitation and reference sites over time.

The Boolgeeda Camp rehabilitation sites follow increasing trajectories in species density, with T1 increasing by 1.2 species per quadrat from 2019 to 2021 and T2 by 1 (Figure 43). Species density at the reference site was relatively constant during this time, with the value recorded in 2021 exceeded by T1 and matched by T2.

Both rehabilitation sites had a total of ten species present in 2020, whilst three species were recorded on the reference site. Species counts increased to 28 and 18 at the rehabilitation with the addition of walk-around assessment results, with both values higher than the 13 species present at the reference site.

Five species recorded on the reference site were also present at both rehabilitation sites, including *Indigofera monophylla*, *Senna artemisioides* subsp. *oligophylla* and *Triodia epactia*. Of the nine species that were seeded, seven were present at BoolCamp_T1 and three were present at BoolCamp_T2, indicating that seeding was moderately to substantially successful.

Native perennial plant density

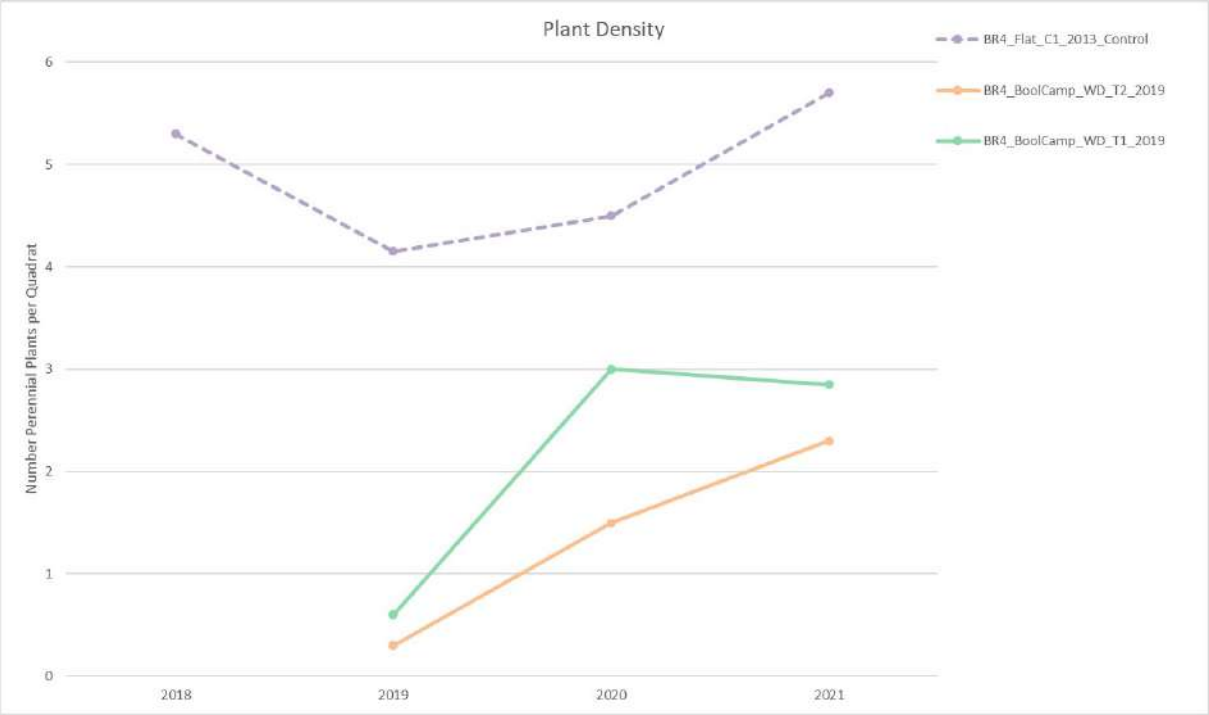


Figure 44: Native perennial species density (species / quadrat) for the Boolgeeda Camp rehabilitation and reference sites over time.

Over the monitoring period, plant density at rehabilitation transects T1 and T2 increased by 2.3 and 2 plants per quadrat respectively, although the rehabilitation values were significantly less than the reference site in all years except 2020 when T1 achieved similarity to the reference site (Figure 44).

These results are not indicative of poor rehabilitation performance as the sites are still young, and both trajectories demonstrate potential further development of vegetation, where plant density will approach target values as the vegetation matures.

Native perennial plant cover

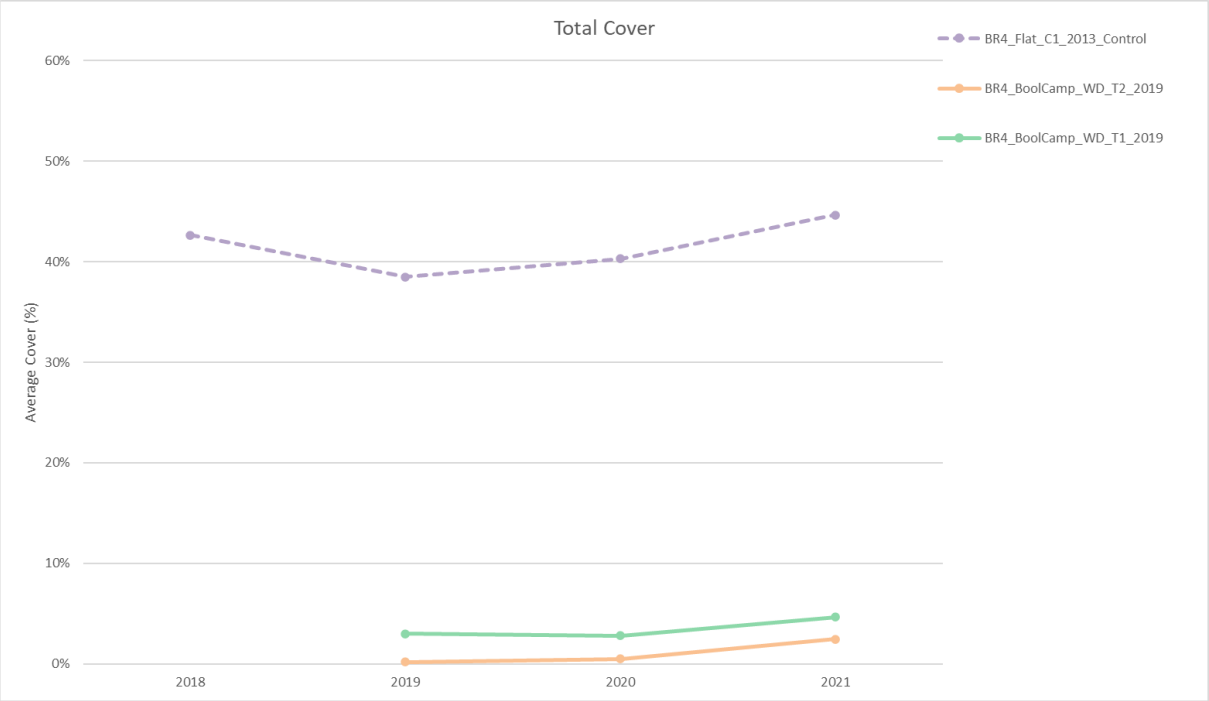


Figure 45: Native perennial total plant cover (%) for the Boolgeeda Camp rehabilitation and reference sites over time.

Native perennial plant cover remained below 5% at the rehabilitation transects despite the inclining trends observed for plant density. Rehabilitation cover values were significantly lower by pairwise comparison than the reference site, which is not unusual during the early stages of rehabilitation.

5.8. Moderate impact disturbance rehabilitation discussion

As expected over such a range of features and respective rehabilitation ages, performance of rehabilitation is variable. As previously discussed in this Summary, records of rehabilitation performed at older sites remain limited and assessment of techniques that are successful more difficult to establish. Broadly, there appears to be observed trends towards more successful establishment of vegetation on sites where seeding has been undertaken. As described previously, rainfall also has a significant impact on the success of vegetation establishment. Variability in performance across landforms is observed more often in sites with limited monitoring transects installed, highlighting the importance of installing a suitable range of monitoring transects.

However, for moderate impact disturbance, rehabilitation techniques employed by Rio Tinto appear to be broadly successful and lead to positive rehabilitation outcomes at many of the sites within this Summary.

5.9. Moderate impact disturbance area monitoring transects

Rehabilitated moderate disturbance areas within the Brockman Operation closure boundary that have been described within Sections 5.5 to 5.7 comprise borrow pit sites and other moderate impact transects categorised as landfill, road / transport facilities, camps / villages, mine pits, mine backfilled pits and airstrip. The monitoring transects associated with the above sections are shown in Figure 46 and Figure 47 below.

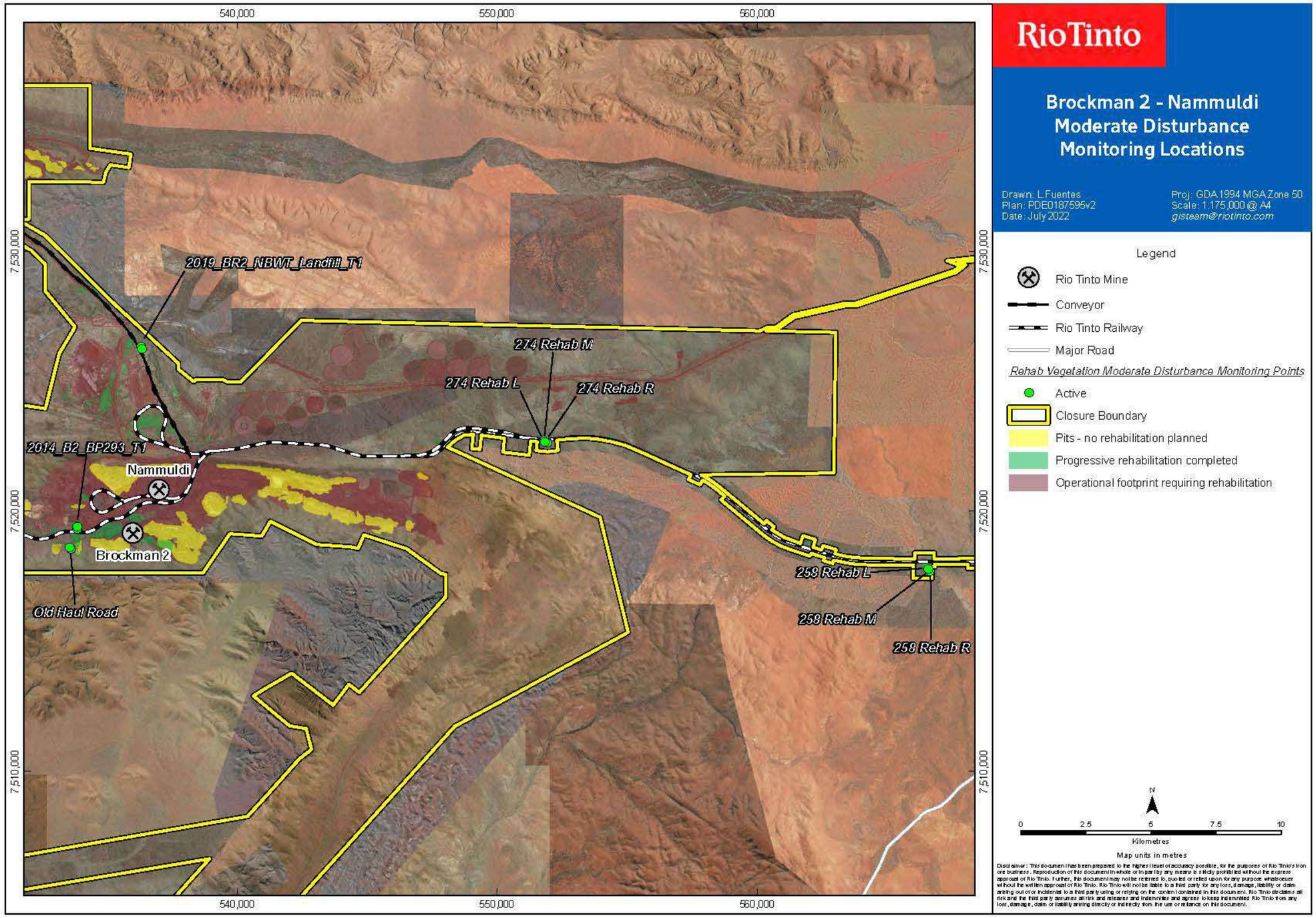


Figure 46: B2N moderate impact disturbance area monitoring transects.

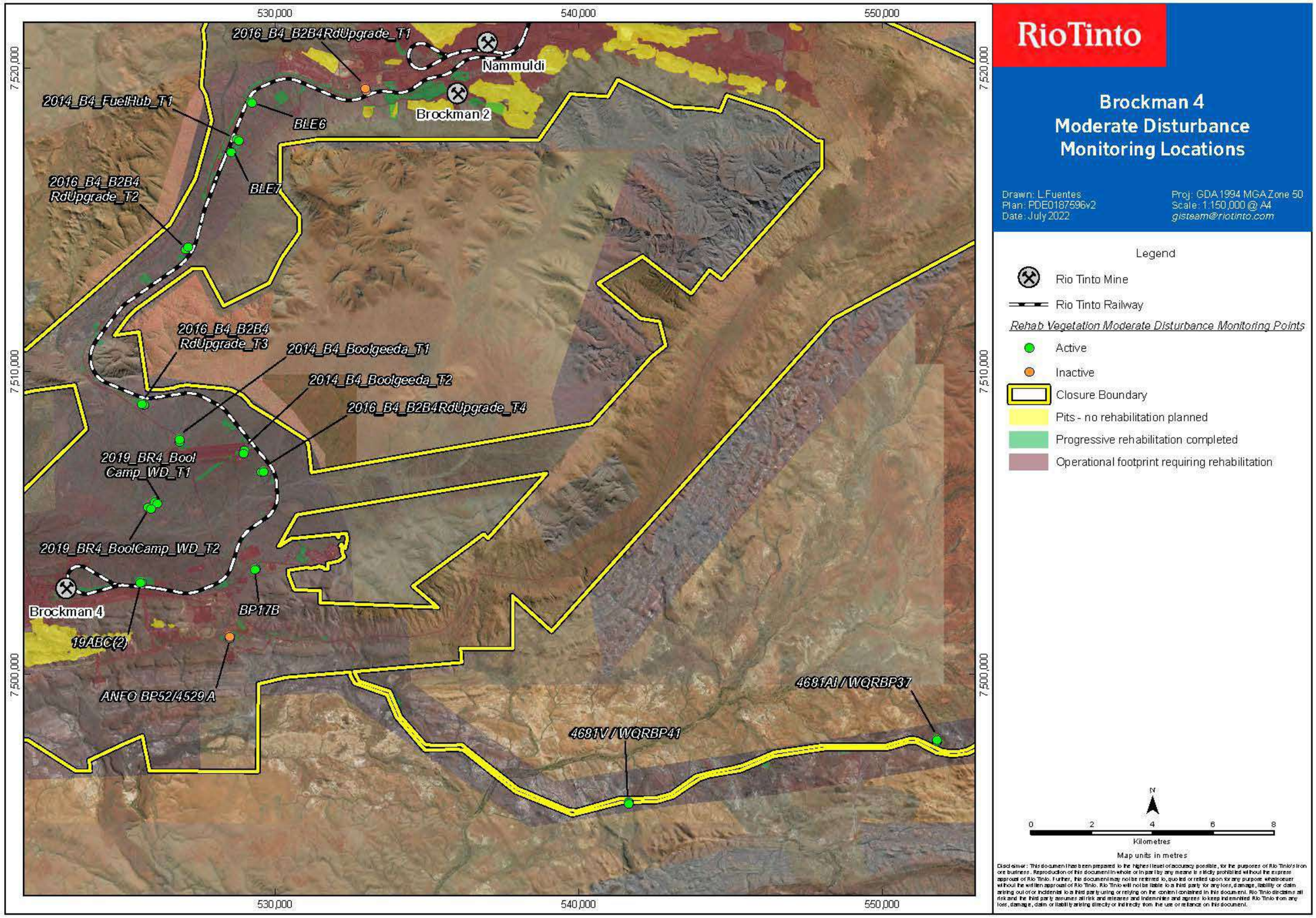


Figure 47: BS4 moderate impact disturbance area monitoring transects.

5.10. Monitoring results – High impact disturbance areas

Progressive rehabilitation of waste dumps within the Greater Brockman closure boundary has occurred since 1996. Although detailed records of rehabilitation methodology are unavailable for some of the older sites, monitoring results demonstrate the success of waste dump initiatives in establishing self-sustaining vegetation systems. Improvements in rehabilitation techniques and quality control (for example, GPS contour and ripping quality control) have since been implemented and will continue to develop as outcomes are documented and communicated, and procedures updated to reflect new knowledge. Details of rehabilitation and monitoring parameters for the high disturbance areas rehabilitated at Brockman Operations are presented in Table 13 to Table 15.

Table 13: Brockman Operation waste dump rehabilitation overview.

REHABILITATION PARAMETER	SITE						
	Nammuldi Lens C WD	**B2N Central and Pit 2 WDs**	**B2N Pit 6 WD**	**B2N South POD WD**	**B2N West WD**	**B2N B Dump**	**BS4 DP1 and DP4**
# Active transects (monitored)	1	3	2 (both now destroyed)	8	1	3	6
Area (ha)	14 ha		9.7 ha	17 ha		32 ha	
Closure domain	Waste dump	Waste dump	Waste dump	Waste dump	Waste dump	Waste dump	Waste dump
Year of rehab	2007	2001	2017	2018	1996	1999	2020
Growth medium	Topsoil / subsoil	Topsoil	Topsoil	Topsoil	Topsoil	Topsoil	Topsoil Also subsoil for northern part of DP4
Depth of growth medium application (mm)	Topsoil: 200 mm. Subsoil: 500 mm.	200 mm	100 mm to 200 mm	Unknown	200 mm	200 mm	Unknown
Time of storage of growth medium (yr)	Subsoil and topsoil were stockpiled when the area was cleared, and topsoil from an area at the toe of the landform was salvaged immediately prior to construction	Unknown	Topsoil from two stockpiles: P10A (6.5kt) approximately 2 months old BRO/99/0/TOPSOIL (32.6k), within 2-5 years old.	Unknown	Unknown	Unknown	Over 5 years
Seeding mix ((Appendix ?)	Documented local native perennial plant mix	N/a	23 native species of local provenance with viability range of 13.3 to 100%	17 native species of local provenance, viability range of 20 to 100%	N/a	N/a	Mix of 25 native species of local provenance, 9.3 to 100% viability, age range: 0.8 to 19.6 years

REHABILITATION PARAMETER	SITE						
	Nammuldi Lens C WD	**B2N Central and Pit 2 WDs**	**B2N Pit 6 WD**	**B2N South POD WD**	**B2N West WD**	**B2N B Dump**	**BS4 DP1 and DP4**
Seeding rate (kg/ha)	7 kg / ha	0	8.6 kg / ha. Seed was applied mechanically by an Ellworx dozer mounted seeder during ripping	8.7 kg / ha	0	0	5 kg / ha at DP1 8 kg /ha at DP4
Soil ameliorant (type)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Rate of application of ameliorant (kg/ha)	Site was ripped (depth unknown)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Contour ripping (depth)	Triple tine	Unknown	Yes (unknown)	600-800 mm	Unknown	Yes (unknown)	Yes (unknown)
Ripping (width)	Topsoil / subsoil	Unknown	Multi-tine ripper without wings. Berms were not planned for ripping and seeding, although due to operator error all were ripped and seeded along the contour	Triple winged tine	Unknown	Yes (unknown)	Yes (unknown)

Table 14: B2N Central and Pit 2 waste dumps, West waste dump and B Dump rehabilitation and reference sites monitoring overview.

MONITORING	REHABILITATION SITE			REFERENCE SITES	TOTAL / RANGE
	B2N Central and Pit 2 WD	**B2N West WD**	**B2N B Dump**	BR2 C1, C2, C5 and C9	
Year rehabilitation completed / year reference sites established	2001	1996	1999	2009	-
Year of latest available monitoring summary	2019	2019	2019	2019	
Number of transects monitored	3	1	3	4	11
Range of species richness values	3 to 7 species	9 species	5 to 14 species	6 to 10 species	3 to 14 species
Range of species density values	1.2 to 2.4 species per quadrat	1.7 species per quadrat	1.8 to 3.0 species per quadrat	1.5 to 3.0 species per quadrat	1.2 to 3.0 species per quadrat
Range of plant density values	3.0 to 5.1 plants per quadrat	4.2 plants per quadrat	3.5 to 5.4 plants per quadrat	5.3 to 12.1 plants per quadrat	3.0 to 12.1 plants per quadrat
Range of spinifex density values	2.0 to 4.6 *Triodia* plants per quadrat	3.1 *Triodia* plants per quadrat	2.0 to 2.9 *Triodia* plants per quadrat	4.9 to 11.2 *Triodia* plants per quadrat	2.0 to 11.2 *Triodia* plants per quadrat
Range of total cover values (%)	28 to 40%	45%	38 to 50%	38 to 64%	28 to 64%
Range of spinifex cover values (%)	12.4 to 37.0%	38.5%	19.7 to 41.5%	34.8 to 57.1%	12.4 to 57.1%
Range of weed cover values (%)	0 to 1.8%	0%	0.7 to 2.1%	0 to 0.2%	0 to 2.1%

MONITORING	REHABILITATION SITE			REFERENCE SITES	TOTAL / RANGE
	B2N Central and Pit 2 WD	**B2N West WD**	**B2N B Dump**	BR2 C1, C2, C5 and C9	
Range of weed density values	0 to 2	0	0.3 to 0.7	0 to 0.1	0 to 2
Range of percentages of quadrats with weeds present	0 to 30%	0%	10 to 20%	0 to 5%	0 to 30%
Range of percentages of quadrats with annuals present	0 to 30%	5%	0%	0%	0 to 30%
Range of # of species flowering / fruiting (inc. walk-around assessment)	2 to 3 flowering / fruiting species	4 flowering / fruiting species	4 to 5 flowering / fruiting species	2 to 3 flowering / fruiting species	2 to 5 flowering / fruiting species
Erosion (number of gullies)	1 gully (stable)	0 gullies	5 gullies (3 stable)	5 gullies (4 stable)	0 to 5 gullies

Table 15: Nammuldi Lens C, B2N Pit 6, B2N South POD and BS4 DP1 and DP4 waste dumps rehabilitation and reference sites overview.

MONITORING	REHABILITATION AND REFERENCE SITES							TOTAL / RANGE
	Nammuldi Lens C WD	BR2 C2 BR2 Lens C Control 1	**B2N Pit 6 WD**	**B2N South POD WD**	BR2 258 Control L BR2 274 Control M BR2 Airstrip Control	**BS4 DP1 and DP4**	BR4 Flat C1 BR4 Flat C5	
Year rehabilitation completed / year reference sites established	2007	2008 (C2) and 2009	2017	2018	1997 (Control L and M) and 2012	2020	2013	-
Year of latest available monitoring summary	Last monitored in 2016 (monitoring data only available from excel)	BR2 Lens C Control 1 last monitored in 2012, thus only BR C2 (2016) values included in this table	2020	2020	2020	2020	2020	-
Number of transects monitored	1	2	2	8	3	6	2	24
Range of species richness values	13 species	9 species	14 to 17 species	6 to 20 species	4 to 12 species	0 to 10 species	3 to 10 species	0 to 20 species
Range of species density values	1.6 species per quadrat	2.1 species per quadrat	2.6 to 3.2 species per quadrat	0.7 to 5 species per quadrat	1.1 to 2.0 species per quadrat	0 to 1 species per quadrat	1.1 to 1.6 species per quadrat	0 to 5 species per quadrat

MONITORING	REHABILITATION AND REFERENCE SITES							TOTAL / RANGE
	Nammuldi Lens C WD	BR2 C2 BR2 Lens C Control 1	**B2N Pit 6 WD**	**B2N South POD WD**	BR2 258 Control L BR2 274 Control M BR2 Airstrip Control	**BS4 DP1 and DP4**	BR4 Flat C1 BR4 Flat C5	
Range of plant density values	2.5 plants per quadrat	7.4 plants per quadrat	4.4 to 6.8 plants per quadrat	0.7 to 11 plants per quadrat	6.2 to 9.7 plants per quadrat	0 to 1 plant per quadrat	4.5 to 12 plants per quadrat	0 to 12 plants per quadrat
Range of spinifex density values	0.5 *Triodia* plants per quadrat	5.3 *Triodia* plants per quadrat	0.1 to 0.2 *Triodia* plants per quadrat	0.3 to 8.7 *Triodia* plants per quadrat	2.2 to 6.3 *Triodia* plants per quadrat	0 to 0.1 *Triodia* plants per quadrat	4.4 to 11 *Triodia* plants per quadrat	0 to 11 *Triodia* plants per quadrat
Range of total cover values (%)	20%	30%	35 to 51%	0.3 to 15%	13 to 36%	0 to 2%	40 to 43%	0 to 51%
Range of spinifex cover values (%)	Unknown*	Unknown*	0.4 to 0.5%	0.05 to 5.8%	7.8 to 30%	0 to 0.01%	31 to 35%	0 to 35%
Range of weed cover values (%)	Unknown*	Unknown*	0%	0 to 0.3%	0 to 0.1%	0%	0 to 0.4%	0 to 0.4%
Range of weed density values	Unknown*	Unknown*	0	0 to 0.5	0 to 0.1	0	0 to 0.2	0 to 0.5
Range of percentages of quadrats with weeds present	Unknown*	Unknown*	0%	0 to 30%	0 to 5%	0%	0 to 5%	0 to 30%

Range of percentages of quadrats with annuals present	Unknown*	Unknown*	90 to 95%	80 to 100%	5 to 50%	0 to 65%	5 to 55%	0 to 100%
Range of # of species flowering / fruiting (inc. walk-around assessment)	Unknown*	Unknown*	7 to 8 flowering / fruiting species	0 to 4 flowering / fruiting species	1 to 4 flowering / fruiting species	0 to 2 flowering / fruiting species	0 to 5 flowering / fruiting species	0 to 8 8 flowering / fruiting species
Erosion (number of gullies)	Moderate	0 gullies	5 gullies (3 unstable)	16 gullies (10 at SouthPod_T2)	0 gullies	41 gullies (stability unknown)	0 gullies	0 to 41 gullies

5.10.1. Nammuldi Lens C Waste Dump

A concave dump design was trialled for the first time at Nammuldi Lens C Waste Dump in 2006 (Figure 48 and Figure 49), with pushdown of the waste dump and concave sloping (ranging from 21.8 degrees at landform crest to 8 degrees at perimeter) conducted prior to rehabilitation of the site in 2007. Subsoil and topsoil were respread across the site to depths of 500 mm and 200 mm respectively, and a native seed mix was applied at a rate of 7 kg / ha (Table 13).

A high rainfall event occurred in March 2007 (Figure 10) when seeding was conducted, resulting in the area receiving more than double the long-term average rainfall for the month. High rainfall was also recorded the following month, creating favourable conditions for plant germination and establishment in the first year.

In 2008, one monitoring transect was installed at Lens C waste dump and has been monitored on six occasions, most recently in 2016, with the next assessment scheduled for 2022. Reference site Lens_C_Control_1 was established in 2008 specifically for evaluating rehabilitation performance at Lens C WD, however it was last monitored in 2012 due to amendments to the rehabilitation monitoring scope. This resulted in subsequent monitoring events utilising alternative reference site (C2 Control, installed in 2009) as the analogue for the rehabilitation.

The Lens C rehabilitation has been free of weed species since establishment, and has generally performed well, having been statistically comparable to the reference sites with respect to most parameters, most notably species density and total plant cover (Figure 50 and Figure 51). Spinifex density and plant density remained relatively low throughout the monitoring period, however plant density at the site followed a very stable trajectory with nominal declines observed and an increasing trend recorded as of the last assessment. The Nammuldi Lens C Waste Dump rehabilitation conformed with species density and plant density trends observed between 2008 and 2010 at the reference sites in response to climatic conditions, indicating the high importance of considering external factors in rehabilitation success.

Moderate erosion gullies (features deeper than 30cm) were recorded at the rehabilitation site, with increases and decreases in gully depth / width / height observed in different areas over time. The rehabilitation is to be disturbed towards the end of this year, and so remediation of any erosion is not currently required.



Figure 48: Lens C waste dump landform pre-rehabilitation works.



Figure 49: Lens C waste dump landform post-rehabilitation works.



Figure 50: Lens C Transect 1 (end) 2008 – 2 years after rehabilitation.



Figure 51: Lens C Transect 1 (end) 2016 – ten years after rehabilitation.

Native perennial species richness and density

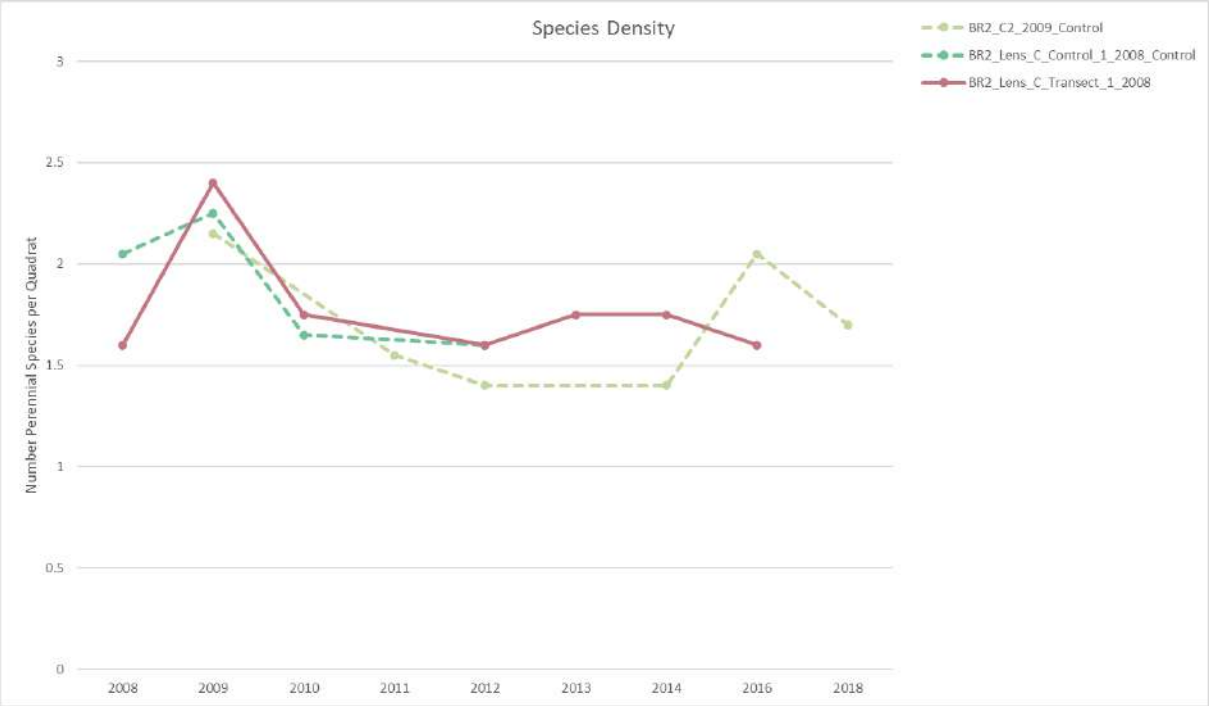


Figure 52: Native perennial species density (species / quadrat) for Nammuldi Lens C Waste Dump rehabilitation and reference sites over time.

The 2016 assessment recorded a small decline in the number of species per quadrat at rehabilitation site Lens C WD, whilst an increasing trend was observed at reference site Control 2, resulting in species density at the rehabilitation falling below Control 2's trajectory for the first time since 2010 (Figure 52). However, the difference in species density between the two sites was not statistically significant and overall, species density at the rehabilitation followed a comparable trajectory to that of the reference sites.

The steepest decline in species density at the rehabilitation was recorded between 2009 and 2010, with the trend reflected at both reference sites, suggesting that unfavourable environmental conditions influenced the loss of species at each site.

High values in species richness were recorded at the rehabilitation transect in each monitoring year, with each assessment recording a higher number of species per quadrat than the corresponding reference site value(s).

Native perennial plant density

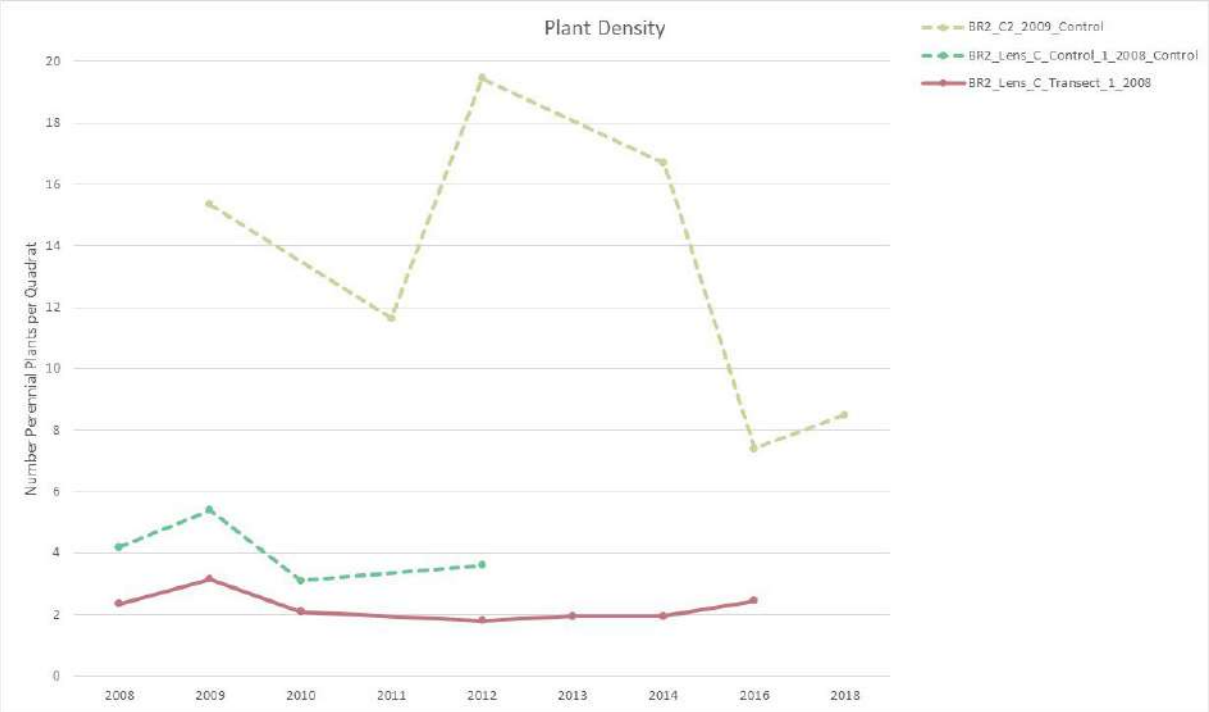


Figure 53: Native perennial plant density (plants / quadrat) for Nammuldi Lens C Waste Dump rehabilitation and reference sites over time.

Plant density at the rehabilitation site followed a stable trajectory over the duration of monitoring period, with highest and lowest values varying by only 1.4 plants per quadrat (Figure 53). Although the rehabilitation trajectory remained below those observed at the reference sites, a higher value was recorded in 2016 than that observed when first monitored, indicating that successful plant establishment has occurred at the site, including longer lived species.

Native perennial plant cover

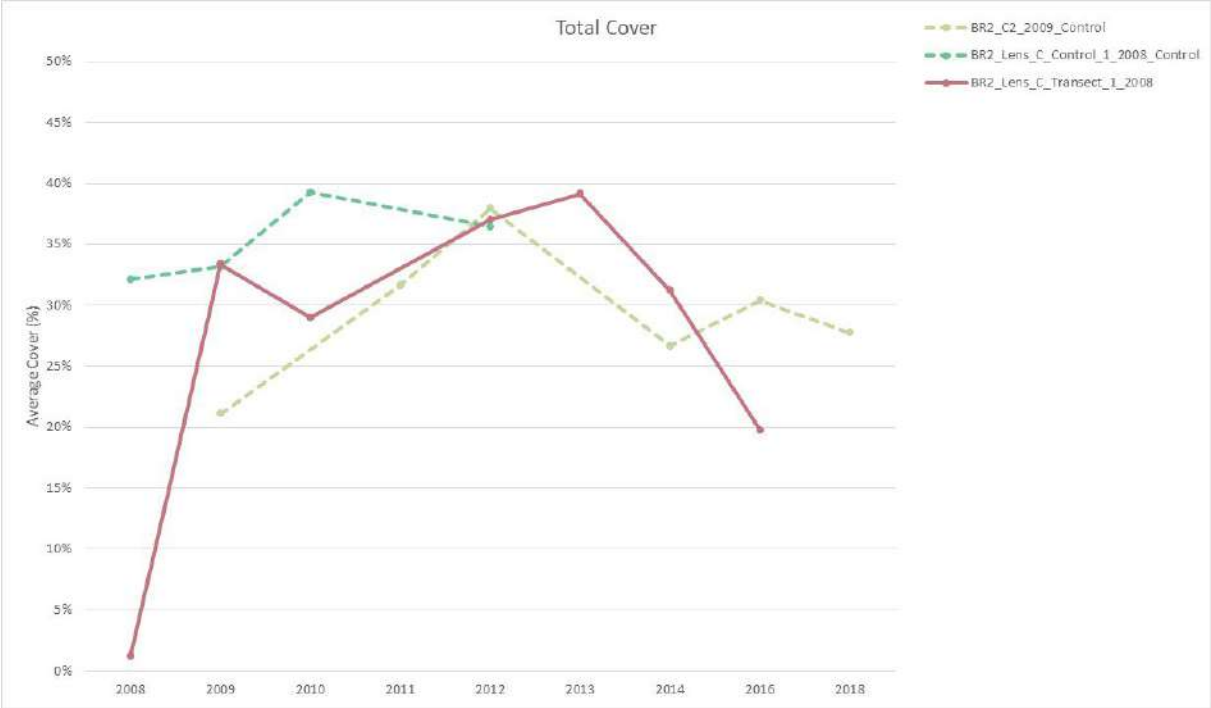


Figure 54: Native perennial total plant cover (%) for Nammuldi Lens C Waste Dump rehabilitation and reference sites over time.

Favourable rainfall post-seeding and topsoil application resulted in plant cover at the rehabilitation increasing from one to 32% within the first two years (Figure 54). An inclining trend also occurred between 2010 and 2013, with the rehabilitation achieving almost 40% cover. The two subsequent monitoring assessments recorded losses of 8% and 11% in total plant cover at the rehabilitation, with a similar loss observed at Control 2 between 2012 to 2014. The trajectory of plant density at the rehabilitation aligns with climatic data which shows favourable conditions during the first half of the monitoring period, and below average rainfall in ensuing assessments which may partially account for the declines observed in later years.

5.10.2. B2N Central and Pit 2 Waste Dumps

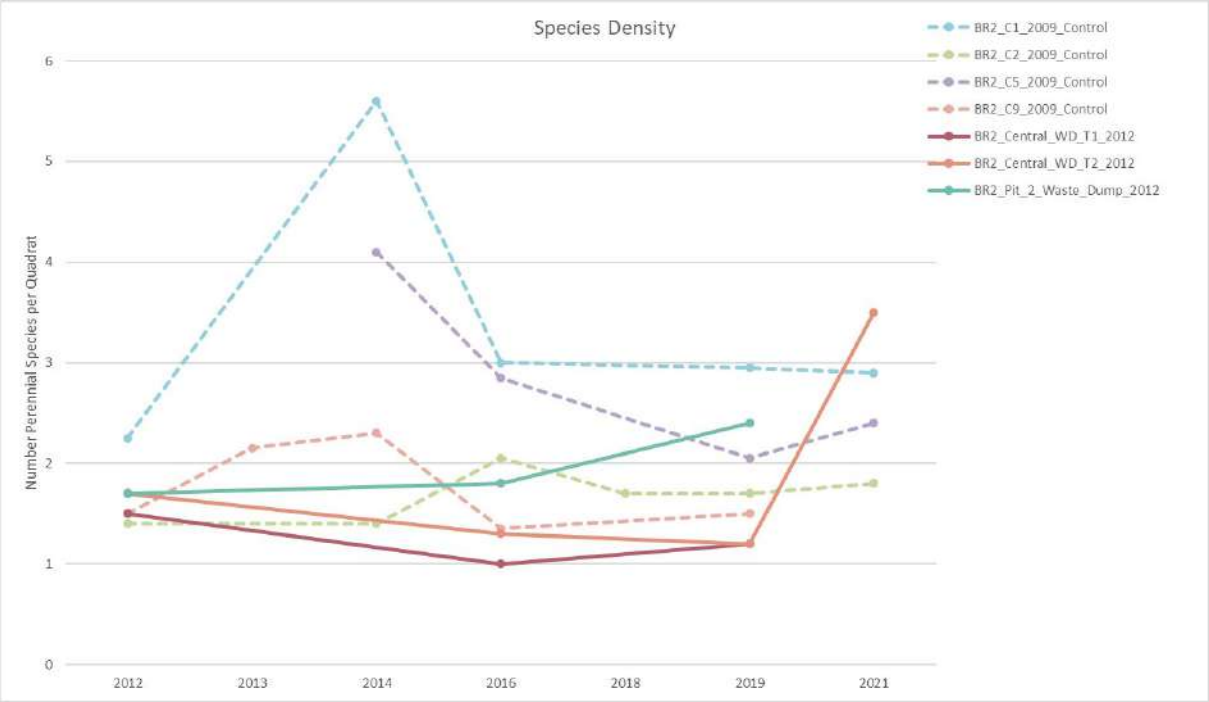


Figure 55: Native perennial species density (species / quadrat) for B2N Central and Pit 2 waste dump rehabilitation and reference sites over time.

The rehabilitation transects follow similar species density trajectories over the monitoring period, with declining trends observed from 2012 until 2016, and whilst Central WD T2 continues to decrease until 2019, ensuing increases were recorded at Pit 2 and Central WD T1 (Figure 55). The variation between the three sites increased with each subsequent assessment, although the difference was never significant. Higher numbers of species per quadrat were observed at Pit 2 which was the only site in 2019 with a species density within the reference site range. The highest overall rehabilitation value was recorded at Central WD T2 in 2021, when approximately 3.5 species per quadrat were documented, although no other rehabilitation site was assessed in this year.

Overall, there was a significant difference between the seven sites monitored in 2019, however, all three rehabilitation sites showed similarity to at least three reference sites which is considered a desirable outcome.

Rehabilitation species richness was highest at the Pit 2 WD, increasing to seven species in 2019, which was within the reference site range of 6 to 10. A cumulative total of 46 plant species were recorded across the rehabilitation and reference sites, including both quadrat and walk-around assessments. Twelve of these species were found on both a rehabilitation site and a reference site. No species were found on all seven sites, although *Acacia bivenosa* and *Triodia wiseana* were present on six sites.

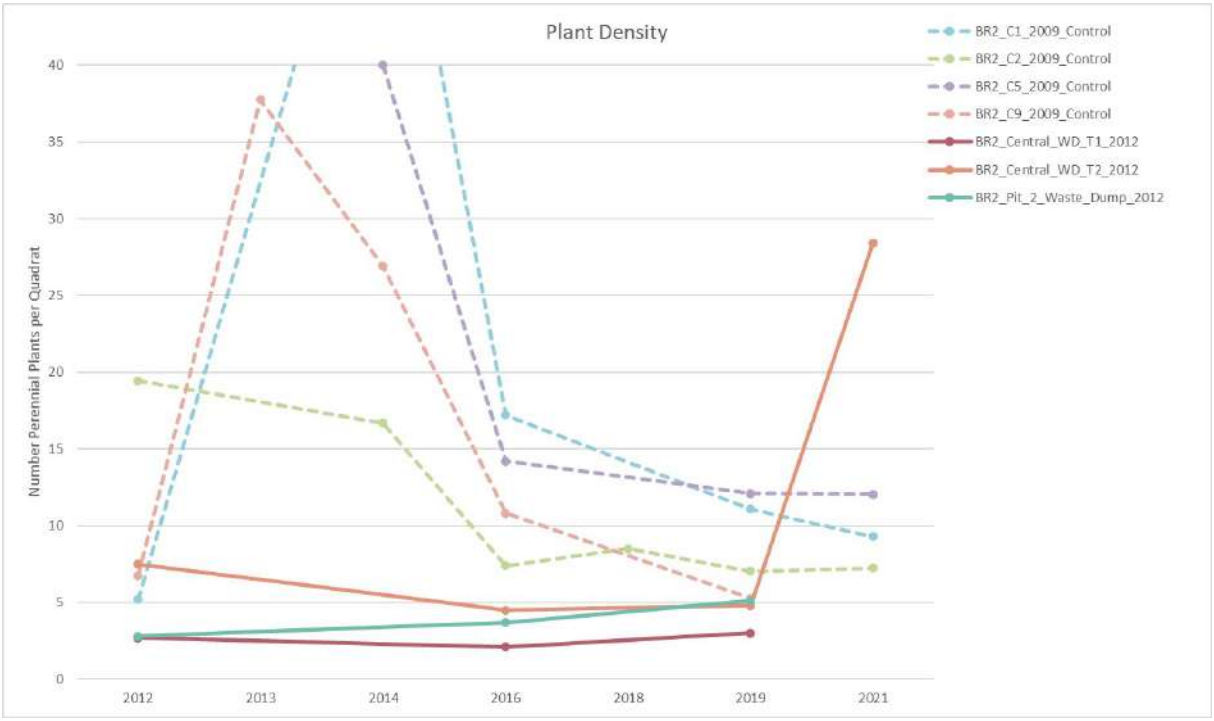


Figure 56: Native perennial plant density (plants / quadrat) for B2N Central and Pit 2 waste dump rehabilitation and reference sites over time.

A significant difference in native perennial plant density was found between all seven transects in 2019 (Figure 56). Values recorded throughout the monitoring period were higher on the reference sites than the rehabilitation in all instances except in 2012 where Central_WD_T2 had more plants per quadrat than two of the four reference sites. Despite the variation all three rehabilitation sites showed similarity to one or two reference sites as of the last monitoring assessment indicating that rehabilitation is performing well for this parameter.

The notably high plant density values recorded at the reference sites in 2014 can be attributed to fire impacting all four sites prior to 2014 monitoring. The lowest value was observed at C2, consistent with fire impacting much less of this transect than the other three.

Native perennial plant cover

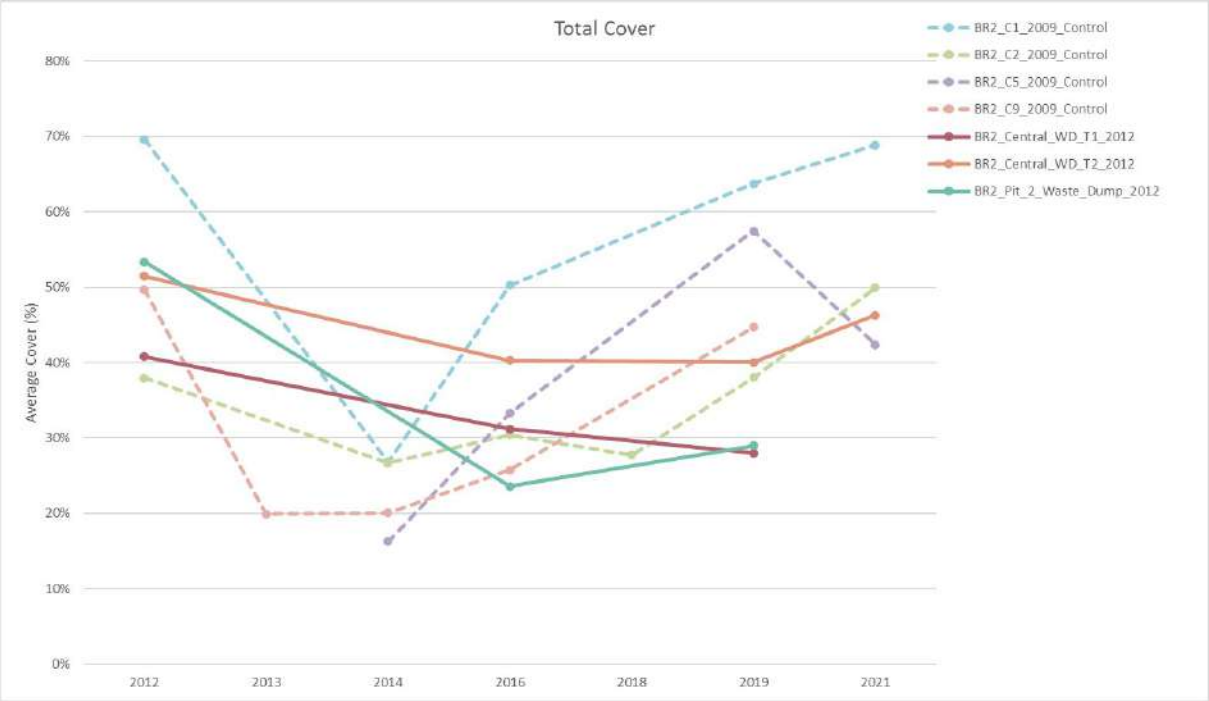


Figure 57: Native perennial plant density (plants / quadrat) for B2N Central and Pit 2 waste dump rehabilitation and reference sites over time.

Total plant cover decreased over the duration of monitoring at all three rehabilitation transects, although an inclining trend was observed at Pit 2 WD between 2016 and 2019 (Figure 57). Central WD 2 was the only rehabilitation site to have native perennial plant cover within the range of the reference sites in 2019, although both Central WD 1 and Pit 2 WD rehabilitation showed similarity to two of the four reference sites. Reference site data showed substantial increases in plant cover from 2014 and 2019 as the sites continue post-fire recovery.

5.10.3. B2N Pit 6 Waste Dump

The B2N Pit 6 waste dump is an example of more recently completed rehabilitation with improved documentation of rehabilitation methodology (Table 13). The landform design included four lifts at a slope of 20 degrees (Figure 58). Two rehabilitation transects were installed at Pit 6 waste dump in 2018 - one on the upper lift and one on the second lift. The area received rainfall well below average in the year preceding rehabilitation activities (Figure 10), but no significant rainfall in the months following seeding.

Application of seed and topsoil appears to have been successful, with data indicating that species have colonised from both the seed bank and seed mix applied (see Figure 59 and Figure 60). The seed mix was predominantly of a very high quality, with viability greater than 90% for most species included (10). A total of 15 species were seeded on the rehabilitation in 2017 and 11 of these species (73%) have been recorded in the rehabilitation to date.

Vegetation parameters on the three-year-old Pit 6 waste dump rehabilitation were generally comparable to or better than the reference site range. There has also been a substantial increase in plant density and cover since previous monitoring assessments. However, the overall structure of the vegetation differed to the reference sites, with a higher proportion of shrub cover on the rehabilitation. Most notably, spinifex density was well below the reference site range, highlighting a potential for remediation to facilitate better establishment of target community key species.



Figure 58: Pit 6 Waste Dump final rehabilitated landform (foreground to mid-ground).



Figure 59: Pit 6_WD_T1 (start) 2018 (one year after rehabilitation).



Figure 60: Pit 6_WD_T1 (start) 2018 (three years after rehabilitation).

Native perennial species density and richness

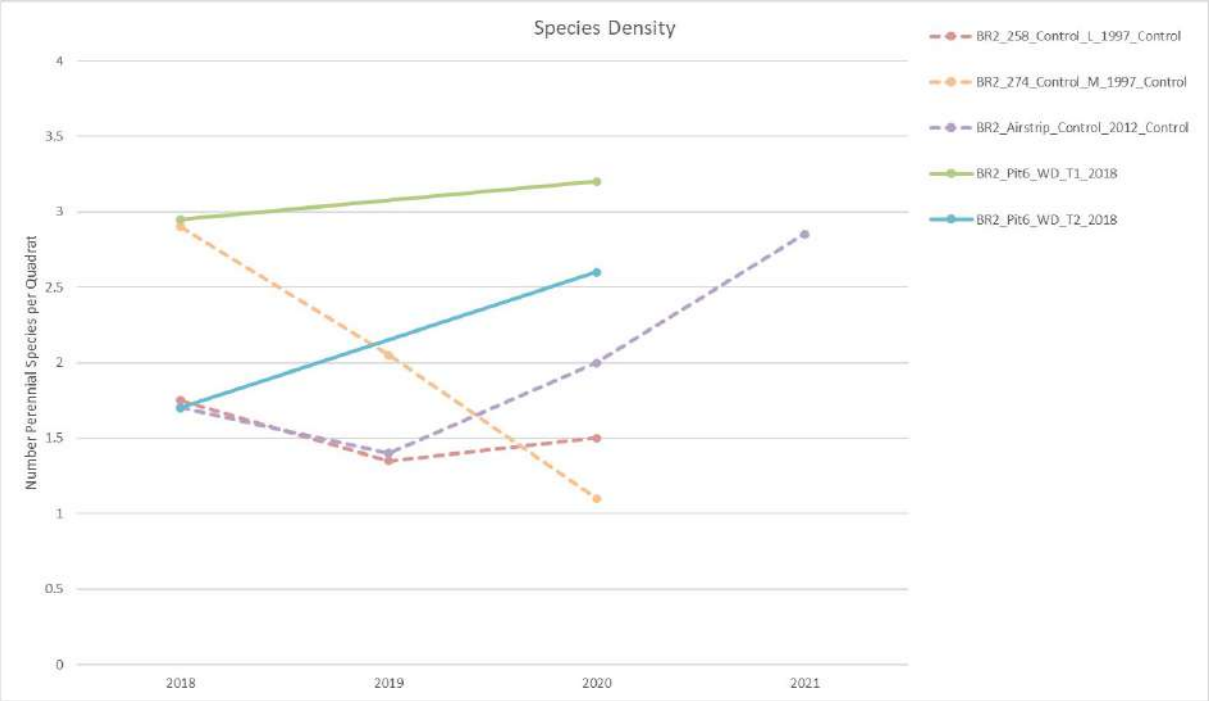


Figure 61: Native perennial species density (species / quadrat) for B2N Pit 6 waste dump rehabilitation and reference sites over time

The average number of perennial species per quadrat improved slightly at each rehabilitation transect between the two monitoring assessments (Figure 61). Both transects had significantly higher species density than 274 Control M and the value recorded Pit 6_T1 was also significantly higher than species density at 258 Control L. It should be noted that species density had decreased at 274 Control M, mostly attributed to a decline in several grass and shrub species such as *Paraneurachne muelleri*, *Eragrostis eriopoda*, *Hibiscus sturtii* var. *randifloras* and *Hibiscus sturtii* var. *platychlamys*. This was most likely due to a combination of below average rainfall and ongoing post-fire recovery

Species richness documented in 2020 was higher at the rehabilitation sites than all three corresponding reference sites (Table 15). The rehabilitation sites' species richness totals either remained unchanged since the initial monitoring event or increased negligibly. Over the same period, species richness at 274 Control M decreased substantially but remained relatively constant at 258 Control L and Airstrip Control. Although species richness along the transect at 274 Control M decreased substantially, most species that were recorded in previous assessments were recorded in the walk-around assessment in 2020, indicating that the lower species richness was driven by a decline in density rather than species losses.

Native perennial plant density

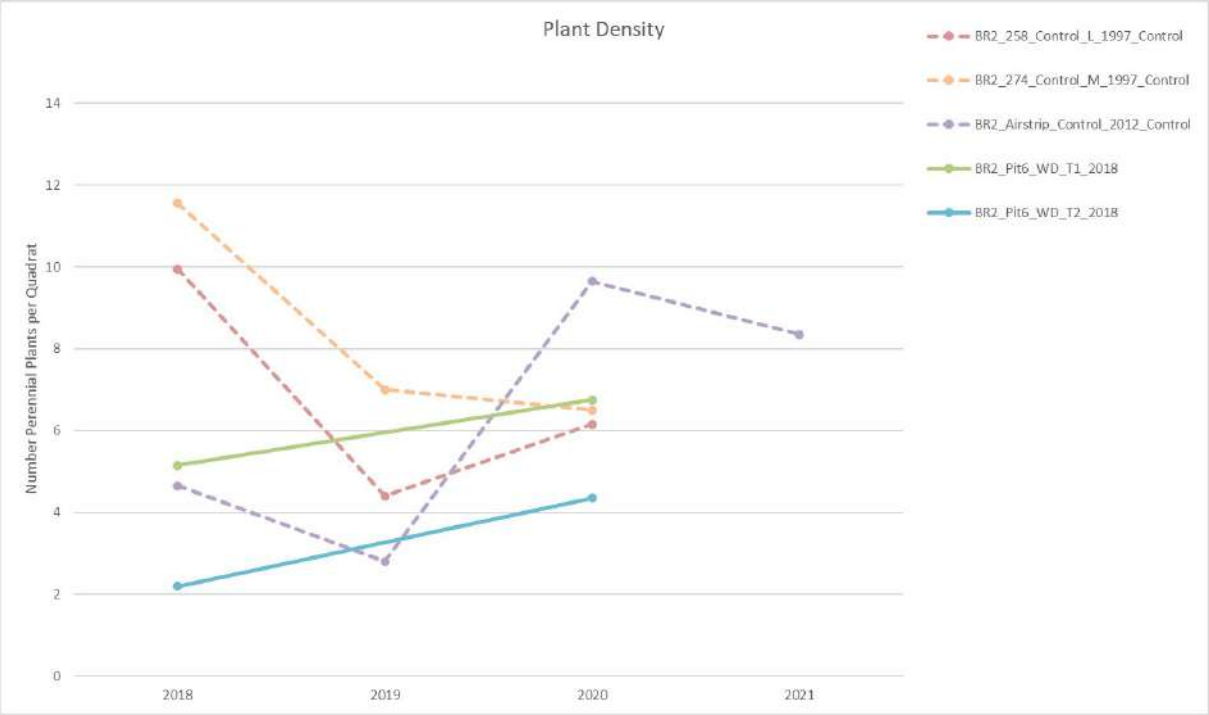


Figure 62: Native perennial plant density (plants / quadrat) for B2N Pit 6 waste dump rehabilitation and reference sites over time.

Inclining trends in native perennial plant density were observed at the rehabilitation from 2018 to 2020, whilst plant density declined at the reference sites between 2018 and 2019, with the 2020 assessment recording increases at the Airstrip Control and 258 Control L (Figure 62). The substantial increase at Airstrip Control was mostly attributed to an increased density of perennial shrub species such as *Corchorus lasiocarpus* subsp. *parvus*, juvenile *Corchorus* sp. and *Indigofera monophylla*. Overall, there were no significant differences between any of the rehabilitation or reference transects in 2020, although plant density at Pit 6_T2 was slightly lower than the reference site range.

The declining trends were most pronounced at 258 Control L and 274 Control M, with losses in several herbaceous species such as *Cheilanthes sieberi*, juvenile *Pterocaulon* sp. and *Sclerolaena cornishiana* observed at 258 Control, likely due to below average rainfall. The decrease in plant density at 274 Control M was most likely attributed to a natural decline in density as the vegetation matured following fire disturbance prior to the 2017 assessment.

Native perennial plant cover

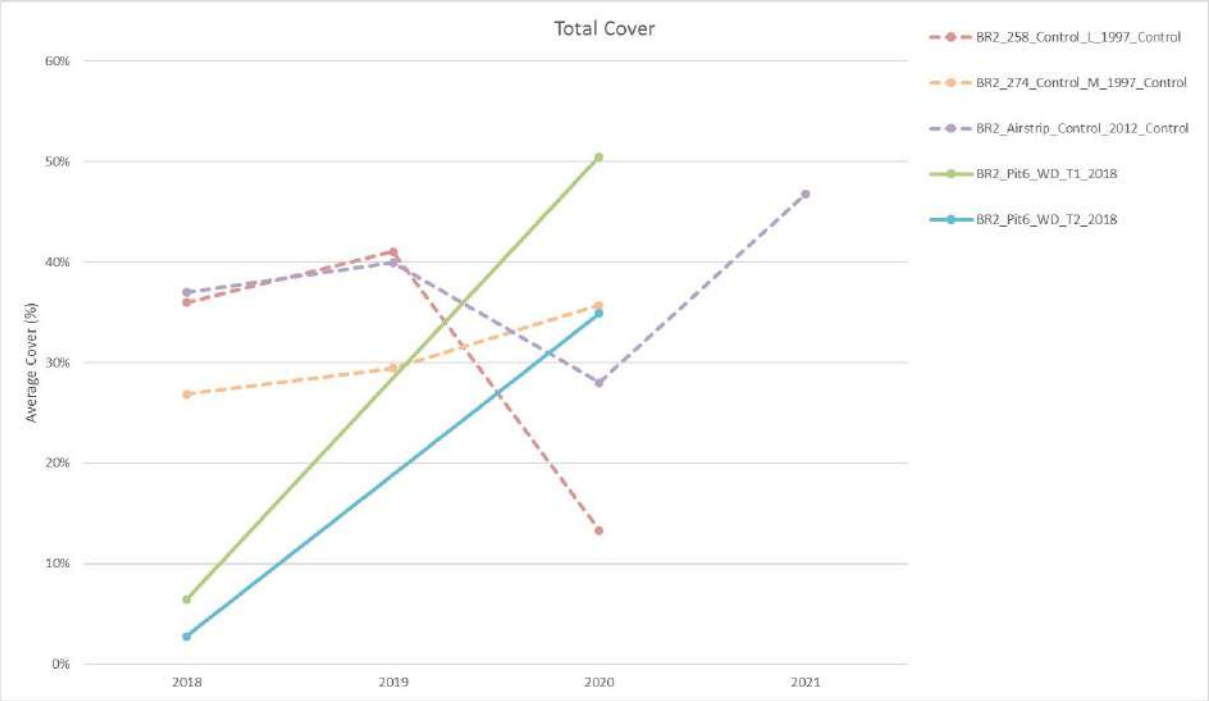


Figure 63: Native perennial plant density (plants / quadrat) for B2N Pit 6 waste dump rehabilitation and reference sites over time.

Substantial increases in native perennial plant cover occurred at each rehabilitation transect between monitoring assessments, with T1 achieving just a cover value of over 50% (Figure 63). Pit 6_T1 had significantly higher cover than 258 Control L and Airstrip Control, whilst Pit 6_T2 had significantly higher cover than 258 Control L. Plant cover at 258 Control L decreased substantially between 2019 and 2020, mostly attributed to a decline in cover of *Acacia aptaneura* and senescence of *Triodia epactia* following below average rainfall recorded in 2017 and 2018 (Figure 10).

Overall, cover at the rehabilitation is progressing considerably well with T1 having more native plant cover than all three reference sites and T2 recording a higher value than two of the reference sites.

5.10.4. B2N South POD Waste Dump

Rehabilitation of the South POD WD, which was built upon a backfilled pit, was completed in 2018. Eight transects were established across both flat and sloping terrain and first monitored in 2019. Seed was applied across the rehabilitation site, with each transect receiving differently treated seed mixes. Seeding methodology was designed to trial the following (by assessing seeding outcomes between):

- Flat versus sloping sites;
- Treated *Triodia* spp. seed ('after-ripening' method) vs. untreated *Triodia* spp. Seed; and
- 'Brushed' vs. non-brushed (Rio Tinto 2018).

Considering the young age of the site, rehabilitation at the South POD waste dump was developing well as of the last monitoring assessment. Most vegetation parameters had improved between the two assessments, with all transects achieving similar species richness to the reference sites. Comparability to reference site values across the other vegetation parameters was also observed, with higher values recorded at some rehabilitation transects.

The sloped rehabilitation areas had lower plant density and cover than the flat areas (Figure 64 to Figure 67), with the best performing site on the landform located on flat terrain (SouthPod_T5) - noting all parameters were within the range of the reference sites. The low density and cover values were likely

a result of the uncharacteristically dry wet season of 2018 which potentially influenced the success of initial species germination and delayed the establishment of vegetation (Figure 10). Additional monitoring assessments are required before forming a conclusion as to the effectiveness of each seed trial.

Some erosion gullies had formed between monitoring assessments and two weed species were observed across the site in 2020 (*Cenchrus ciliaris* and *Rumex vesicarius*), one of which (*C. ciliaris*) exhibiting an expanding presence from only one transect in 2019 to half the transects in 2020.



Figure 64: BR2_SouthPod_WD_T1_2019 (start) 2019 – one year after rehabilitation.



Figure 65: BR2_SouthPod_WD_T1_2019 (start) 2020 – two years after rehabilitation.



Figure 66: BR2_SouthPod_WD_T2_2019 (start) 2019 – one year after rehabilitation.



Figure 67: BR2_SouthPod_WD_T2_2019 (start) 2020 – two years after rehabilitation.

Native perennial species density and richness

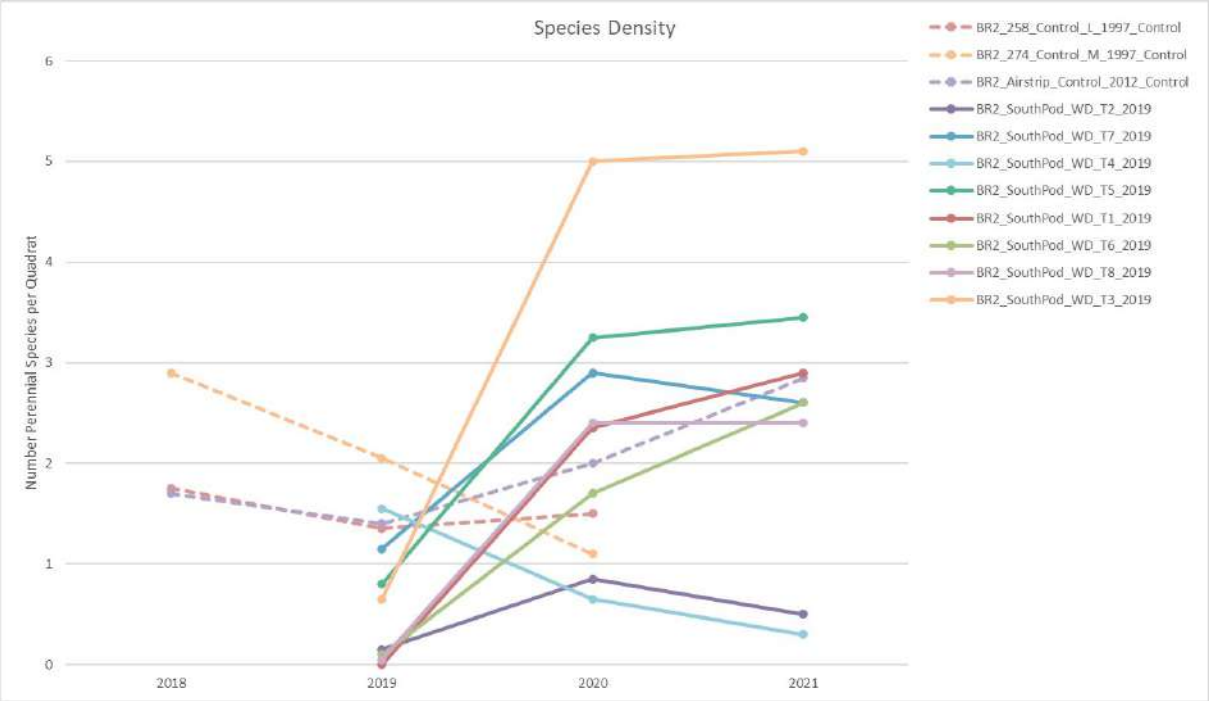


Figure 68: Native perennial species density (species / quadrat) for B2N South POD waste dump rehabilitation and reference sites over time.

Species richness varied widely across the eight rehabilitation transects, with values ranging from six at SouthPod_T2, to 20 at SouthPod_T3 (Table 15). All values were within the range of species richness values recorded at the reference sites (four to 12). A total of 41 plant species were recorded across the rehabilitation and reference sites, including both quadrat and walk-around assessments. Of these, nine were recorded on at least one rehabilitation site and one reference site. Of the 27 species recorded across the rehabilitation sites, seven were seeded or planted as tubestock.

Overall, the number of species per quadrat increased over the duration of monitoring at all rehabilitation transects except for SouthPod_T4 which had the highest initial value and lowest 2021 value (Figure 68: Native perennial species density (species / quadrat) for B2N South POD waste dump rehabilitation and reference sites over time.). The 2020 assessment recorded higher species density at five rehabilitation transects than all three reference sites, whilst in 2021 three transects had more species per quadrat than the one monitored reference site. In comparison, species density at the reference sites either remained relatively constant between 2019 and 2020 (Airstrip Control, 258 Control L) or decreased (274 Control M).

On average, species density was significantly higher for the untreated *Triodia* seed transects (0.85 species/quadrat compared to 0.26 species/quadrat for the treated seeds), but no trend was apparent between species density and the other treatments.

Native perennial plant density

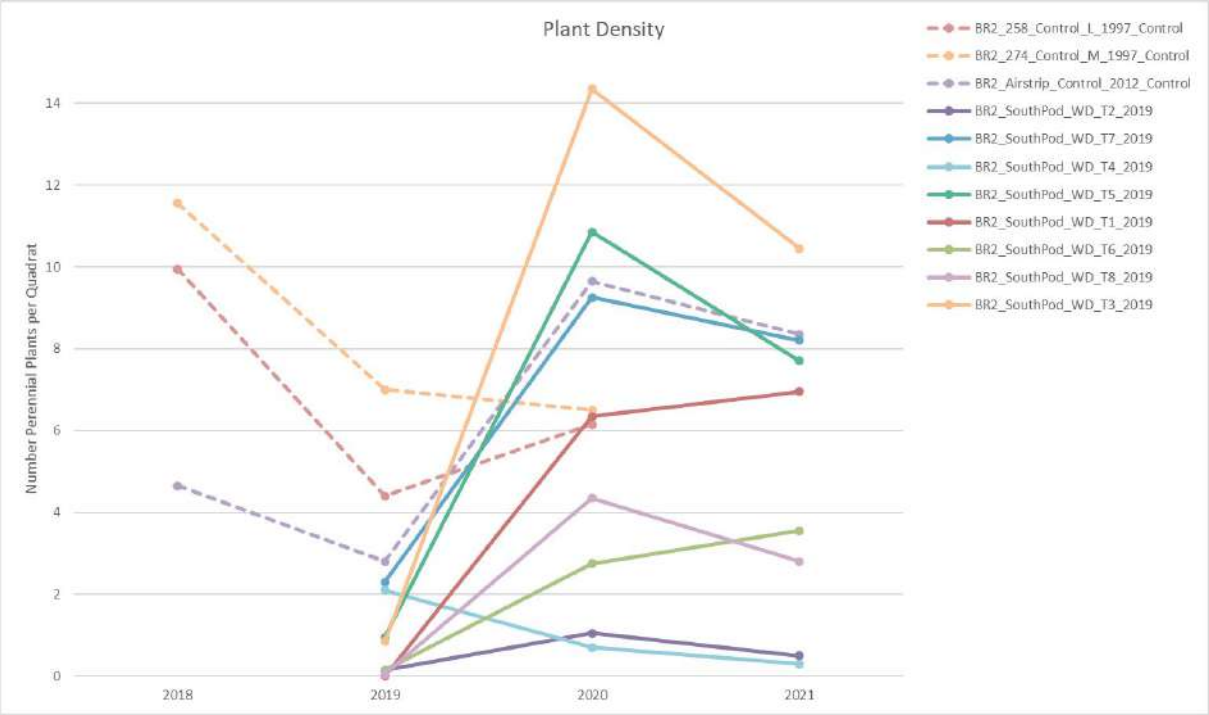


Figure 69: Native perennial plant density (plants / quadrat) for B2N South POD waste dump rehabilitation and reference sites over time.

Increasing trends in native perennial plant density were observed between 2019 and 2020 at all rehabilitation transects except for SouthPod_T4 where the number of plants per quadrat decreased by over 50%. Generally, plant density was higher at the flat transects compared to the sloped transects. SouthPod_T3 and SouthPod_T5 both had higher plant densities than the reference sites in 2020 (Figure 69).

The 2021 assessment recorded declines across most of the rehabilitation, with slight increases observed at T1 and T6. Low values may be attributed to the very young age of the sites and low rainfall conditions. Perennial plant density was mostly contributed by *Triodia* spp. at both the rehabilitation and reference sites in 2020.

Native perennial plant cover

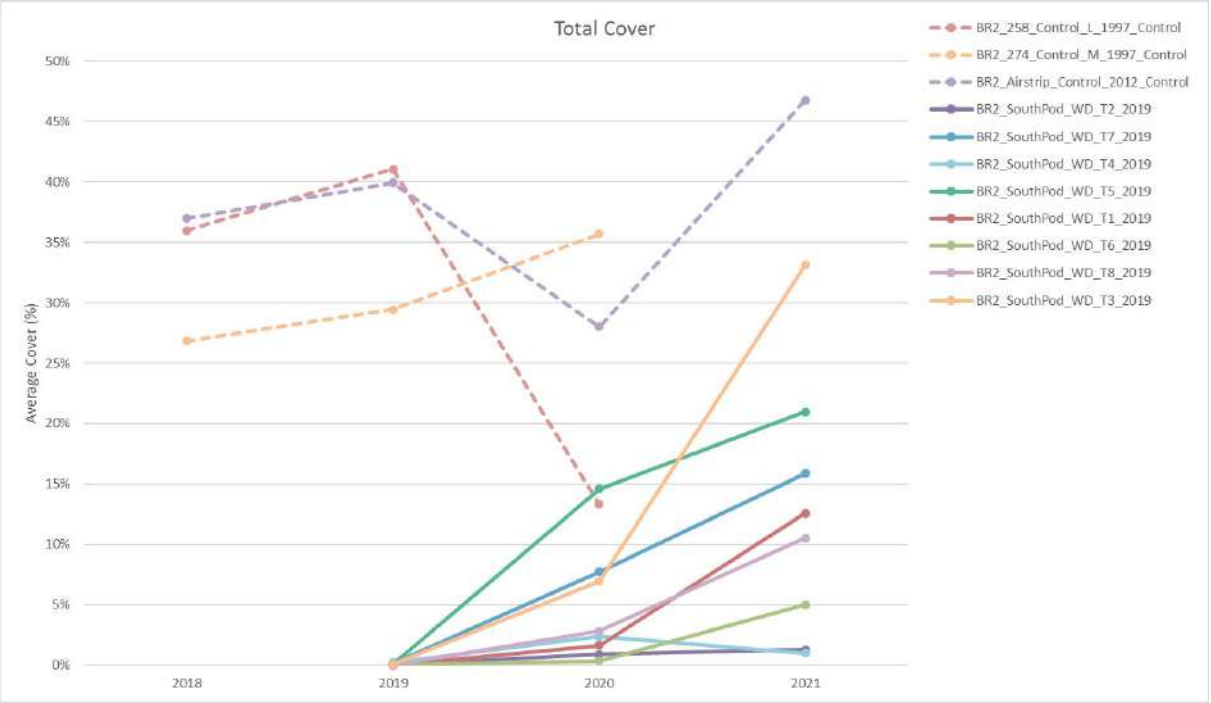


Figure 70: Native perennial plant cover (plants / quadrat) for B2N South POD waste dump rehabilitation and reference sites over time.

As expected of such young rehabilitation, plant cover was either absent or negligible during the first monitoring year, with T3, T5 and T7 performing best in this parameter (Figure 70). Consistent with species density and plant density results, SouthPod_T4 was the only transect where a declining trend was observed (between 2020 and 2021). Significant differences were found between all sites, with the least variation to a reference site achieved at T3.

5.10.5. B2N West Waste Dump

As the oldest waste dump rehabilitation site (completion in 1996), the B2N West waste dump provides an ample dataset for evaluating rehabilitation outcomes as monitoring has been conducted at the site for almost two decades. Overall, rehabilitation was progressing reasonably well, achieving values within or above the reference sites for species density and total cover. Although plant density was lower at the waste dump compared to all four reference sites the difference was insignificant and the last assessment recorded an increase. Plant density and species density trajectories peak significantly in 2003, with the inverse observed for plant cover.

Native perennial species density and richness

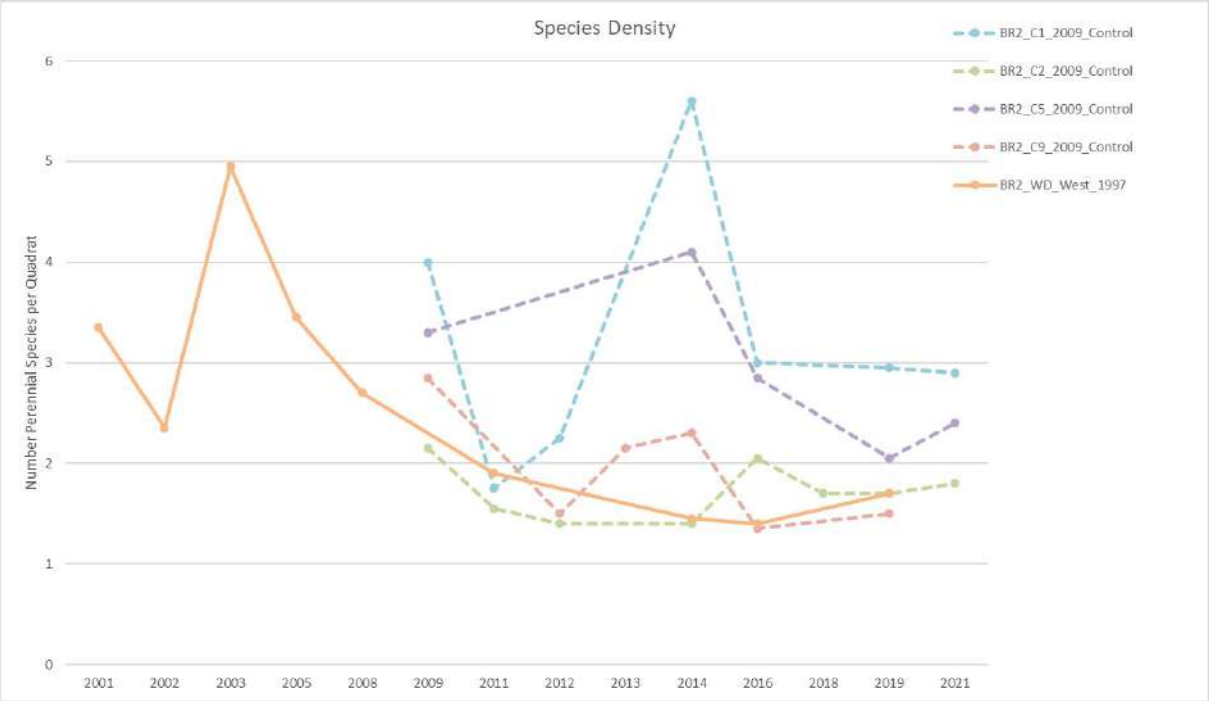


Figure 71: Native perennial species density (species / quadrat) for B2N West waste dump rehabilitation and reference sites over time.

Species richness recorded at the B2N West waste dump rehabilitation in 2019 was nine, which was within the range of the four reference sites, where seven to 10 species were observed (Table 14). Total species on the rehabilitation had increased by three since 2016, whilst the changes on the reference sites were more variable. A total of 20 plant species were recorded during walk-around and quadrat assessment across the rehabilitation and reference sites, with twelve common to both the rehabilitation and at least one reference site. *Acacia bivenosa*, *Eucalyptus leucophloia* and *Triodia wiseana* were present at all five sites.

The 2019 assessment found a significant difference in species density between the five sites, however, the rehabilitation achieved comparability to three of the four reference sites (C2, C5 and C9) and had increased since 2016. Prior to this, the number of species per quadrat at the West WD had progressively declined from the high value recorded in 2003 (Figure 71).

Native perennial plant density

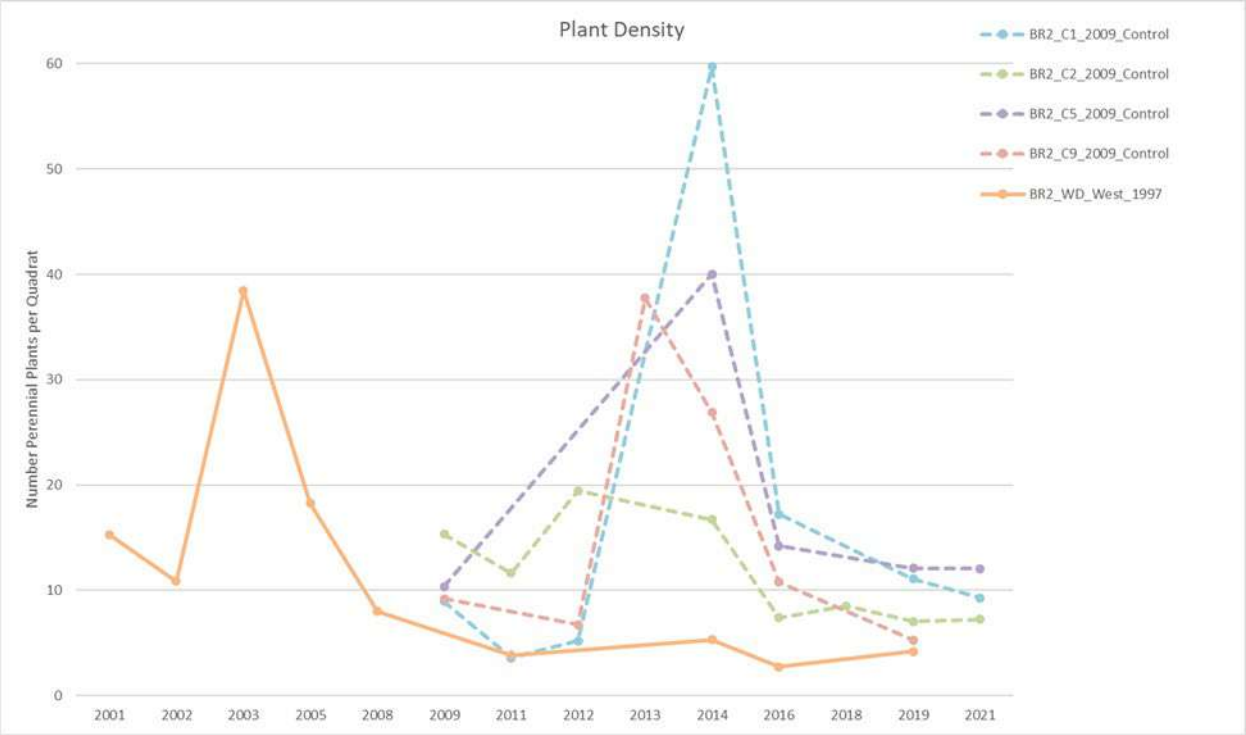


Figure 72: Native perennial plant density (plants / quadrat) for B2N West waste dump rehabilitation and reference sites over time.

The native perennial plant density recorded at the rehabilitation in 2019 showed similarity to C9, whilst varied significantly to the remaining reference sites. An inclining trend occurred from 2016 to 2019 at the West WD site, whilst declines were observed across the reference sites (Figure 72). The increase from 2.8 plants / quadrat to 4.2 plants / quadrat at the rehabilitation is considerable given the maturity of the site. The reference site trajectories of C1, C5 and C9 from 2012 to 2016 reflect fire disturbance and the subsequent post-fire recovery.

Native perennial plant cover

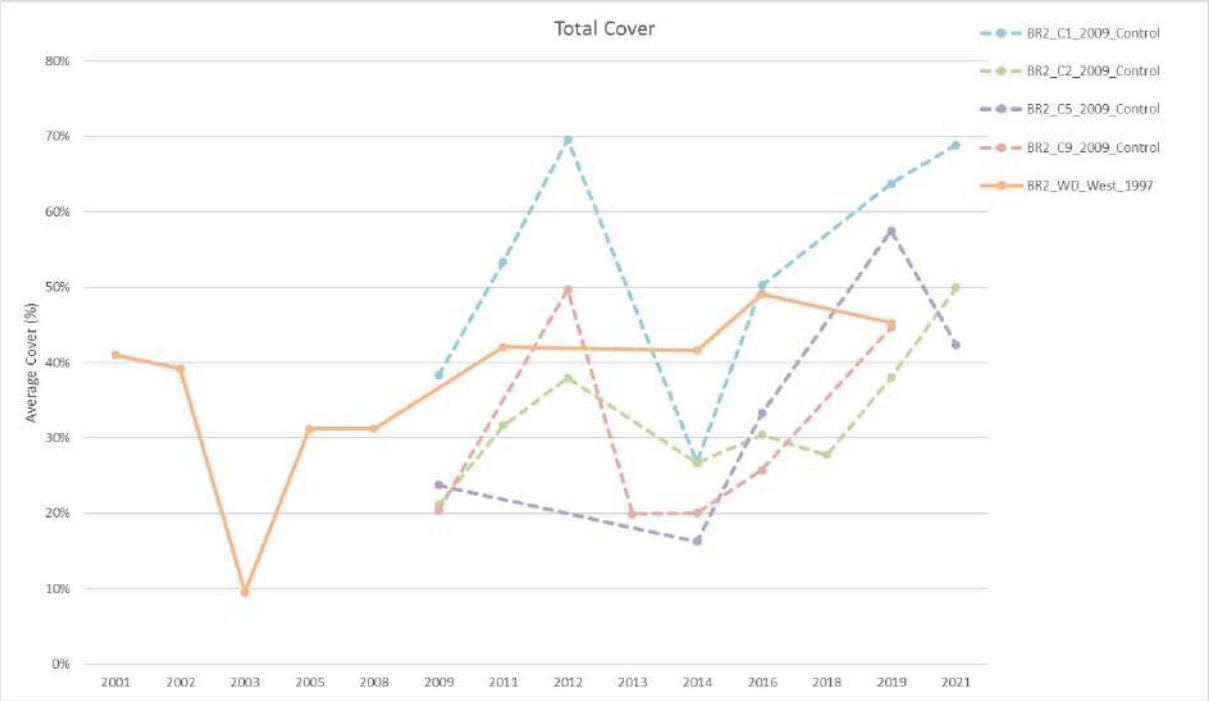


Figure 73: Native perennial plant cover (%) for B2N West waste dump rehabilitation and reference sites over time.

Large increases in native perennial plant cover occurred at the reference sites from 2014 onwards as they continue post-fire recovery (Figure 73). Conversely, plant cover decreased marginally at the rehabilitation between 2016 and 2019, from 49% to 45%. Although cover values varied significantly between the five sites in 2019, the rehabilitation showed similarity to all four reference sites and a steady increase since 2003.

5.10.6. B2N B dump

As rehabilitation of the B2N B dump was completed in 1999, there is little available rehabilitation methodology information. Monitoring of three transects on the landform commenced in 2012 and the monitoring data was compared to four reference sites, all of which were burnt or partially burnt prior to the 2013 or 2014 assessment. Although comparisons to reference sites showing signs of continued post-fire recovery (e.g. high plant cover) can complicate the evaluations of rehabilitation performance, B Dump vegetation parameter values were within or approaching the reference site range, indicating desirable progression.

Although spinifex density was notably lower across the rehabilitation, some increases had occurred since 2016. Weeds were present across the landform but at low cover and density, and *Cenchrus ciliaris* (Buffel Grass) was also observed at reference site C1. Erosion gullies were only present at B Dump 3 in 2019, whilst gullies previously detected at the other two sites had either flattened or infilled with material. Given the age of the B Dump rehabilitation (20 years), it is unlikely that substantial changes in vegetation structure and composition will occur in the short term. Figure 74 and Figure 75 provide an example of the rehabilitation site 13 and 20 years after works were completed.



Figure 74: B Dump T2 (start) 2012 – 13 years after rehabilitation.



Figure 75: B Dump T2 (start) 2012 – 20 years after rehabilitation.

Native perennial species density and richness

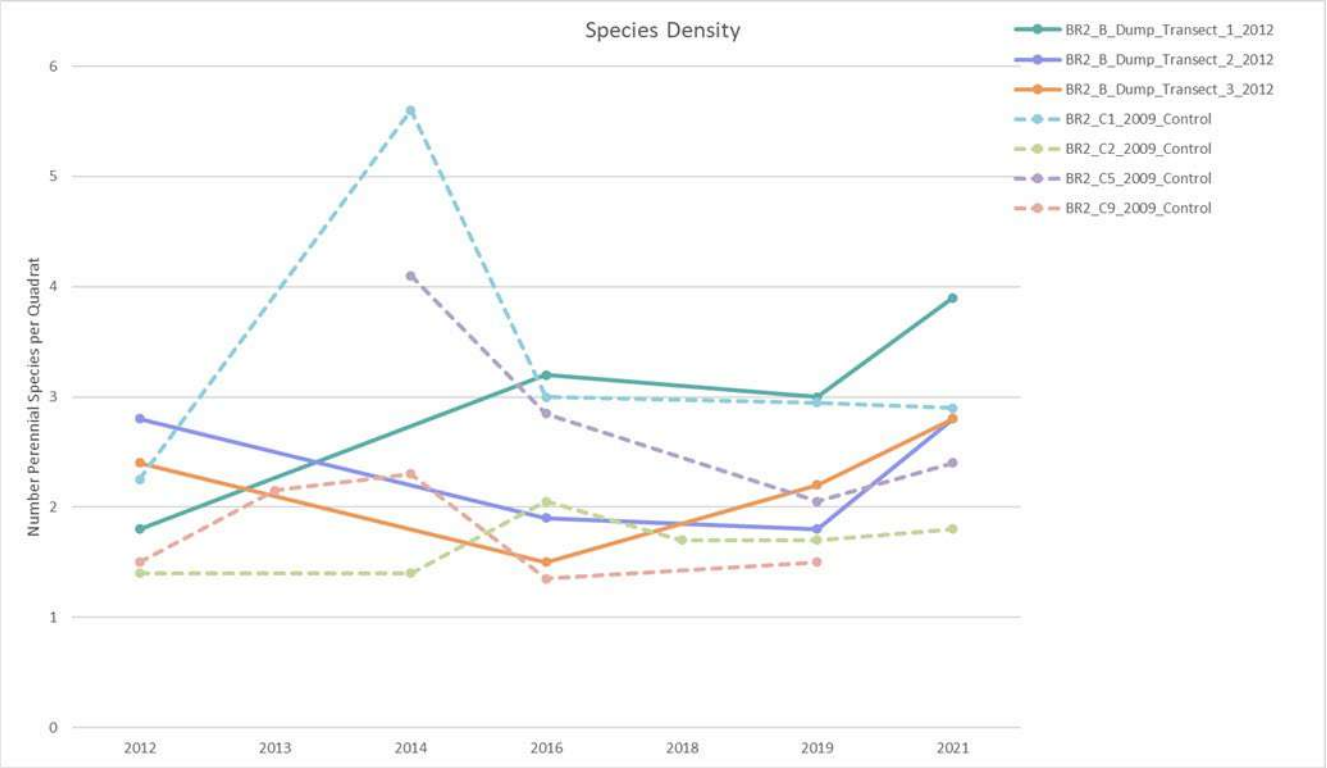


Figure 76: Native perennial species density (species / quadrat) for B2N B Dump rehabilitation and reference sites over time.

Species richness ranged from five at B Dump 2, to 14 at B Dump 1 and six to 10 species across the reference sites. The cumulative species count (including both quadrat and walk-around assessments) across the rehabilitation and reference sites was 41, fourteen of which were present at both a rehabilitation and a reference site. *Triodia wiseana* was the only species found on all seven sites.

Species density between the seven sites varied by approximately two species per quadrat in 2019, with each rehabilitation site (Figure 76).

Native perennial plant density

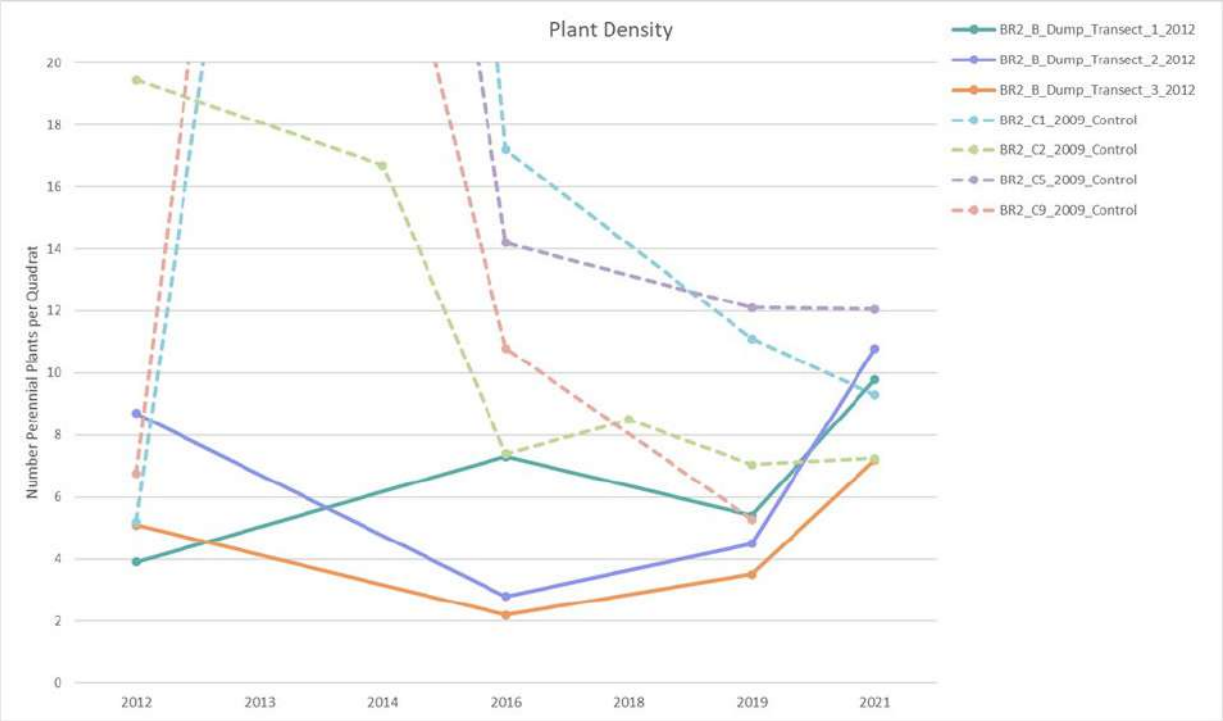


Figure 77: Native perennial plant density (plants / quadrat) for B2N B Dump rehabilitation and reference sites over time.[3]

Native perennial plant density increased overall at the rehabilitation transects, although substantial declines were recorded at transect 2 and 3 between 2012 and 2016, with a moderate declining trend observed at transect 1 from 2016 to 2019 (Figure 77). The variation between sites in 2019 was statistically significant, and the rehabilitation sites achieved similarity to plant density at C2 and C9 only. The considerably high values recorded at the reference sites in 2013 / 2014 are a result of fire disturbance and the trajectories observed indicate continued post-fire recovery, which may set unrealistic density targets for the rehabilitation.

[3] Note that maximum values of control sites not presented in this figure due to scaling issues.

Native perennial plant cover

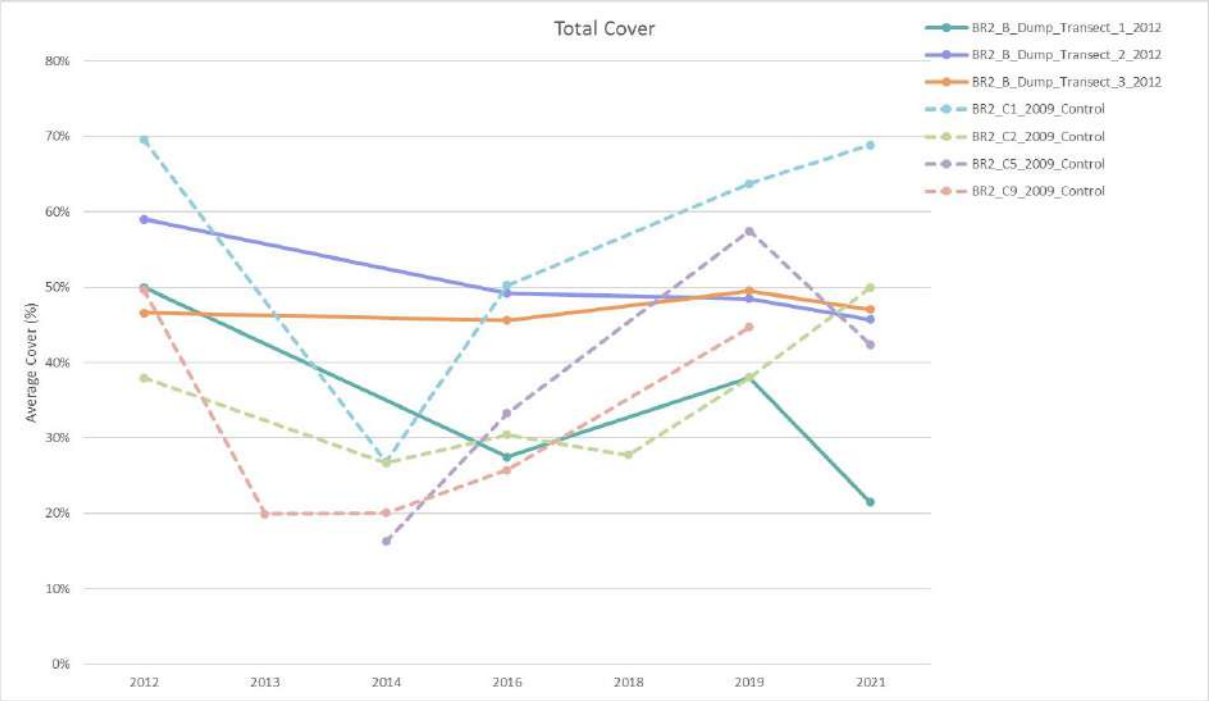


Figure 78: Native perennial plant cover (%) for B2N B Dump rehabilitation and reference sites over time.

There was a significant difference in plant cover (%) between the seven sites in 2019, however, each rehabilitation site showed similarity to three of the four reference sites. Plant cover at BDump transect 1 and 3 increased from 2016 to 2019, whilst a very slight decline occurred at transect 2 (Figure 78). Increasing trends occurred at the reference sites during this time, which can be attributed to the continued post-fire maturation of coloniser species at the sites, such as *Acacia* spp. which have a larger canopy cover but tend to senesce after 15 to 20 years.

5.10.7. BS4 DP1 and DP4

Minimal vegetation was recorded at the DP1 and DP4 rehabilitation sites in 2020, although the assessment was conducted less than 12 months post completion. The two DP1 transects had a similar species richness, although DP4_T3 was the only transect where the total number of species was within the range of the reference sites. In 2021, one rehabilitation transect achieved species density within the reference range, and another one recorded plant density higher than both reference sites. The 41 erosion gullies recorded across both landforms (39 of which were recorded DP4) in 2020 may be attributed to rainfall in the months preceding the assessment, with extremely high rainfall received in February 2020. Monitoring of these gullies will continue as the rehabilitation ages to determine if rework of areas may be required.

Native perennial species density and richness

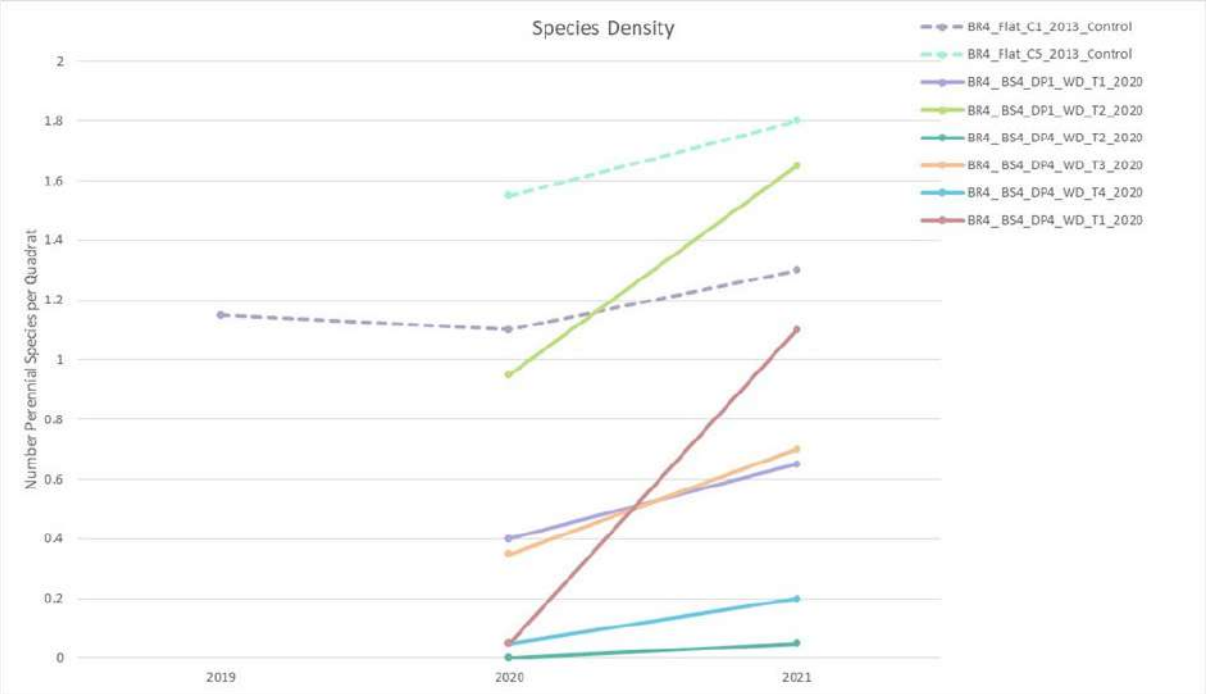


Figure 79: Native perennial species density (species / quadrat) for BS4 DP1 and DP4 rehabilitation and reference sites over time.

Species richness ranged from zero to ten across the rehabilitation in 2020 six to 10, whilst three to 10 species were present at the reference sites (Table 15). DP1 transects were within the reference site range.

Including both quadrat and walk-around assessments, there were between zero and 13 species present at the rehabilitation, whilst 13 to 21 species were recorded across the reference sites. Species recorded on the rehabilitation that were also present on at least one reference site included *Acacia ancistrocarpa*, Corchorus lasiocarpus subsp. *parvus* and *Triodia epactia*. Five seeded species were recorded at DP1, all of which were *Acacia* species, whilst two seeded species, *Acacia bivenosa* and *Senna artemisioides* subsp. *oligophylla*, were recorded at DP4_T3.

Species density in 2020 was less than one at all DP4 rehabilitation transects (significantly lower than the reference sites), with one transect achieving just over one species per quadrat by 2021. DP1_T1 had a significantly lower species density than the reference sites in 2020, whilst some similarity was achieved by DP1_T2. Inclining trends occurred at each DP1 transect between 2020 and 2021, with the highest increase observed at DP1_T2.

Native perennial plant density

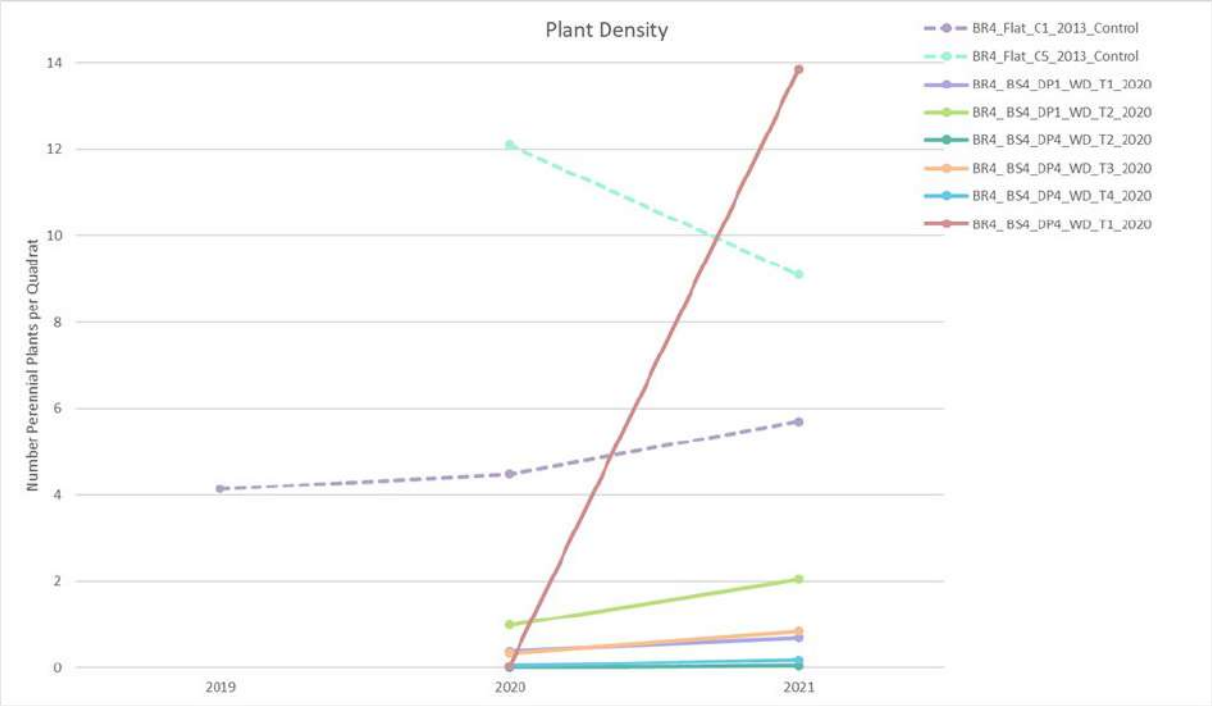


Figure 80: Native perennial plant density (plants / quadrat) for BS4 DP1 and DP4 rehabilitation and reference sites over time.

The initial number of native perennial plants per quadrat was substantially lower at the rehabilitation sites compared to the reference sites (Figure 80), despite above-average rainfall received in February 2020 when rehabilitation works were completed. In general, there was minimal establishment of perennial species at the time of the first monitoring assessment. As per species density, plant density was less than one at all DP4 sites in 2020, compared to reference site values of 4.5 and 12 (Table 15). A substantial increase occurred at DP4_T1 between monitoring assessments, with almost 14 plants per quadrat observed in 2021. A moderate increase occurred at DP1_T2, reaching just over two plants per quadrat by 2021.

Native perennial plant cover

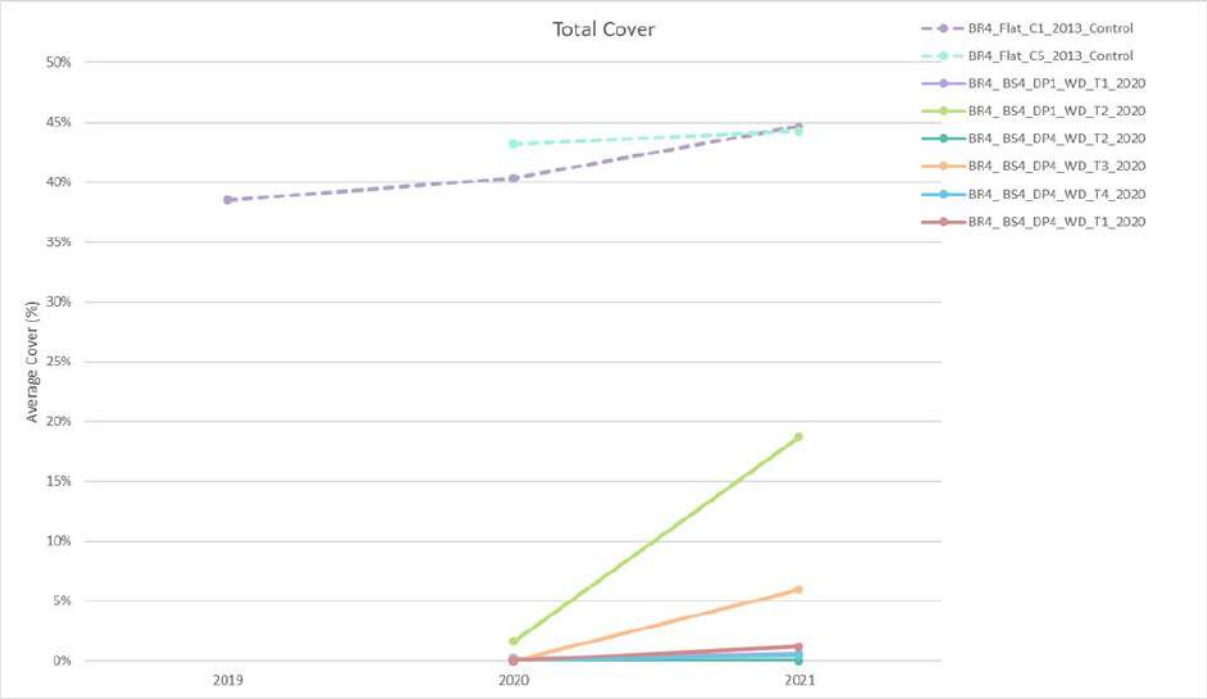


Figure 81: Native perennial plant cover (%) for BS4 DP1 and DP4 rehabilitation and reference sites over time.

In 2020, native perennial plant cover across the DP1 rehabilitation was 2% or less and zero at the DP4 transects, with all values significantly lower than the 40% and 43% of cover observed at the reference sites (Table 15). Given the young age of the rehabilitation, this result is not unexpected. Two DP1 transects show encouraging inclining trends between 2020 and 2021, with little to no change recorded at all other rehabilitation transects (Figure 81). Perennial species recorded at the rehabilitation sites in 2020 were juvenile, and as such contributed very little cover.

5.11. High impact disturbance rehabilitation discussion

Rehabilitation undertaken of high impact disturbance at the Brockman Operations ranges from older landforms through to recently rehabilitated landforms. The oldest landform included in this Summary is B2N West Waste Dump, which has been monitored since 2001 and currently demonstrates consistently similar monitoring results to those of the reference sites. This landform could be considered to have reached a state representative of the surrounding environment and may aid in the development of more detailed completion criteria as Brockman Operations progress. Other older waste landforms (B2N B Dump) are similar with regards to rehabilitation performance and demonstrate that rehabilitation success towards reference sites values is achievable over time. However, a lack of detailed rehabilitation methodology utilised in the construction of this landform may make replicating successful techniques more challenging.

More recent rehabilitation of waste dumps (South POD, B2N Pit 6 and BS1 DP1 and DP4) show rehabilitation performance progressing in a trajectory expected of establishing vegetation. These rehabilitation techniques utilised on these landforms has been documented in detail and will be valuable towards replicating successful rehabilitation techniques over time. Recent monitoring outcomes demonstrate the importance of rainfall to rehabilitation success, as declines in all parameters observed at the South POD sites correlates to a dry rainfall season observed from meteorological observations. The installation and utilisation of appropriate reference sites remains important to comparison of rehabilitation performance, with suitable sites at the BS4 operations currently lacking for comparison of high impact disturbance on sloped ground.

5.12. High impact disturbance area monitoring transects

Rehabilitated high disturbance areas within the Brockman Operation closure boundary that have been described within Section 5.9 are comprised of waste dumps only at the time of writing this Summary waste dumps. The monitoring transects associated with these domains are shown in Figure 82 and Figure 83 below.

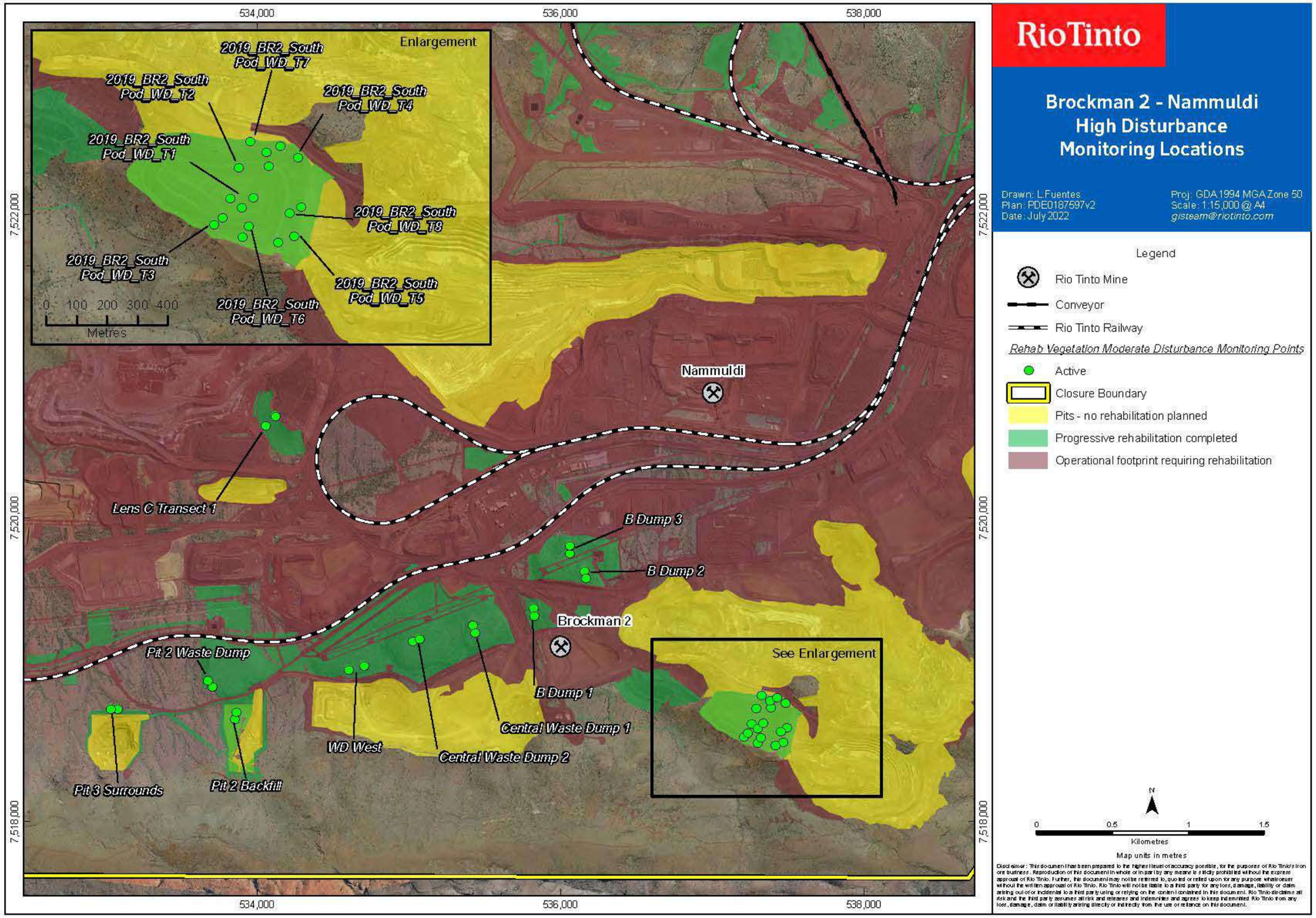


Figure 82: B2N high impact disturbance monitoring transects.

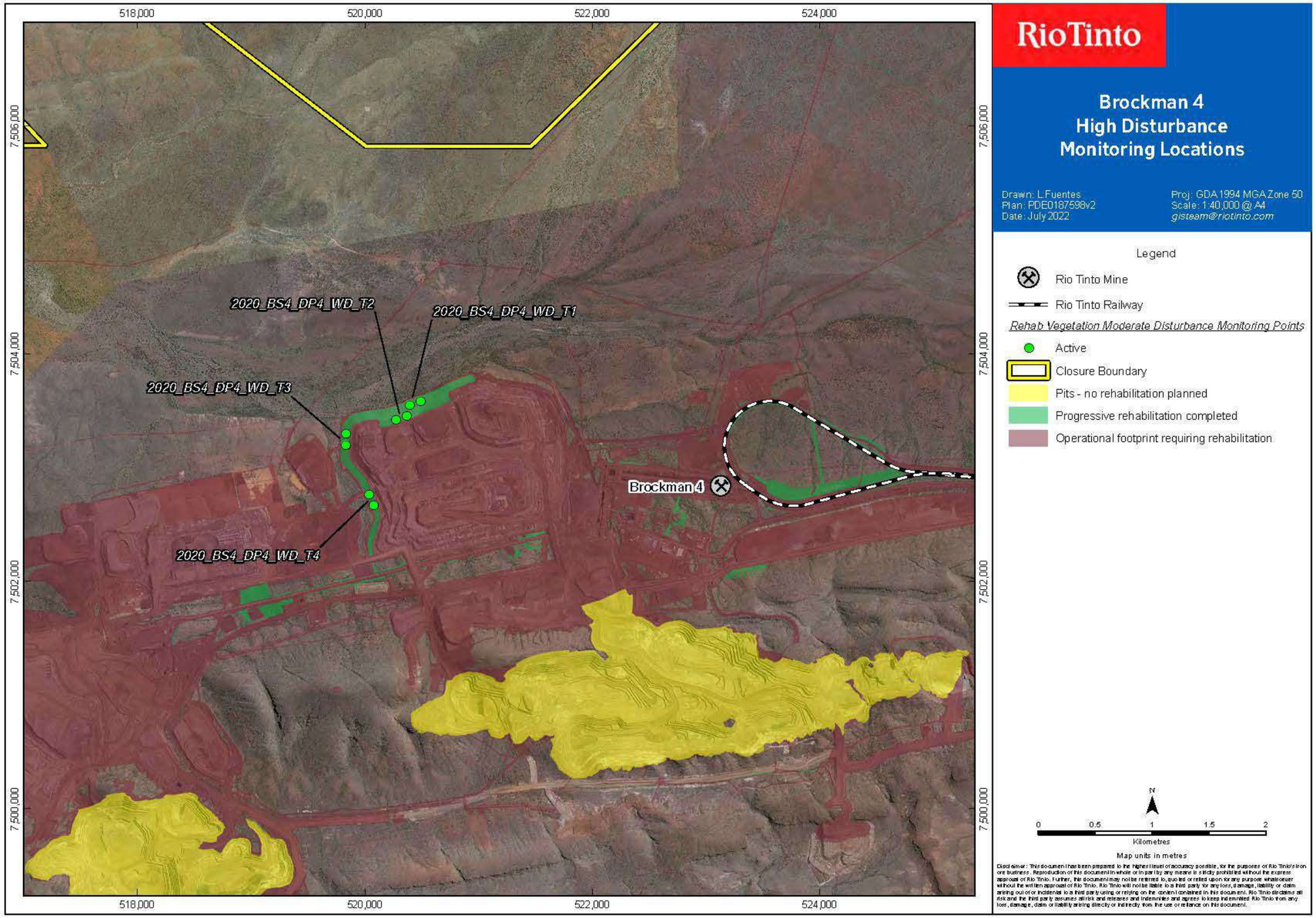


Figure 83: BS4 high impact disturbance monitoring transects.

6. RESEARCH AND DEVELOPMENT

Rio Tinto undertakes research and development in order to increase its understanding of the local natural ecosystems, optimise its rehabilitation techniques and improve confidence in the ability to achieve closure outcomes. Research and development projects range from opportunistic on-ground trials to large-scale multi-partner funded research programmes. Trial monitoring data is reviewed regularly to identify opportunities to refine rehabilitation techniques, such as the germination rates of sown seed, for continual improvement.

Although some research and trial projects described below were not conducted specifically on the tenements covered by this report, the learnings can be applied to works conducted on these sites and indicate the scientific approach applied to strive for continual improvement. A selection of recent research and development projects are summarised below.

6.1. Eco-engineering solutions to improve mine site rehabilitation outcomes

Rio Tinto Iron Ore and BHP Western Australia Iron Ore are partners in a federally funded research program investigating the rapidly developing field of Restoration Engineering, with a particular focus on the mining-intensive Pilbara region of Western Australia. This 4-year Global Innovation Linkages (GIL) project is led by the Kings Park Science research team and has additional partners from The University of Western Australia (UWA), Greening Australia, University of California, Brigham Young University, the University of Nevada, and Natural Resource Conservation LLC (a private US-based consultancy). The Restoration Engineering approach partners ecological research, focussed on best practice use of seeds from a recruitment biology point of view, with innovative ecologically guided engineering solutions focussed on the invention and modification of seeding equipment needed to deliver native seeds at scale.

This project has continued to test a range of custom-built precision seeding machines for use in sloped and rocky soils of the Pilbara. Firstly, a critical evaluation of the field limitations of current mechanised seeding techniques has been undertaken. Broadcasting seeds onto the soil surface is now known to be problematic and un-desirable. With this, new precision seed delivery machines have been designed, constructed, and field tested over the past three Pilbara summers in sites operated by both mining partners. Preliminary findings of this work have demonstrated that seeds are being incorporated in the upper soil layer more efficiently than previously achieved. Monitoring of these sites after significant rain events is suggesting seedling recruitment and rehabilitation performance of targeted genera such as Triodia is improving.

By experimentally comparing seed sowing depth (standard practice versus precision placement with the newly designed machinery) and manipulating the recruitment dynamics of seeds (standard ‘off-the-shelf’ seed treatments versus seeds treated to maximise recruitment potential – using treatment such as flash flaming or smoke-priming of seeds), the research group have shown that perennial grasses establishment of focal *Triodia* species can be increased to 35 seedlings per square metre (6-fold higher that standard, common seeding practices). These findings were observed after this trial site received suitable cyclonic rainfall (Figure 84). In the summer season of 2020/2021, replicated, multi-hectare trials have been installed across both mining partner sites (Rio Tinto Iron Ore and BHP) in over 30 hectares that are made up of different landforms and soil types. These repeat trials are critical to assess the performance of the precision seed delivery machinery and seed treatments across years and under varying conditions of rainfall.

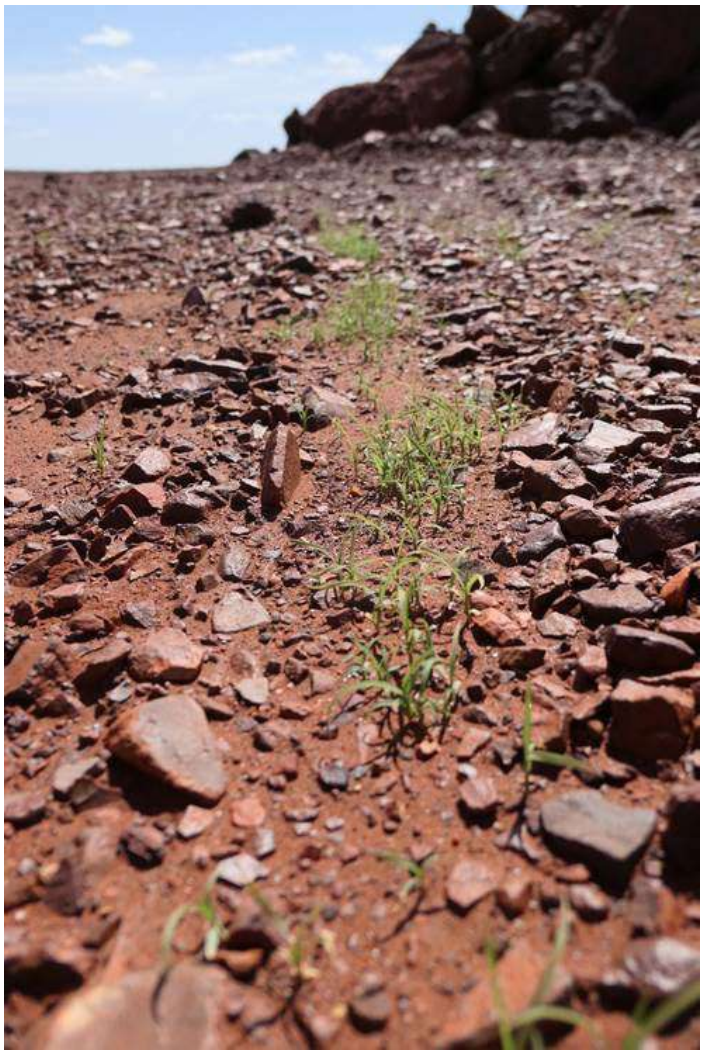


Figure 84: Germination of grass seed following trial of precision seeding equipment.

6.2. Acceptable rates of erosion for rehabilitated mineral waste landforms

A major consideration for rehabilitation and closure of waste landforms on mine sites is long-term erosion stability. In Western Australia, regulators require that landforms will remain 'stable' for hundreds of years or in the 'long-term'. Therefore, assessment of a landform's potential long-term erosion stability requires the use of erosion and/or landform evolution models and defensible erosion thresholds below which rehabilitation landform designs are considered acceptably erosion resistant or 'stable'.

To date, definitions of acceptable long-term erosion rates used in mining settings have been based on limiting the initiation of key erosion processes for steeply sloping land (i.e., rill and gully erosion). These approaches have been observed to achieve suitable results but may be somewhat conservative. Importantly, the rates currently applied as acceptable in landform design were based on measurements of erosion during rehabilitation monitoring and on landform evolution modelling for a limited range of materials and climates. To address this, Rio Tinto, with three other member companies of the Pilbara Rehabilitation Group (PRG), BHP, Fortescue Metals Group and Roy Hill, initiated a project aimed at defining acceptable rates of erosion for rehabilitation landform design for the Pilbara region of Western Australia. Landloch Pty Ltd was selected to undertake the work for this project using information derived from PRG member sites, with the Western Australian Biodiversity Science Institute (WABSI) acting as the project facilitator.

As part of the project, a review of information relating to erosion rates on natural and man-made landforms was conducted. This review showed that a wide range of approaches has been used to

define acceptable erosion rates, including a linking to rates of soil formation; maintenance of soil quality (which may include considerations of plant/crop productivity, effective soil depth and soil organic matter and nutrient stores); rates of natural erosion in adjoining areas; potential for gully formation; and water quality impacts. Based on this review, a guideline was developed to define acceptable erosion rates for use in the design of stable mine waste landforms in the Pilbara region. The guideline uses a risk-based approach, with erosion thresholds being linked to the physical properties of the waste material and the adverse environmental impacts that may result from landform failure. The first phase of this project was completed in 2018 and stakeholder engagement occurred to communicate key project findings. Further work is underway to define how to incorporate this guideline into Rio Tinto's landform design processes and to understand implications for the business.

6.3. Additional waste samples for batter selector

Rio Tinto is looking to build a more robust test work programme to determine erodibility data for waste types across Rio Tinto mine sites in the Pilbara. The key driver for the work is to ensure that key waste types across the various mine sites and lithologies are well understood and that detail is provided on the thresholds used to derive the Rio Tinto erodibility classifications of low, moderate, and high.

Rio Tinto utilise a Batter Selector Tool (BST), that is based on laboratory testing of individual waste types to optimise the final landform design by determining appropriate lift heights, slope angles, berm widths and berm back slope angles on an individual landform basis. The BST is based on the ongoing testing of waste material samples over a number of years; however, sampling has historically been biased towards some sites and some waste types more than others. This project seeks to address identified gaps and build greater certainty into the application of the BST.

Landloch undertook a gap analysis of the BST in 2018 and provided input on key wastes to consider in future revisions of the tool. Rio Tinto have developed a list of sampling priorities based on the gap analysis. The list provides detail on the site, geology, consolidated rock type and priority rating based on existing waste characterisation data completed by Landloch and presented within the BST. Test work will continue, facilitating advancements within waste type classification methodology, and the BST and landform design will continue evolve.

6.4. Channar scree slope trial

In 2014, as part of a preliminary closure study for the Channar mine, it was proposed to use rock armouring for a number of constructed legacy landforms, including land bridges and waste dumps, where access for standard rehabilitation earthworks purposes is constrained and/or too steep to safely bench and push down the slopes. Specific design criteria were developed based on modelling to meet acceptable erosion rate and long-term stability, including maximum batter heights, gradient, and rock size. The Department of Mines and Petroleum (now DMIRS) were consulted regarding this approach in May 2015 and indicated the requirement of further information and certainty before such an approach could be endorsed. In August 2019, DMIRS were advised that planning for a trial of the concept was underway. This project aimed to implement a scree slope (rock armouring) trial at the Channar mine on the CHE WD1 NE waste dump.

From October to late December 2020, contractors constructed a ~1m thick, rock armour on the CHE WD1 NE. This was achieved by screening various stockpiled or blasted material in Channar NE, to test for rocky material yield. This rocky material was then hauled to the tip head, where it was tipped short and pushed over. This process usually took 2 or 3 days for material to be built up enough to push over the tip head (Figure 85 and Figure 86). The trial demonstrated that sufficient rocky material to build the rock armour, is achievable through screening stockpiled/dumped (or blasted) material. However, productivity of the screening plant can be variable. Achieved Yield was lower in stockpiles. The trial indicated that, based on yield, the most suitable rock armour material would be a mix of banded iron formation (BIF) and hard cap. The trial was able to demonstrate that the scree slope design could be

achieved from a constructability perspective achieving a consistent 1m rock armour cap along the slope, with minor variation attributed to the pre-trial landform profile.

The scree slope trial will be monitored using high resolution define UAV survey for a minimum of 5 years, to monitor the long-term stability of the scree slope rehabilitation strategy.



Figure 85: Pre-project slope.



Figure 86: Post-project slope.

6.5. Growth media trials

Throughout the Pilbara, there is an ongoing opportunity to utilise mineral waste as soil substitutes or supplements for rehabilitation activities. It is anticipated that alternative growth media (AGM) will provide a suitable growth medium in rehabilitation areas where topsoil and subsoil are unavailable or limited. Research is underway to determine if utilising various types of AGM in various situation will provide acceptable rehabilitation outcomes.

When a waste type is identified as potentially suitable as an AGM, testing for standard parameters occurs, and then stockpiling will occur with relevant location information recorded on mine site survey records. Alternative growth media material has been previously identified and tested at Marandoo, Tom Price, Western Turner Syncline and Channar. Stockpiling of suitable material has commenced, with additional investigations to incorporate materials into the mine plans for future recovery also underway.

During 2017 the MMW4 rehabilitation project at Tom Price utilised S652 Gravels with monitoring of the rehabilitation showing positive trends and vegetation establishment. Monitoring progress of this area continued into 2020, and the materials are proposed for use at a future rehabilitation project at the Marra Mamba South waste dump, tentatively planned for 2022 completion.

During 2019 a rehabilitation project, at the Brockman DP4 waste dump, had different ages of topsoil, subsoil and no soil incorporated into the design (Figure 87). The aim of the trial was to evaluate the performance of the soil materials, and to consider modifying the seed mix to better reflect the growth media. The rehabilitation of this area was completed in early 2020 and monitoring of its performance will be undertaken to provide a comparison of revegetation performance using fresh topsoil, stockpiled topsoil or subsoil.



Figure 87: Soil and alternative growth media trial design at the Brockman 4 DP1 and DP4 projects.

6.6. Mycorrhizal fungi trials at Middle Robe legacy rehabilitation sites

In 2020, a rehabilitation project targeting legacy areas was undertaken, which provided an opportunity to investigate the use of mycorrhizal fungi on rehabilitation performance. Most native Australian flora have a relationship with mycorrhizal fungi, which are often eradicated during heavy disturbance events. There is evidence that inoculating soil with a variety of mycorrhizae fungi will improve plant survivability and germination (Koziol et al., 2018). There is also evidence that mycorrhizae fungi may assist some native species to establish that otherwise wouldn't through traditional rehabilitation methods (Jeffries et al., 2003).

In the Middle Robe project, seed was coated in powder form mycorrhizae fungi for several trial areas (Figure 88). The expectation is that when moisture is encountered, the mycorrhizae will propagate and expand into the surrounding soil, inhabiting the new plants roots and assisting with plant nutrient uptake. The trial areas were incorporated into the 2021 monitoring program and will therefore enable control and trial data to be collection and analysed through time.



Figure 88: Mycorrhizal fungi trial areas.

7. PLANNED STRATEGIC PROJECTS

The Rehabilitation and Closure team facilitates a quarterly regulator forum. It is intended that this forum is utilised for ongoing updates on the:

- Annual progressive rehabilitation program.
- Research and development.
- Strategic improvement projects.

7.1. Rehabilitation performance and completion criteria development

A Rehabilitation performance and improvement framework incorporating a plan, do, check and act (PDCA) cycle to centralise and improve the management and communication of rehabilitation performance status, learnings, remediation requirements, risks, knowledge gaps and associated actions is a planned initiative for 2022.

In association with this initiative, a strategic project to review both the current monitoring programme methodology and available rehabilitation monitoring data to develop a standardised method to develop suitable SMART completion criteria for all operations is also scheduled for development in 2022. The development of quantitative completion criteria will then follow with a prioritisation for those assets approaching closure.

This has already occurred at Eastern Range and Channar and the completion criteria have been submitted with the MCP to regulators. Pending regulator feedback will be utilised for the alignment of the development process.

An associated outcome of this strategic work will be a defined procedure for the determination of when and where remedial works are required for rehabilitated sites where performance is not tracking towards acceptable performance criteria.

7.2. Seed strategic plan

If seed is not of a sufficient quantity, type and/or quality, the rehabilitation performance of implemented works will not meet agreed completion criteria to the satisfaction of stakeholders. Therefore, a strategic project will be undertaken to ensure suitable seed species and volumes are available to meet increasing rehabilitation outputs through to 2027 and beyond. The integration of Traditional Owner businesses into the seed supply chain will also be investigated.

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APPENDIX A: REHABILITATION MONITORING SCHEDULES

A.1: Borrow pit sites

BORROW PIT REHABILITATION SITE	YEAR OF REHAB	MONITORING EVENTS CONDUCTED						
		1st	**2nd**	**3rd**	**4th**	**5th**	**6th onwards**	**Next Scheduled**
Nammuldi ANFO Facility BPs	2014	2018	2020	-	-	-		None as transects destroyed
Nammuldi Rail Loop and BWT HV BPs	2014	2016	2017	2018	2020	-		2022
B2N 1991 BPs	1991	1997	1998	1999	2000	2001	2002 2003 2005 2008 2011 2014 2017	2022
BS4 BPs	2009	2010 (excluding transect BR4_19ABC(2)_2010)	2011	2012	2014	2017	2020	2024
B2N to BS4 Access Rd BPs	2015	2016	2017	2018	2020			
BS4 White Quartz Rd BPs	2019	2011	2012	2014	2017	2020		

A.2: Other moderate impact sites

REHABILITATION SITE	YEAR OF REHAB	MONITORING EVENTS CONDUCTED						
		1st	2nd	3rd	4th	5th	6th onwards	Next Scheduled
Nammuldi BWT Landfill	2018 /2019	2019	2020	2021				
B2N Old Haul Road	1998 / 1999	2012	2016	2019	2021 (two transects only)			
Pit 2 Backfill	1998 / 1999	2012	2016	2019	2021 (two transect only)			
Pit 3 Surrounds	1998 / 1999	2012	2016	2019	2021 (two transect only)			
Boolgeeda Aerodrome	2012	2014	2016	2018	2020			
BS4 Fuel Hub	2013	2014	2016	2018	2020			
Boolgeeda Camp	2018	2019	2020	2021				

A.3: High impact disturbance – waste dumps

WASTE DUMP REHABILITATION SITE	YEAR OF REHAB	MONITORING EVENTS CONDUCTED						
		1st	2nd	3rd	4th	5th	6th onwards	Next Scheduled
B2N Central and Pit 2 Waste Dumps	2001	2012	2016	2019	2021 (one transect only)			
Nammuldi Lens C Waste Dump	2007	2008	2009	2010	2012	2013	2014 2016 2018	
B2N Pit 6 Waste Dump	2017	2018	2020					
B2N South POD Waste Dump	2018	2019	2020	2021				
B2N Waste Dump West	1996	2001	2003	2005	2008	2012	2016 2019	
B2N B Dump	1999	2012	2016	2019	2021			
BS4 DP1 and DP4	2020	2020	2021	-				

APPENDIX B: SUPPLEMENTARY REFERENCE SITES

B.1: Overview of reference sites at B2N / SGE

Site name	Establishment date and company	Topography type	Monitoring method
258 Control L	1997 (Rio Tinto)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
258 Control M	1997 (Rio Tinto)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
258 Control R	1997 (Rio Tinto)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
274 Control L	1997 (Rio Tinto)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
274 Control M	1997 (Rio Tinto)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
274 Control R	1997 (Rio Tinto)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
Airstrip Control	2012 (EMRC)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
C1	2009 (Mattiske)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
C2	2009 (Mattiske)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
C5	2009 (Mattiske)	Lower slope	2 x 2 m quadrat, 5 m intervals, 100 m long
C9	2009 (Mattiske)	Mid-slope	2 x 2 m quadrat, 5 m intervals, 100 m long
Control Pit 2	2012 (EMRC)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_CalcFlats_2017_C10	2017 (Biota)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_ClayPlain_2017_C6	2017 (Biota)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_ClayPlain_2017_C7	2017 (Biota)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_Flats_2017_C2	2017 (Biota)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_Flats_2017_C4	2017 (Biota)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_HillCrest_2017_C5	2017 (Biota)	Hill	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_HillCrest_2017_C9	2017 (Biota)	Hill	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_HillSlope_2017_C3	2017 (Biota)	Hill	2 x 2 m quadrat, 5 m intervals, 100 m long
SILV_HillSlope_2017_C8	2017 (Biota)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long

B.2: Overview of reference sites at B2N / SGE

Site name	Establishment date and company	Topography type	Monitoring method
Flat C1	2013 (Outback Ecology)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
Flat C5	2013 (Outback Ecology)	Flat	2 x 2 m quadrat, 5 m intervals, 100 m long
Control 1	2011 (EMRC)	Flat	2 x 2 m quadrat, 5 m intervals, 50 m long
Control 2	2011 (EMRC)	Flat	2 x 2 m quadrat, 5 m intervals, 50 m long

APPENDIX C: SUPPLEMENTARY REHABILITATION DATA

C.1: Overview of borrow pit transects

Transect ID	Status	Operational site / location	Year rehab completed	First year monitored	Topography
BR4_B2_BP293_T1_2014	Active	Brockman 2	2009	2014	Flat
BR2_258_Rehab_L_1997	Active	Brockman 2	1991	1997	Flat
BR2_258_Rehab_M_1997	Active	Brockman 2	1991	1997	Flat
BR2_258_Rehab_R_1997	Active	Brockman 2	1991	1997	Flat
BR2_274_Rehab_L_1997	Active	Brockman 2	1991	1997	Flat
BR2_274_Rehab_M_1997	Active	Brockman 2	1991	1997	Flat
BR2_274_Rehab_R_1997	Active	Brockman 2	1991	1997	Flat
BR2_Rehab_Flat_L_1997	Destroyed	Brockman 2	1991	1997	Flat
BR2_Rehab_Flat_M_1997	Destroyed	Brockman 2	1991	1997	Flat
BR2_Rehab_Flat_R_1997	Destroyed	Brockman 2	1991	1997	Flat
BR4_19ABC_2010	Destroyed	Brockman 4	2009	2010	Flat
BR4_19ABC(2)_2010	Active	Brockman 4	2009	2011	Flat
BR4_4681AI/WQRBP37_2010	Active	Brockman 4 (White Quartz Road)	2009	2010	Flat
BR4_4681V/WQRBP41_2010	Active	Brockman 4 (White Quartz Road)	2009	2010	Flat
BR4_ANFO_BP52/4529A_2010	Inactive*	Brockman 4	2009	2010	Flat

Transect ID	Status	Operational site / location	Year rehab completed	First year monitored	Topography
BR4_BLE6_2010	Active	Brockman 4	2009	2010	Flat
BR4_BLE7_2010	Active	Brockman 4	2009	2010	Flat
BR4_BP17B_2010	Active	Brockman 4 (White Quartz Road)	2009	2010	Flat
BR4_4681AM/WQRBP06_2010	Active	Brockman 4 (White Quartz Road)	2009	2010	Flat
BR2_Nammuldi_HV_Rd_T1_2016	Active	Nammuldi BWT	2014	2016	Flat
BR2_Nammuldi_HV_Rd_T2_2016	Active	Nammuldi BWT	2014	2016	Flat
BR2_Nammuldi_Railloop_T1_2016	Active	Nammuldi BWT (Rail Loop)	2014	2016	Flat
BR2_Nammuldi_Railloop_T2_2016	Active	Nammuldi BWT (Rail Loop)	2014	2016	Flat
BR2_Nammuldi_Railloop_T3_2016	Active	Nammuldi BWT (Rail Loop)	2014	2016	Flat
BR2_NAM_Anfo_T1_2018	Inactive	Nammuldi BWT (ANFO)	2014	2018	Flat
BR2_NAM_Anfo_T2_2018	Inactive	Nammuldi BWT (ANFO)	2014	2018	Flat
BR2_NAM_Anfo_T3_2018	Destroyed	Nammuldi BWT (ANFO)	2014	2018	Flat
BR4_B2B4_Access_Rd_T1_2016	Active	BR4 to B2B4 Access Road	2015	2016	Flat
BR4_B2B4_Access_Rd_T2_2016	Active	BR4 to B2B4 Access Road	2015	2016	Flat
BR4_B2B4_Access_Rd_T3_2016	Active	BR4 to B2B4 Access Road	2015	2016	Flat
BR4_B2B4_Access_Rd_T4_2016	Active	BR4 to B2B4 Access Road	2015	2016	Flat