Rio Tinto Iron Ore

Brockman Syncline 4 – Revised Proposal

Assessment on Proponent Information

Environmental Review Document

Hamersley Iron Pty Limited

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July 2014

RTIO-HSE-0209902

Disclaimer and Limitation

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1 INTRODUCTION

1.1 PROPONENT DETAILS

The Proponent for this Proposal is Hamersley Iron Pty Limited

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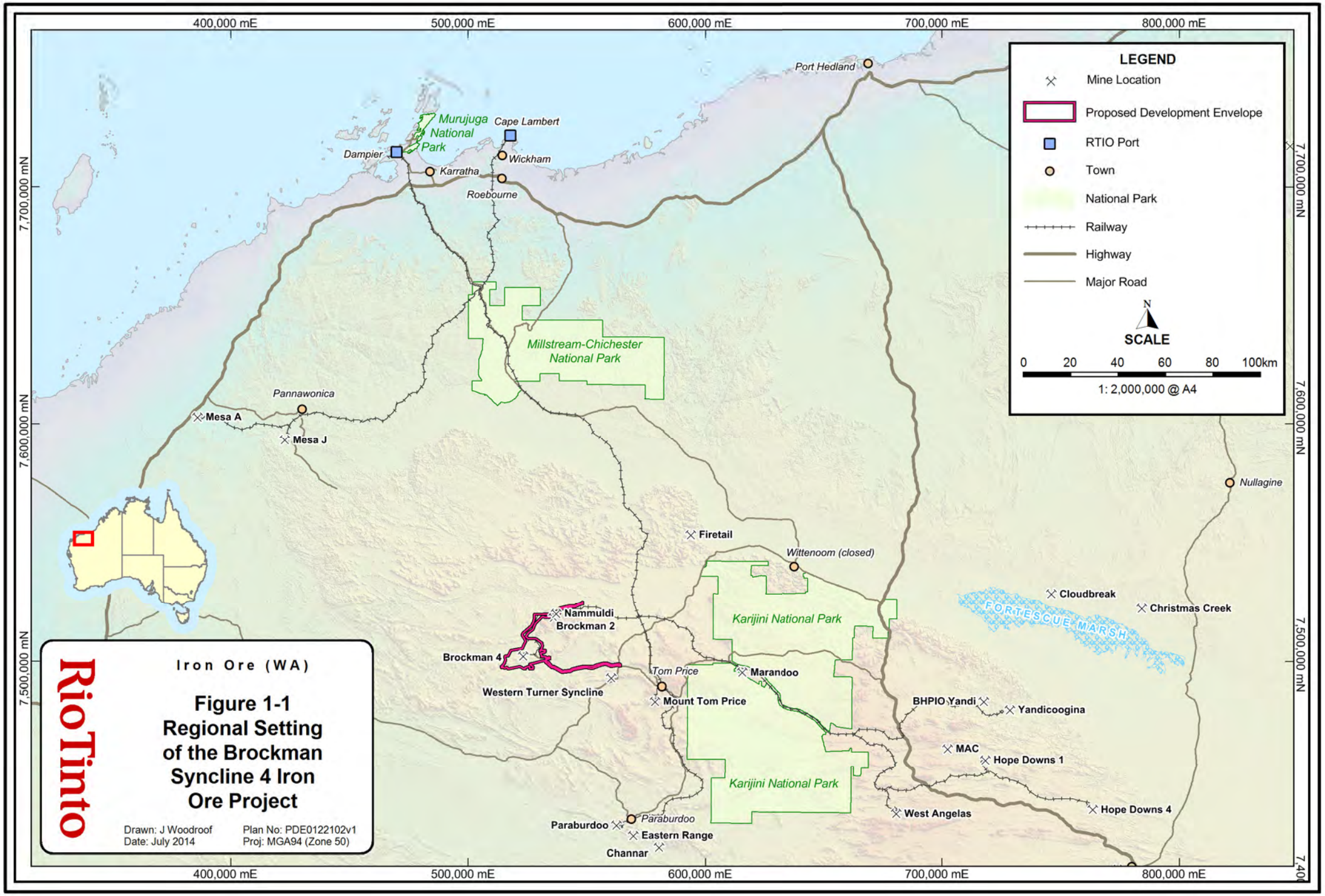
1.2 THE BROCKMAN SYNCLINE 4 PROJECT

Hamersley Iron Pty Limited (**Hamersley Iron**) (a wholly owned subsidiary of Rio Tinto) is operating the Brockman Syncline 4 Iron Ore Project (the **B4 Operation**) as approved by Ministerial Statement 717 (**MS 717**). Refer to Figure 1-1 for the regional setting of the B4 Operation.

The B4 Operation, as implemented, consists of:

- Three main mining areas (Western, Central and Eastern lenses of mineralisation) with approximately 20% of the orebody occurring below the water table.
- A dry processing plant with a nominal capacity of 42 Mtpa.
- Associated iron ore mine infrastructure (e.g. product stockpiles, waste dumps, topsoil, low-grade stockpiles and haul roads).
- Associated infrastructure (e.g. mine access roads, offices, warehouses, accommodation, bore fields, fuel storage facilities and utilities).
- A rail spur and siding works from the B4 Project to the rail spur at Brockman 2 Iron Ore Mine.
- Infrastructure corridor for power supply.
- Groundwater abstraction of 4.38 GL/annum (equivalent to 12 ML/day annualised) plus 0.15 GL/annum (equivalent to 400 kL/day annualised) for mine camp needs.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700,000 mE
800,000 mE
7,700,000 mN
7,600,000 mN
7,500,000 mN
LEGEND
Mine Location
Proposed Development Envelope
RTIO Port
Town
National Park
Railway
Highway
Major Road
N
SCALE
0 20 40 60 80 100km
1: 2,000,000 @ A4
Port Hedland
Murujuga National Park
Cape Lambert
Dampier
Wickham
Karratha
Roebourne
Millstream-Chichester National Park
Pannawonica
Mesa A
Mesa J
Nullagine
Firetail
Wittenoom (closed)
Cloudbreak
Christmas Creek
FORTESCUE MARSH
Nammuldi
Brockman 2
Karijini National Park
Brockman 4
Western Turner Syncline
Tom Price
Marandoo
Mount Tom Price
BHPIO Yandi
Yandicoogina
MAC
Hope Downs 1
Hope Downs 4
West Angelas
Karijini National Park
Paraburdoo
Paraburdoo
Eastern Range
Channar
Iron Ore (WA)
Figure 1-1
Regional Setting of the Brockman Syncline 4 Iron Ore Project
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
RioTinto

A summary of the Key Characteristics of the B4 Operation (from MS 717) is provided below in Table 1-1.

Table 1-1: Summary of Key Characteristics of the B4 Operation (MS 717)

Element	Description
General	
Project life	Estimated 30 years
Area of disturbance	Approximately 2,610[1] ha
Potential ore reserves	600 Mt high grade (>60%Fe), 280 Mt low grade (>50% Fe)
Mining rate	42 Mtpa of product
Waste rock	420 Mt (approx. 150 Mt will be used to backfill pits)
Greenhouse Gas Emissions	5.59 kg CO_{2e} per tonne of production per annum
Mine and mining	
Pits and ore type	Three mining areas with high phosphorus Brockman ore. The deposit extends approximately 14 km in length, is 1 km wide and averages 150 m deep.
Ore below water table	Approximately 20% of total ore (variable between each pit).
Stripping ratio	Ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average 1.2:1).
Waste rock disposal	Surface dumps until mined-out pit voids become available, then backfilled to above pre-mine water table.
Waste dumps, high grade and low grade stockpiles – location, height	Original site as shown in Figure 2 of Attachment 1 of MS 717 and a stockpile area adjacent to rail loop as shown in Figure 5 of Attachment 2 of MS 717. Height of waste dumps to be total height of 50m.
Dewatering	Dewatering is required to access ore from below the water table.
Infrastructure	
Water supply	Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor. 4.38 GL/annum (dust management) plus additional 0.15 GL/annum (mine camp).

[1] B4 Phase 2 S45C application, approved (4 November 2008) an increase in clearing from 2,470 ha to 2,610 ha. Schedule 1 of MS 717 was not correctly updated to reflect this.

Element	Description
Power supply	25 MW supplied from the Dampier-Tom Price 220 kV transmission system via a 33 kV sub-transmission system. Power lines will approach the mine within the infrastructure corridor, except at the southern end where the route diverges from the infrastructure corridor (Figure 4 of MS 717).
Processing plant	A dry plant with a crushing and screening circuit for a total 42Mtpa of product.
Product transport	By rail via a 35 km long rail spur from the project area to Brockman 2 mine, then along the existing Brockman 2 rail spur and the main railway to port including rail siding earthworks between Brockman 2 and B4.
Rail Spur	330 ha footprint (see Figures 1a and 1b of MS 717)
Plant, administration, workshops and stockpiles location	Original site as shown in Figure 2 of Attachment 1 of MS 717 and a stockpile area adjacent to rail loop as shown in Figure 5 of Attachment 2 of MS 717.
Mine access roads	Construction of a sealed access road from the Brockman 2 Mine that will mostly be provided by bitumen sealing of the approved B4 infrastructure corridor service road (no additional footprint); some deviations from the approved track are required and these will create additional footprint.
Workforce	
Construction operation	Peak of 700 300 (plus approximately 40 during periodic shutdown maintenance periods)
Accommodation	A permanent village and contractor's camp, plus small rail spur camps Total 570 rooms Total 1350 rooms

1.2.1 Environmental Approvals History

Exploration drilling was undertaken over a period of years, prior to Part IV approval under Part IV of the *Environmental Protection Act 1986* (**EP Act**), as part of the pre-feasibility and feasibility studies conducted to design and develop the Brockman Syncline 4 Iron Ore Mine (**B4 Operation**).

This ground disturbance was authorised primarily via notification under the *Iron Ore (Hamersley Range) State Agreement Act 1963* or Notices of Intent under the *Mining Act 1978* as appropriate. More recently vegetation disturbance for exploration outside of the Part IV footprint has been authorised via Native Vegetation Clearing Permit (**NVCP**) under Part V of the EP Act. NVCPs include conditions on rehabilitation.

The Minister for the Environment issued MS 717 on 24 March 2006 allowing implementation of the B4 Operation. Since then several changes have been approved under Part IV of the EP Act as summarised below in Table 1-2. A copy of MS 717 is provided in Appendix 2.

Table 1-2: Summary of Changes to MS 717

Change	Date	Nature of Change	Approval
1	19/09/07	Minor changes including: - re-design of approved mine site layout - re-design of approved rail spur - relocation of approved 220kV power line and construction of 33kV power line reticulation system - increase in throughput from 20Mtpa to 22Mtpa - increase in water use from 2.26 GL/annum (6.2ML/day) to 2.92 GL/annum (8ML/day) plus 0.11GL/a (300kL/day) (mine camp) purposes - bitumen sealing of the White Quartz Road; and - removal of the conveyor and a new airstrip[2].	S45C
2	22/09/08	Rerouting of the power line corridor and change in power capacity.	S45C
3	17/12/08	Minor changes including: - an increase in throughput from 22Mtpa to 42Mtpa - increase in waste dump height and additional locations - changes to infrastructure and accommodation - an increase in water use from 8ML/day to 12ML/day (4.38GL/a), plus an increase from 300kL/day to 400kL/day (0.15GL/a) for mine camp needs; and - an increase in the clearing limit - removal of requirement to bitumen seal White Quartz Road.	S45C

The Brockman Syncline 4 - Nammuldi Water Pipeline Corridor Proposal was granted *Not Assessed – Public Advice Given* in May 2011 after the Office of the Environmental Protection Authority (**OEPA**) determined that the scope of works was not significant as to warrant formal assessment or the setting of conditions. This proposal included a pipeline between Nammuldi and the B4 Operation to supplement water supply at the B4 Operation and reduce surplus discharge associated with the Nammuldi-Silvergrass Expansion. This proposal has not been implemented as the B4 Operation has been able to meet its own water demand.

First ore was railed from the B4 Operation in 2010.

[2] Note that clearing for an airstrip was subsequently approved via an NVCP

2 PROPOSAL DESCRIPTION

This Environmental Review (**ER**) document has been referred to the OEPA in order to enable assessment under the provisions of Part IV of EP Act and has been prepared in accordance with the information requirements for a API Category A as set out in the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012* (**2012 Administrative Procedures**). The s38 Referral Form is provided in Appendix 1.

This Proposal is a revision to the B4 Operation with the following proposed changes (the Revised Proposal is depicted in Figure 2-1):

- provision of a Development Envelope (refer to Section 2.1, Section 8 and Section 9);
- surface discharge of surplus dewatering water to Boolgeeda Creek (refer to Section 2.2, Section 6 and Section 7);
- new clearing of up to 950 ha for pits, dumps and infrastructure, within the Development Envelope, to support ongoing production at the B4 Operation (refer to Figure 2-2 and Figure 2-3, Section 2.3 and Section 8);
- other changes to Schedule 1 of MS 717, such as:
    - waste dump optimisation (refer to Section 10.1); and
    - changes to the Key Characteristics (refer to Section 10.2).

Note that the following terminology is used throughout this ER document:

B4 Operation - existing Brockman Syncline 4 as approved under MS 717

Proposal – the changes requested as described in this ER document

Revised Proposal – all components of the Brockman Syncline 4 Iron Ore Mine that are currently authorised under MS 717, plus the changes that are described in this Proposal. The operation that will be authorised by a new Ministerial Statement, in the event of acceptance by the Minister of the changes requested in this ER.

2.1 PROVISION OF A DEVELOPMENT ENVELOPE

The EPA's Environmental Assessment Guideline No. 1 (**EAG1**) allows for the disturbance footprint of a proposal to be defined within a broader Development Envelope provided that appropriate biological surveys and an environmental impact assessment have been conducted for the area.

The authorised footprint for the B4 Operation (Appendix 2, Figure 2 - Schedule 1 of MS 717) specifies locations of all pits and infrastructure with no flexibility built-in to accommodate changes due to avoidance of impacts, geotechnical or design related reasons. The Proponent requires flexibility to maximise the development of the approved ore bodies at B4, therefore this Proposal includes the delineation of a Development Envelope for the Brockman Syncline 4 Revised Proposal (**Revised Proposal**).

The extent of the Development Envelope is depicted in Figure 2-1 and it includes all elements currently authorised under MS 717 as well as relevant changes sought in this Proposal.

Based on discussion with the OEPA, the Development Envelope has been divided into the following two sections:

- mine operations area (**Area 1**); and
- northern and southern linear infrastructure corridors (combined to form **Area 2**).

This separation acknowledges the relative differences in flexibility and nature of impacts of clearing to mine an orebody (that cannot be moved) compared to clearing for construction of linear infrastructure (that overall tends to be a more flexible option).Area 1 includes the bulk of the mining and ore handling operation and therefore has a larger proposed clearing limit of 2,160 ha, whilst Area 2 comprises the northern and southern corridors that contain existing linear infrastructure such as mine access roads, power and rail with associated disturbance (borrow pits, drainage works, etc.). The northern and southern corridors have a proposed combined clearing limit of 1,400 ha.

The proposed total clearing limit for the B4 Revised Proposal is 3,560 ha within a 20,046 ha Development Envelope (where Area 1 is 14,227 ha and Area 2 is 5,818 ha).

Sections 8 and 9 describe the flora, vegetation, fauna and fauna habitats of conservation significance that occur within the proposed Development Envelope.

2.2 DEWATERING AND DISCHARGE

Improvements in hydrogeological knowledge and ongoing constraints on the mine plan, resulting from sub-optimal dewatering of the orebody, have resulted in a revision of the conceptual hydrogeological model for the B4 Operation. Current modelling has identified the need to increase the dewatering rate in order to achieve production rates.

The proposed increase in dewatering will generate surplus water that will require management. An assessment of surplus water management options was conducted and the option to discharge surplus water to nearby Boolgeeda Creek was selected.

Further details and the rationale for this change to the B4 Operation are provided in Section 4.

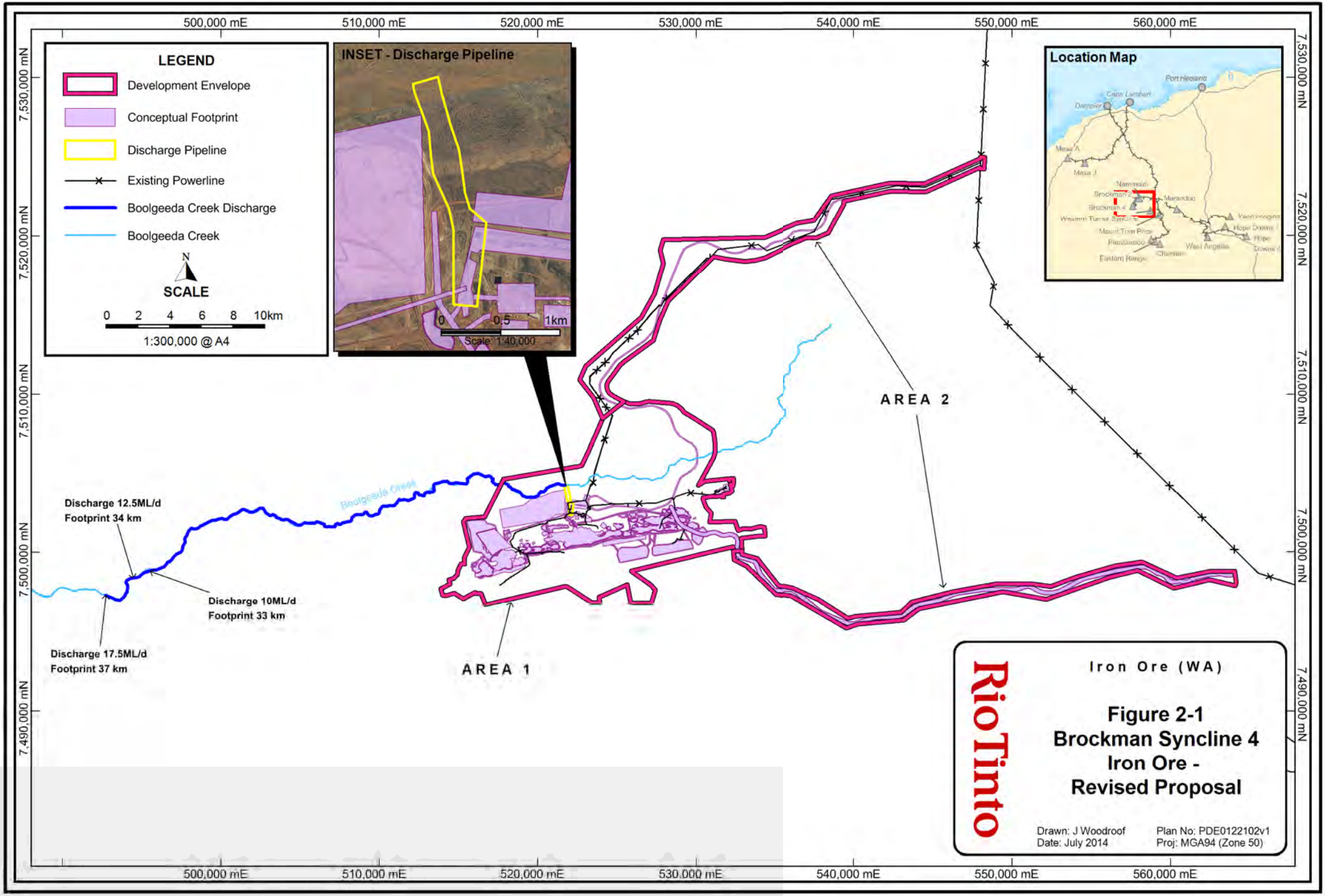
2.3 ADDITIONAL CLEARING

Additional clearing of 950 ha is required to accommodate changes to the mine plan, primarily revision of the waste management strategy. Additional waste dumps will allow waste to be placed out of pit pending availability of mined out voids for backfilling.

A portion of the additional clearing will be allocated to minor changes to pit boundaries, roads, operational areas etc. within the Development Envelope as required to support future mining and to minimise the requirement to obtain NVCP's for exploration and minor works.

Figure 2-2 and Figure 2-3 show the extent of existing clearing for a range of purposes authorised under a combination of the State Agreement Act; Mining Act; NVCPs; MS 717 (B4 Operation); MS 925 (Nammuldi Silvergrass Expansion); and MS 131 (Brockman 2). Also shown is planned disturbance areas authorised under these approvals. Note that clearing limits apply to each of the approvals listed and ground disturbance is kept within the limit in each instance.

The Additional clearing is overlain on the existing/authorised disturbance footprint in Figure 2-3.


LEGEND
Development Envelope
Conceptual Footprint
Discharge Pipeline
Existing Powerline
Boolgeeda Creek Discharge
Boolgeeda Creek
N
SCALE
0 2 4 6 8 10km
1:300,000 @ A4
INSET - Discharge Pipeline
0 0.5 1km
Scale: 1:40,000
Location Map
500,000 mE
510,000 mE
520,000 mE
530,000 mE
540,000 mE
550,000 mE
560,000 mE
7,530,000 mN
7,520,000 mN
7,510,000 mN
7,500,000 mN
7,490,000 mN
AREA 1
AREA 2
Boolgeeda Creek
Discharge 12.5ML/d
Footprint 34 km
Discharge 10ML/d
Footprint 33 km
Discharge 17.5ML/d
Footprint 37 km
RioTinto
Iron Ore (WA)
Figure 2-1
Brockman Syncline 4
Iron Ore -
Revised Proposal
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)

Iron Ore (WA)

Figure 2-2 Disturbance Footprint

Drawn: A. Coulson
Date: July, 2014

Plan No: PDE0122102v1
Proj: MGA94 Zone 50

Location Map

520,000 mE
530,000 mE
540,000 mE
550,000 mE
560,000 mE

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

Discharge Location

LEGEND

- Area 1 & Area 2 - Proposed Development Envelope
- Proposed New Clearing
- Disturbance Under MS717
- Disturbance Under Other Approvals
- MS 925 Boundary
- MS 946 Boundary
- Proposed Discharge Location
- Boolgeeda Creek Discharge

N

SCALE

0 1 2 3 4 5km

1:150 000 @ A3

Geospatial Information and Mapping

515,000 mE
517,500 mE
520,000 mE
522,500 mE
525,000 mE
527,500 mE
530,000 mE
532,500 mE

7,505,000 mN
7,502,500 mN
7,500,000 mN
7,497,500 mN
7,495,000 mN

Discharge Location

RioTinto

Iron Ore (WA)

Figure 2-3
Disturbance Footprint
- Area 1

Drawn: A. Coulson
Date: July, 2014

Plan No: PDE0122102v1
Proj: MGA94 Zone 50

Location Map

LEGEND

- Area 1 - Proposed Development Envelope
- Proposed New Clearing
- Disturbance Under MS717
- Disturbance Under Other Approvals
- Proposed Discharge Location
- Boolgeeda Creek Discharge

N

SCALE

0 0.5 1 1.5 2 2.5km

1:50 000 @ A3

Geospatial Information and Mapping

3 ENVIRONMENTAL APPROVAL PROCESS

The OEPA has determined that this Proposal is a revised proposal to the B4 Operation (MS 717). An EPA-Prepared Scoping Guideline for the B4 Revised Proposal was issued on 27 May 2014. This ER has been prepared in accordance with that guideline.

It is expected that upon approval of this Proposal, a new Ministerial Statement will be issued which will supersede MS 717 and any associated s45c attachments, providing one overall contemporary Ministerial Statement for the B4 Revised Proposal.

This ER has been revised in line within the EPA's Environmental Assessment Guidelines (**EAGs**): specifically Defining the Key Characteristics of a Proposal *Environmental Protection Act 1986* (EAG 1) and EAG for Environmental factors and objectives (**EAG 8**).

3.1 KEY PROPOSAL CHARACTERISTICS OF THE B4 REVISED PROPOSAL

It is intended that this Proposal will be implemented as part of the B4 Operation and will be managed in accordance with existing legislative conditions and Rio Tinto management systems and procedures. Table 3-1 provides a summary of the B4 Revised Proposal.

Table 3-1: Summary of the B4 Revised Proposal

	Description
Proposal Title	Brockman Syncline 4 Iron Ore Project – Revised Proposal
Proponent Name	Hamersley Iron Pty Limited
Short description	The Brockman Syncline 4 Iron Ore Project – Revised Proposal is located approximately 60 km west-north-west of Tom Price in the Central Pilbara. The Revised Proposal includes: • mining both above and below the water table; • dry processing plant; • associated mine infrastructure and supporting utilities; • access roads from Brockman 2 to Brockman 4; and Nanutarra Road to Brockman 4 (White Quartz Road); • an existing rail spur with siding works from the Brockman 4 to the rail spur at Brockman 2 Iron Ore Mine; • clearing of up to 3,560 hectares of native vegetation; and • dewatering of up to 6.4GL per year over the life of Brockman 4 with surplus dewater management including onsite use and discharge to Boolgeeda Creek.

Table 3-2 and Table 3-3 provide details on the proposed location and authorised extent of physical and operational elements of the Proposal. The new or modified factors being assessed in this Proposal are highlighted to assist with identification.

Table 3-2: Location and Extent of Physical Elements of the – B4 Revised Proposal

Element	Location	Proposed Extent
Mine Operations Area (refer to Section 8.1)	Area 1 on Figure 2-1	Clearing no more than 2,160 hectares within a 20,046 ha Development Envelope. Mining of deposit to a depth of 150m.
Linear Infrastructure Corridors	Area 2 Figure 2-1	Clearing no more than 1,400 hectares within a 20,046 ha Development Envelope.
Backfilling of mine pits	Area 1 on Figure 2-1	Mine pits are to be backfilled at closure so that the final surface levels are at a higher elevation than the pre-mining groundwater level to prevent the formation of pit lakes.

Table 3-3: Location and Extent of Operational Elements of the – B4 Revised Proposal

Element	Location	Proposed Extent
Water abstraction	Area 1 on Figure 2-1	Groundwater abstraction no more than 6.4 GL/a.
Management of surplus dewater	Figure 2-1	Dewater disposal through use on site and controlled surface discharge of surplus water to Boolgeeda Creek of no more than 6.4 GL/a.

3.2 KEY ENVIRONMENTAL FACTORS

In its Scoping Guideline (27 May 2014, Appendix 3) the EPA identified that the following preliminary Key Environmental Factors may be relevant to the Proposal and that they should be reported on in this ER document.

- Hydrological Processes – groundwater drawdown and altered surface water flow regimes.
- Flora and Vegetation – clearing, groundwater drawdown and surface discharge of surplus mine dewater.
- Terrestrial fauna (conservation significant fauna species and their habitats) - vegetation clearing and vehicle movements.

The Proponent also independently assessed and identified all environmental factors that may be relevant to this Proposal, based on the EPA's EAG8. The assessment included consideration of existing legislative controls for each identified key and non-significant factors. The outcome of this assessment is shown in Figure 3-1.

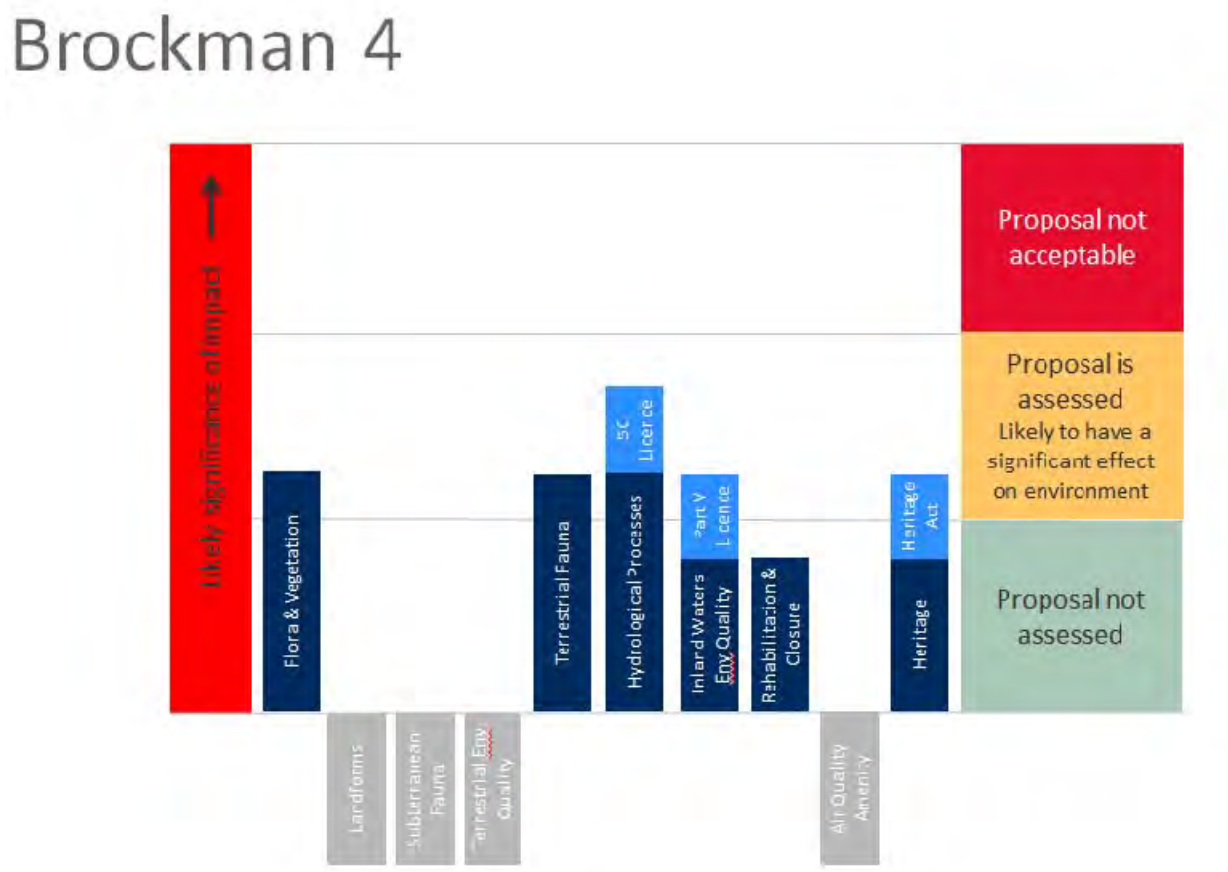


Figure 3-1 Identified Environmental Factors and Legislative Controls for the Revised Proposal (from EAG8)

The preliminary Key Environmental Factors that are relevant to this Proposal are described and discussed in this ER as follows:

- Hydrological Processes (Section 7)
- Flora and Vegetation (Section 8)
- Terrestrial Fauna (Section 9)

The Proponent considers that for the following factors the B4 Revised Proposal will not result in any significant change in addition to, or different from, that originally assessed and approved under MS 717. Each of these factors has been addressed in this ER as indicated:

- Rehabilitation and Closure (Section 11)
- Heritage (Section 11)
- Air Quality (Section 11)
- Visual Amenity (Section 11)
- Residual Risk and Management (Section 13).

3.3 PROPOSED ENVIRONMENTAL CONDITIONS

The Proponent has developed proposed environmental conditions (refer to Appendix 4) to address the key environmental aspects of the B4 Revised Proposal. It is proposed that these environmental conditions be applied to the B4 Revised Proposal (i.e. the B4 Operation and this Proposal) and to replace the existing MS 717.

These environmental conditions have been proposed so as to not duplicate other regulatory controls that are, or will be, applied under other existing legislation (refer to Section 14).

A condition has not been proposed if the environmental factor is considered to be adequately addressed by other environmental control instruments (i.e. the existing B4 Operation Environmental Management Plan {**EMP**}).

4 PROPOSAL TENURE

4.1 STATE AGREEMENT AND MINING ACT

The B4 Operation is located on Mineral Lease 4SA (ML4SA) which was granted in 1965 under the *Iron Ore (Hamersley Range) Agreement Act 1963* (Figure 4-1). State Agreements are contracts between the State and major project developers that establish a framework of rights and obligations for both parties to facilitate the development of resources and/or downstream processing projects in Western Australia. The State Agreement provides rights of renewal of ML4SA for further periods of 21 years; the current expiry date of ML4S is 24 March 2028.

The infrastructure associated with the B4 Operation is located on a number of Miscellaneous Licences and General Purpose Leases that were granted under the *Mining Act 1978* (Figure 4-1). These include Miscellaneous Licences 47/141; 47/152; 47/153; 47/184; and 47/185 and General Purpose Leases 47/1225; 47/1227; and 47/1232. This tenure supports the B2 – B4 railway and road, the B4 powerline, the B4 airstrip, the Boolgeeda exploration camp and the B4 accommodation village.

In regards to tenure that has been granted under the *Land Administration Act 1997*, the majority of the B4 Operation is situated on Rocklea Station which is held by the Proponent. A portion of the proposed Development Envelope lies on Hamersley Station which is also held by the Proponent. The western part of the proposed Development Envelope extends onto Cheela Plains Station, and the maximum modelled extent of the proposed discharge footprint extends across parts of Rocklea, Cheela Plains and Mt Stuart stations. Cheela Plains and Mt Stuart stations are held by separate third parties.

All pastoral leases in Western Australia issued under the now repealed *Land Act 1993* expire on 30 June 2015. When these pastoral leases are reissued to lessees some portions of some stations across the region will be retained by the State and added to the conservation estate and other areas will be set aside for conservation management under conservation agreements with the Department of Parks and Wildlife (**DPaW**). The parts of Rocklea Station, Hamersley Station, Cheela Plains Station or Mt Stuart Station that are relevant to this proposal will not be subject to these changes.

4.2 NATIVE TITLE

The proposed Development Envelope lies within Native Title claim areas belonging to two Traditional Owner groups.

The native title claim over the western area was lodged in 2001 by the Puutu Kunti Kurrama and Pinikura (**PKKP**) people; in March 2011 a claim wide participation agreement was signed with the Proponent which provides consent of the PKKP people to the Proponent's operations including to this Proposal.

The Eastern Guruma group has determined native title over land covered by the eastern part of the proposed Development Envelope. This part of the proposed Development Envelope is subject to an Indigenous Land Use Agreement between the Eastern Guruma group and the Proponent, and provides consent of the Eastern Guruma people to Rio Tinto's operations including to this Proposal.

4.3 LAND USE AND SOCIAL ENVIRONMENT IN PROXIMITY TO THE PROPOSAL

The Proposal is located in the Shire of Ashburton (Pilbara Region) and is approximately 60 km and 80 km from the towns of Tom Price and Paraburdoo respectively (refer to Figure 1-1).

4.3.1 Pastoral Activities

Pastoralism has been active in the area for over 100 years, with grazing by sheep until 1970 and by cattle thereafter. The Proponent holds and directly manages five stations in the Pilbara region: Karratha, Hamersley, Rocklea; Yarraloola and Juna Downs. The Proponent also holds a sixth station in the Pilbara (Yalleen) which is sub-leased to a third party.

The Revised Proposal is mostly located within Rocklea Station which borders Hamersley Station (Figure 4-1). The Hamersley Station homestead is the closest residential premise (other than the Proponent's accommodation: the Brockman 2 camp, the B4 village and the Jeeriwah Village at Nammuldi) and is located approximately 23 km from the Proposal. Cheela Plains Station homestead is approximately 30 km south-west of the Development Envelope. Cheela Plains Station is a family owned and managed cattle station which was formerly part of Wyloo Station until 2001. The Mt Stuart Station is a family owned and managed cattle station located west of Cheela Plains Station. The now abandoned Duck Creek Homestead is located on Mt Stuart Station.

4.3.2 Relationship with existing operations

The Brockman 2 Detrital Iron Ore Mine (Brockman 2) and Nammuldi Silvergrass Iron Ore Mines (Nammuldi-Silvergrass) are located approximately 22km and 32km north east of the Develop Envelope, respectively.

The Brockman rail spur extends from the Proponent's existing Paraburdoo – Dampier rail line and services the Brockman 2, Nammuldi, Silvergrass and Brockman 4 operations. Similarly power for each of these operations is supplied from the main 220 kV powerline that extends from Dampier to Brockman 2.

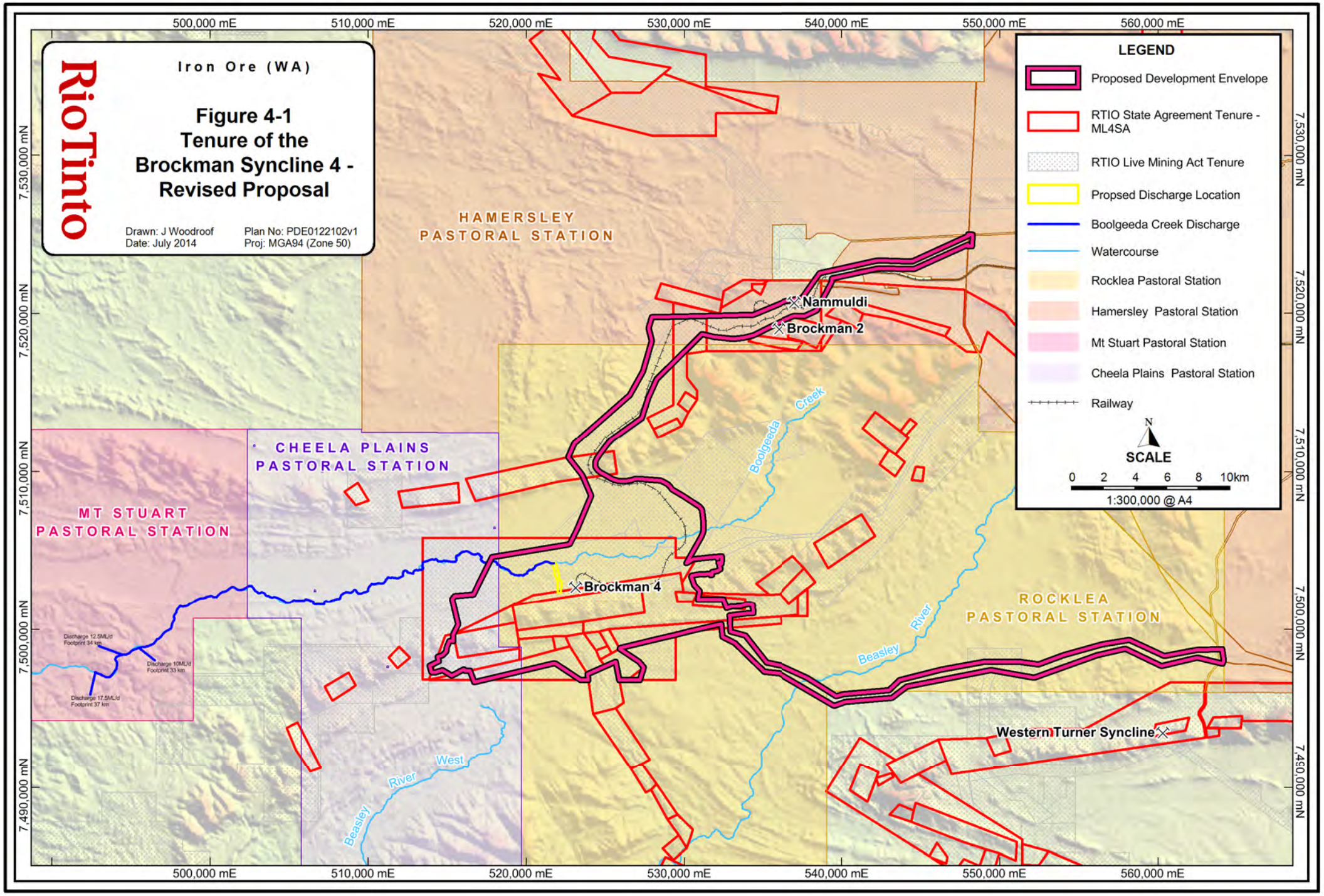
The Nammuldi-Silvergrass Expansion Project Area overlaps the Brockman 2 operation and includes provision for vehicle access from B4 to Nammuldi, thence to Silvergrass. Linear infrastructure authorised for B4 under MS 717 (rail, power, roads, water pipeline) extends from north-east of the Nammuldi mine, through both Nammuldi and Brockman 2 to the B4 operation. The Nammuldi-Silvergrass Expansion Project Area, Brockman 2 operation and the proposed B4 Development Envelope therefore overlap (Figure 4-1).

The Western Turner Syncline Stage 2 operation is located 40 km east/south east from the Proposed Development Envelope (refer to Figure 4-1). The southern linear infrastructure corridor of the proposed Development Envelope (Area 2) intersects with the WTS Stage 2 Development Envelope along its north-western edge.

4.3.3 Tourism

National Parks are the major tourism focus in the central Pilbara region. The Revised Proposal is located approximately 90 km from the nearest boundary of the Karijini National Park and 100 km from the nearest boundary of the Millstream Chichester National Park.

The Development Envelope contains no significant features that warrant attention from the tourism sector. There are few public roads in the vicinity to facilitate access for tourists; therefore tourism is very limited in, or adjacent to, the Development Envelope.


RioTinto
Iron Ore (WA)
Figure 4-1
Tenure of the
Brockman Syncline 4 -
Revised Proposal
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
LEGEND
Proposed Development Envelope
RTIO State Agreement Tenure - ML4SA
RTIO Live Mining Act Tenure
Propsed Discharge Location
Boolgeeda Creek Discharge
Watercourse
Rocklea Pastoral Station
Hamersley Pastoral Station
Mt Stuart Pastoral Station
Cheela Plains Pastoral Station
Railway
N
SCALE
0 2 4 6 8 10km
1:300,000 @ A4
HAMERSLEY PASTORAL STATION
CHEELA PLAINS PASTORAL STATION
MT STUART PASTORAL STATION
ROCKLEA PASTORAL STATION
Nammuldi
Brockman 2
Brockman 4
Western Turner Syncline
Boolgeeda Creek
Beasley River
West Beasley River
Discharge 12.5ML/d Footprint 34 km
Discharge 10ML/d Footprint 33 km
Discharge 17.5ML/d Footprint 37 km
500,000 mE
510,000 mE
520,000 mE
530,000 mE
540,000 mE
550,000 mE
560,000 mE
7,530,000 mN
7,520,000 mN
7,510,000 mN
7,500,000 mN
7,490,000 mN

5 STAKEHOLDER CONSULTATION

Identified key stakeholders for this Proposal include:

- Government agencies:
    - Office of the Environmental Protection Authority (**OEPA**);
    - Department of Parks and Wildlife (**DPaW**) – Pilbara region, Perth Environmental Management Branch (**EMB**);
    - Department of Environment and Regulation (**DER**);
    - Department of State Development (**DSD**);
    - Department of Mines and Petroleum (**DMP**);
    - Department of Water (**DoW**) – Pilbara regional office, Perth office; and
    - Department of Aboriginal Affairs (**DAA**).
- Traditional Owners:
    - Puutu Kunti Kurrama and Pinikura People (**PKKP**); and
    - Eastern Guruma Group.
- Cheela Plains Pastoral Station.
- Mt Stuart Pastoral Station

Stakeholder consultation undertaken to date, and the Proponent's response to issues raised, is detailed in Table 5-1. The Proponent will continue to consult with relevant stakeholders during the environmental approval process and during implementation of the Proposal.

Table 5-1: Stakeholder Consultation Relevant to this Proposal

Date	Topics/Issues Raised	Proponent Response
Office of the Environmental Protection Authority (OEPA)		
02/07/2013	The Proponent provided a detailed overview of the Proposal and discussed the preferred approvals pathway. OEPA advised that surface discharge, as a new factor in addition to MS 717, should be assessed via an API A.	The Proponent accepted the OEPA's position that the Proposal warranted formal assessment via an API A.
26/09/2013	The Proponent discussed additions to the scope of the Proposal which included additional clearing at B4 and some administrative changes to Schedule 1 of MS 717. The OEPA requested detailed information regarding the significance of the proposed clearing. OEPA advised that the administrative changes to Schedule 1 of MS 717 could proceed via a s45c application.	The Proponent provided detailed information regarding the additional clearing required.
12/11/2013	Based on the information provided by the Proponent regarding the significance of the proposed clearing, the OEPA requested that the clearing be included in the API for assessment with the proposed surface water discharge.	The Proponent revised the draft API and s45C documents accordingly.
25/11/2013	The OEPA advised the Proponent that all proposed works should be included in the API as a Revised Proposal to MS 717.	The Proponent revised the draft API document accordingly.
2/4/2014	The OEPA advised the Proponent that additional information was required in the API document prior to assessment including further details on alternatives considered for surplus water management, vegetation mapping, terrestrial fauna and revision to the proposed Development Envelope. The requirement for and timing of a discharge monitoring and management plan was also discussed and agreed.	The Proponent revised the draft API document accordingly and prepared the draft Discharge and Riparian Vegetation Monitoring and Management Plan for submission with the revised API document.
28/05/2014	Discussion was held regarding the format and extent of the proposed Development Envelope allocation of clearing between aspects of the B4 Project.	The Proponent revised the proposed Development Envelope and allocation of clearing.

Date	Topics/Issues Raised	Proponent Response
Department of Parks and Wildlife (DPaW)		
29/07/2013	Rio Tinto - DPAW Quarterly Meeting: the Proponent presented on the proposed surface discharge to Boolgeeda Creek at the Rio Tinto – DPaW Quarterly meeting. No issues or concerns were raised by DPaW.	The Proponent will continue to consult with DPaW throughout the environmental approvals process.
Department of Environment Regulation (DER)		
Ongoing	The Proponent will apply for approval to discharge surplus dewatering water to the environment under Part V of the *Environmental Protection Act 1986*. This includes providing a detailed overview of the Proposal, relevant environmental studies, potential environmental impacts and proposed management.	
Department of Mines and Petroleum (DMP) – Operations and Environment Division		
30/06/2014	The Proponent gave an overview of the proposal, the level and progress of the assessment under Part IV of the EP Act. DMP indicated that should it have questions or require clarification on any aspect of the proposal it would request a meeting with the Proponent.	
Department of Water (DoW) – Perth Office		
Ongoing	The Proponent is liaising with the DoW to amend the existing *Rights in Water and Irrigation Act 1914* Groundwater Licence (GWL164398), to increase the abstraction limit from 4.53 GL/a to 6.4 GL/a. The Groundwater Operating Strategy under GWL164398 will also be updated. This involves providing an overview of the Proposal, relevant hydrogeological studies and proposed management measures, with a focus on groundwater management issues.	
Department of State Development		
Ongoing	The Proponent provides ongoing updates on relevant projects at monthly meetings with the DSD. No specific concerns have been raised to date with the Proposal.	The Proponent will continue consultation with DSD.

Date	Topics/Issues Raised	Proponent Response
Department of Aboriginal Affairs		
Ongoing	The Proponent provides ongoing updates on relevant Proposals and heritage matters at regular liaison meetings.	The Proponent will continue liaising with the DAA and will discuss Proposal specific matters as required. The Proponent will consult with DAA regarding any planned submissions for approval under s18 of the *Aboriginal Heritage Act 1972* to disturb any heritage sites that cannot be avoided.
Cheela Plains Station Owners		
28/11/2013	Meeting with Evan and Robin Pensini of Cheela Plains Station in town of Paraburdoo. The Proponent provided the background approvals history for the B4 Project and outlined details of the Proposal. Key issues of concern raised and discussed included: • The Station owners preferred choice of surplus water management for the B4 Project is re-injection to another aquifer. • Discharge of open waters into Boolgeeda Creek that will extend into Cheela Plains station is likely to attract feral animals (mainly donkeys and cattle). • The public availability of the SCARD Management Plan. • Agreement to meet again toward the end of January 2014 once the API document is drafted.	The Proponent advised that the API document would provide information regarding the consideration of alternative surplus water management options and that it would address the issue for feral animals. The Proponent, if requested, will provide information from the Proponent's SCARD Management Plan. A follow-up meeting was scheduled to coincide with Cheela Plains Station owners being in Perth between 26 January and 11 February 2014.
7/2/2014	Meeting with Evan and Robin Pensini of Cheela Plains Station in the Proponent's Perth office – a follow up to the previous meeting in November 2013. The Proponent provided a copy of draft API document (version dated February 2014 Revision 1) as issued to the OEPA on 3 February 2014 and went through the broad structure and content of the document. Confirmation was given that the SCARD plan was included in the draft API document. Evan and Robin Pensini sought confirmation that the earlier consultation and the matters raised at that meeting had been incorporated in the draft API.	The Proponent advised that it would keep Evan and Robin Pensini advised on key developments in the approvals process and that comments received back from them on the draft API would be considered in future revisions of the document. The Proponent provided a copy of the API document to Mr and Mrs Pensini's Legal Counsel in response to a request in a follow up email.

Date	Topics/Issues Raised	Proponent Response
21/03/2014	Meeting between Robyn Sermon (Rio Tinto) and Evan and Robin Pensini of Cheela Plains Station in the Proponent's Perth office. Issues raised and discussed included: • Environmental and economic concerns about the impact of the proposed discharge of surplus waters from Brockman 4 Project into Boolgeeda Creek. • Questions about discharge of waters into Beasley River from Western Turner Syncline. • Concerns about ongoing development by the Proponent on Cheela Plains Station in the future.	The Proponent agreed to: • Visit Cheela Plains. • Organise a briefing on future plans. • Provide update on the surplus water discharge Proposal for Boolgeeda Creek and send a copy of Appendices disk (disk with Appendices sent on 26 March 2014).
13/06/2014	Mr and Mrs Pensini were provided with a copy of the draft Discharge MMP	
17/06/2014	Meeting between Robyn Sermon, Peter Royce and Jenny Carter (Rio Tinto) and Evan Pensini of Cheela Plains Station at Cheela Plains Station. The draft Water Discharge and Riparian Vegetation Monitoring and Management Plan was discussed and Boolgeeda Creek in the vicinity of the B4 project was visited. Issues raised and discussed included: • Environmental and economic concerns about impact of dewatering from the Brockman 4 Project and discharge into of surplus waters into Boolgeeda Creek. In particular: o Attraction of feral animals and control. o Spread of weeds and control. o Effect of permanent water on biodiversity and ecosystem structure along the creek. • Responsibility for management of impacts resulting from discharge	The Proponent agreed to: • Revise the draft MMP to include management actions for impacts from feral animals and weeds on Cheela Plains Station that may result from discharge to Boolgeeda Creek. • Provide copies of the revised API document and the revised draft Discharge MMP to Mr and Mrs Pensini following submission to OEPA.
In addition to the meetings detailed above, communication is ongoing with Mr and Mrs Pensini of Cheela Plains Station.		

Date	Topics/Issues Raised	Proponent Response
Mt Stuart Station and Badgingarra Owners		
13/01/2014	Conversation with Martin (at Mt Stuart Station) and Deborah (at Badgingarra farm) Avery. The Proponent provided the background approvals history for the B4 Operation and outlined details of the Proposal. Key issues of concern raised and discussed included: • Will the quality of the discharge water into Boolgeeda Creek be suitable for feral herbivores/cattle? • It was considered that water would not pool along Boolgeeda Creek for more than a day or so (based on cyclonic rainfall events). • Provision of Proposal details.	The Proponent noted these comments and addressed water quality in the API document. A copy of the API, as submitted to the OEPA, will be provided to both the Mt Stuart Station and Badgingarra properties.
Puutu Kunti Kurrama and Pinikura (PKKP) – Traditional Owner		
Ongoing	Issues relevant to the B4 Project are discussed with PKKP at six monthly Local Implementation Committee (LIC) meetings, as agreed to in the claim-wide Participation Agreement. This proposal was raised at the LIC meeting in Dampier on the 26 November 2013.	The Proponent will continue with regular consultation with PKKP through the LIC meetings.
Eastern Guruma – Traditional Owner		
Ongoing	Any issues relevant to the Eastern Guruma People are raised at quarterly Monitoring and Liaison Meetings. It is a condition of the Agreements that notification of any activities is provided to Eastern Guruma prior to works taking place and effort is made to address any areas of concern raised by the group.	The Proponent will continue with regular consultation with Eastern Guruma through the Monitoring and Liaison meetings.

6 DEWATERING AND SURPLUS WATER MANAGEMENT

This section describes the changes to the orebody dewatering, site water balance and surplus water management strategy that forms part of this Proposal. Assessments of impacts that may result from these changes are discussed in Section 6 and Section 7.

6.1 HYDROGEOLOGICAL MODELLING

Hydrogeological modelling undertaken in 2008 predicted that relatively low rates of dewatering would be required over several years in order to mine the below water table orebodies of the B4 Project (Aquaterra 2005; 2008a and 2008b). Key improvements in the hydrogeological conceptual model for the B4 Operation have been made since that time (Figure 6-1) (Rio Tinto 2013b and Rio Tinto 2013c). These include:

- The permeability of the dolerite sill within the Brockman Iron Formation is now thought to be lower than originally modelled. The result is that this appears to hydraulically disconnect the Boolgeeda Valley and the Hamersley Group that lie above the sill (Zone 1) from the mineralised Brockman Iron Formation (Zone 2). This disconnect is confirmed by a measured difference in groundwater levels of up to 10m between the two zones.

- The lower un-mineralised Marra Mamba Iron Formation and the Fortescue Group (Zone 4) are now thought to be disconnected from the mineralised Marra Mamba Iron Formation and Wittenoom Formation (Zone 3) due to their very low permeability. These have now been designated as an inactive zone in the groundwater model.

- The mineralised Brockman Iron Formation (Zone 2) and the Wittenoom Formation (Zone 3) are juxtaposed by faulting between the Centre and Western Pits which allows for hydraulic connection.

Hydrogeological modelling using this improved understanding has indicated that the groundwater drawdown at the end of mining due to dewatering is likely to be less extensive than that predicted in 2008 (Figure 6-2). The change in drawdown is due to inclusion in the revised model of lower permeability rates of the sill and the lower un-mineralised Marra Mamba and Fortescue Group.

Conversely, the peak dewatering rate is predicted to be higher at 16.7 ML/d (6.12 GL/a). This increase is due in part to the increased hydraulic connection between the Brockman Iron Formation and the Wittenoom Formation in the revised model, but is compounded by the sub-optimum dewatering undertaken, between 2008 and 2013. In order to optimise dewatering for mining and to make up for the constraints on dewatering that have been in place to date, the abstraction rate will need to be increased. This optimised dewatering rate combined with the lower permeability rates described above will result in deeper drawdown with a reduced lateral footprint over the mine life.

As the groundwater drawdown of the proposal is expected to be smaller overall than that approved under the Original Proposal (Figure 6-2), the impacts of dewatering on groundwater levels and subterranean fauna have not been considered in this document.

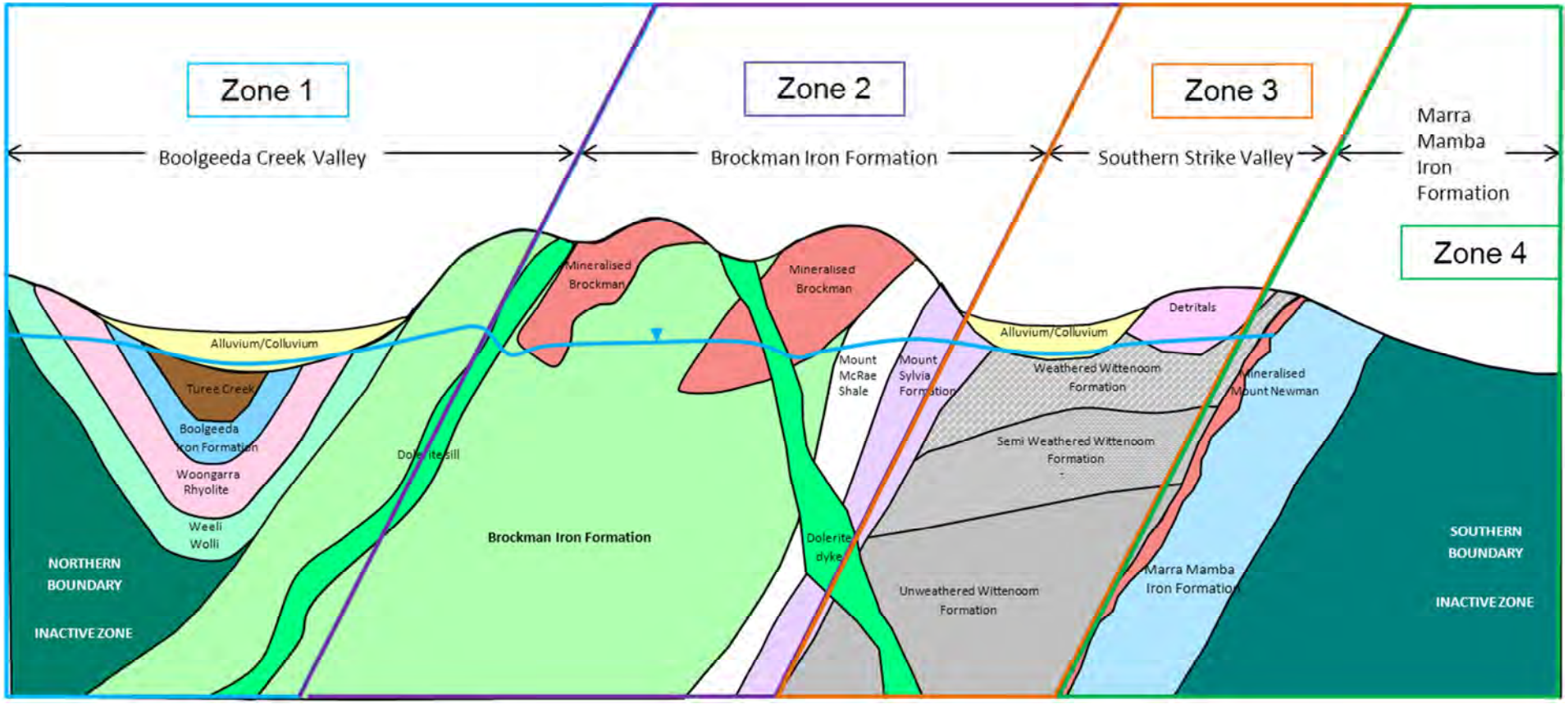
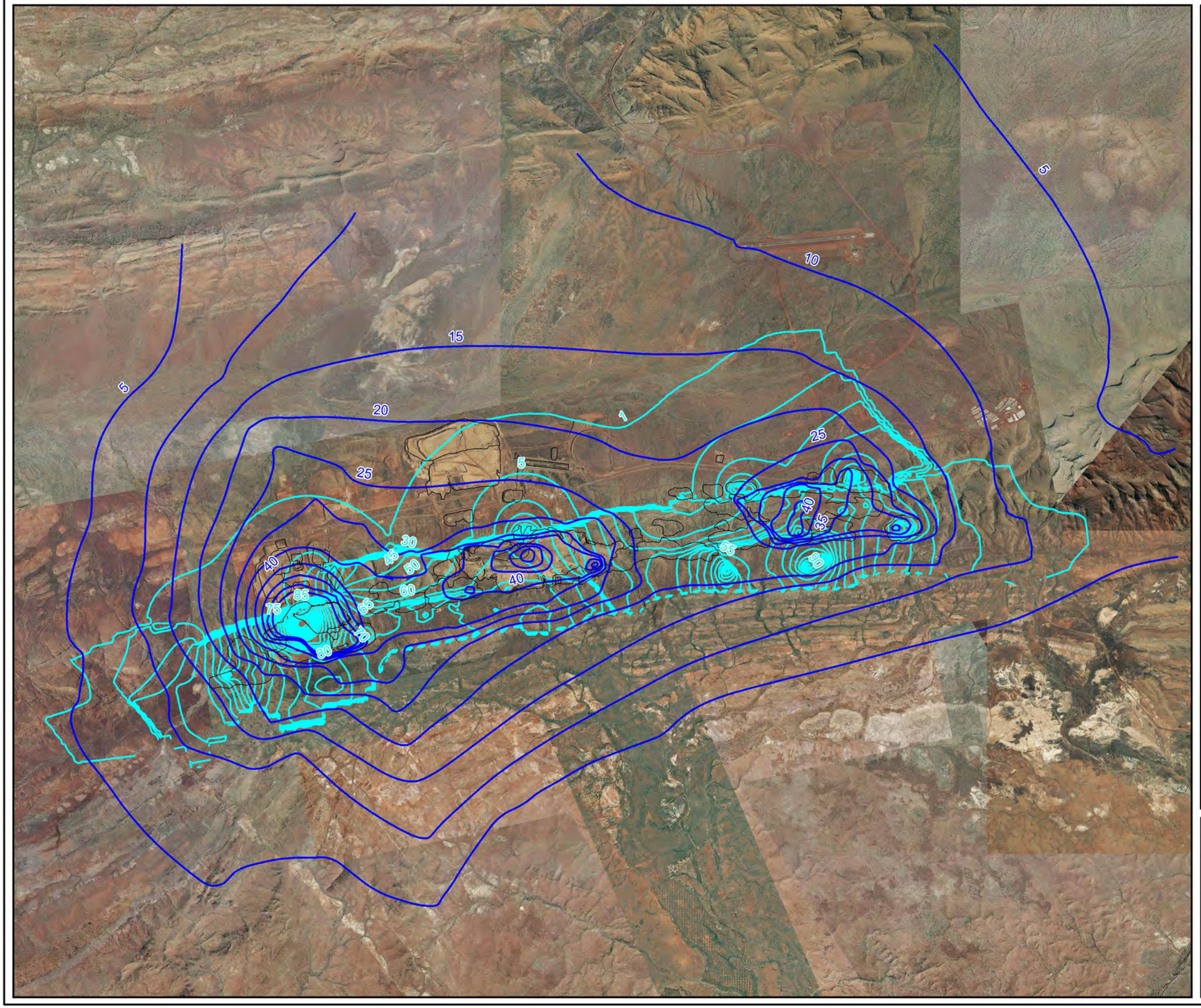


Figure 6-1 B4 conceptual hydrogeological model



LEGEND

Modelled drawdown 2008

Modelled drawdown 2013

BS4 Mine Layout

RioTinto

Figure 6-2
Comparison of predicted end of mining drawdown

Drawn: E McGivern
Date: 12/12/13

Plan No:
Proj: MGA94 zone 50

6.2 OREBODY DEWATERING AND WATER BALANCE

The initial groundwater modelling for the B4 Operation predicted that water generated from dewatering could be entirely used to meet onsite demand (Aquaterra 2005; 2008a and 2008b). It was also determined that later in the mine life an additional external source of water would be required to meet demand following reduction in predicted dewatering volumes. Consequently, in the Original Proposal, management of surplus water was not considered necessary.

When approval was obtained in December 2008 for an increase in throughput at the B4 Operation (from 22 to 42 Mtpa) the ongoing water demand for the site was estimated at approximately 4.53 GL/a (4.38 GL/annum plus 0.15 GL/annum to supply the mine camp), overall this was equivalent to 12.4 ML/d. To date, this volume of water use has not been required (Table 6-1), meaning that under the existing approval (with no surplus water management option) the dewatering required to safely mine below the water table safely has not been possible. The result is that the mine plan has been constrained by availability of dry ore for a number of years.

Table 6-1: Actual Abstraction and Water Use at the B4 Project

Year	Actual Abstraction/Water Use	
	GL/annum	ML/day
2008	0.67	1.8
2009	0.74	2.0
2010	1.15	3.2
2011	2.39	6.5
2012	2.66	7.3
2013	2.68	7.3

With an improved understanding of the hydrogeology of the area from monitoring data and further hydrogeological drilling and testing programs, the mine plan has been revised and an update to the future dewatering requirements has been undertaken. A demand-based dewatering strategy can no longer be used to meet the mine plan and therefore a surplus water management strategy is required. Figure 6-3 depicts the expected water demand and surplus water volume based on the current predicted dewatering requirements[3].

Figure 6-3 illustrates the predicted water demand for the B4 Project, the predicted dewatering volumes and the likely surplus water volumes on an annual basis. This simplified conceptual water balance includes the assumption that although the actual dewatering requirement will vary, the water demand will remain relatively constant at around 8 ML/day for the life of mine[4]. Under this circumstance the surplus water volume is predicted to be in the order of 4-5ML/day for much of the life of the operation, with the occasional peak in abstraction volume in the order of 16-17 ML/day; with a corresponding increase in discharge.

Peaks in abstraction rates are generally encountered when new below water table pits are developed (i.e. dewatering commences in a new area of the aquifer), when vertical mining rates increase or when a part of the aquifer with increased permeability is encountered. Consequently the timing and

[3] Predicted abstraction, demand and surplus volumes based on mine plan as at May 2014

[4] For a production rate of ~45Mtpa product

scale of the peaks in abstraction are largely influenced by the mining schedule and the nature of the aquifer being dewatered and will vary according to operational circumstances.

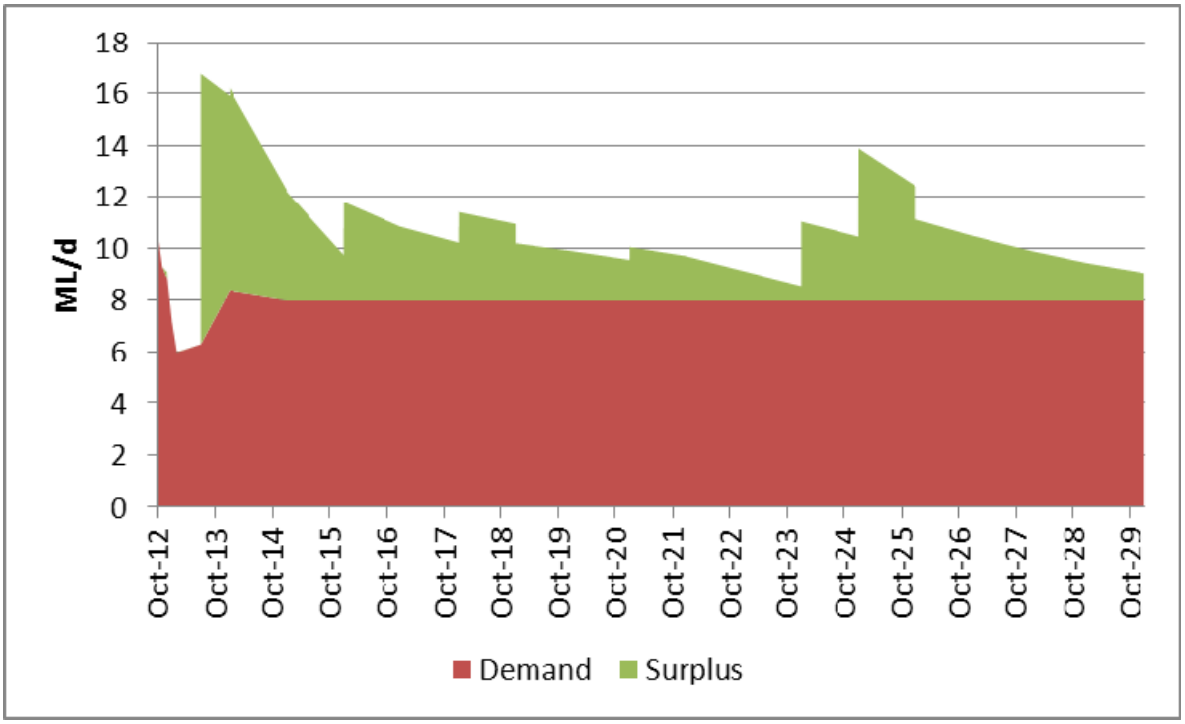


Figure 6-3: Conceptual Water Balance for the B4 Project

The volumes indicated here are based on hydrogeological and water use modelling. The figures provided differ from those presented for the B4 Operation and represent a progression in the hydrogeological conceptualisation of the area based on actual dewatering to-date combined with further investigation of the orebody. In addition changes have been made to the mine plan since the B4 Operation was developed. Such changes are common and are often implemented in response to factors such as conditions encountered during mining, grade requirements, ore quality, market conditions, performance of the dewatering system and water usage on site. These factors will continue to influence the dewatering volumes during the remainder of the life of the B4 Operation, making it difficult to predict exactly how much water will be abstracted, used or discharged at any point in time.

The environmental approvals process under Part IV of the EP Act is such that a reasonable prediction of abstraction and discharge volumes is required to be presented by the Proponent based on technically-sound information that is available at the time. This is so that the scale of any resultant environmental impacts can be realistically assessed and addressed and a limit can be applied to the authorised abstraction and/or discharge volumes in Schedule 1 of the associated Ministerial Statement. The Proponent considers that a conservative upper limit on abstraction and discharge is appropriate given that the prediction of these volumes:

1) is the result of modelling;

2) is required to apply to an operation in the long term (e.g. 20-30 years); and

3) can be influenced by a number of factors during the execution of the project (as described above).

Adoption of a conservative limit allows flexibility in managing the dewatering program to maximise efficiency without an artificial constraint on abstraction volumes. In the long term, an efficiently run targeted dewatering program produces less water overall than an inefficient system, run at a sub-optimal abstraction rate. Where water is abstracted at an insufficient rate, an orebody aquifer may be allowed to continually refill and will therefore require dewatering over a longer period of time in order to mine the same pits, resulting in a greater volume of water abstracted over the life of the mine.

Therefore this Proposal includes an abstraction limit of 17.5 ML/day: a volume above that which is predicted by the current model (16.7 ML/day). This is considered to represent a realistic limit that allows for fluctuation in the actual peak abstraction, although for the majority of years the abstraction is expected to be lower. A similar approach to setting conservative abstraction limits was adopted for the Nammuldi-Silvergrass Expansion (MS 925, 11 January 2013).

Whilst water use at the B4 Project is expected to be constant at about 8 ML/day, there will be operational factors that may apply on a day to day basis that result in more than or less than this volume being used. The processing plant and dust suppression together account for the greatest on-site consumption of water. Clearly during periods of rain the requirement for dust suppression on haul roads and other open areas is significantly reduced and consequently so is the demand for water. In the event of a plant shutdown, water use is similarly reduced. These are normal occurrences in the operation of a mine where short-term water demand may fall. Under such circumstances mine dewatering continues in order to allow continued access to below water table ore and therefore when demand falls there is a corresponding short-term increase in the surplus water volume that requires management.

Under this Proposal, the additional surplus water produced in such circumstances would be discharged into Boolgeeda Creek, as required, up to the prescribed limit. This management option is discussed in the following sections. Note that the difference in the extent of the maximum discharge footprint resulting from 17.5 ML/day compared to 16.7 ML/day (a difference equivalent to 0.8 ML/day) is not expected to be significant and nor is it expected to cause impact to any additional identified environmental values of high conservation significance.

6.3 CONSIDERATION OF OPTIONS FOR SURPLUS WATER MANAGMENT

Management of surplus water on the Proponent's sites follows environmental and water use standards that align with the Western Australian DoW's preferred options for surplus water disposal (DoW 2013). The DoW recommended disposal options are:

- use on site;
- transfer to another site or industrial location;
- reintroduction to aquifer(s);
- controlled discharge to natural watercourses (e.g. irrigation, storage and periodic discharge); and

- uncontrolled discharge to watercourses.

The following surplus water use assessment (Table 6-2) is based on that conducted for the Nammuldi-Silvergrass Expansion (**Expansion**) which was assessed by EPA in 2012 (Report No. 1457). Whilst the surplus water volumes predicted for the Expansion are significantly in excess of those predicted for the B4 Revised Proposal, the operations are located approximately 35 km apart, within the same region. It is therefore considered that the surplus water management assessment conducted for the Expansion can reasonably be applied to the B4 Revised Proposal. The Expansion assessment has been reviewed in consideration of the following differences for the B4 Revised Proposal:

1) Lower volume of surplus water: dewatering of up to 6.4 GL/annum for the B4 Revised Proposal (annualised volume based on 17.5 ML/day) and on average 4-5 ML/day (vs combined dewatering of up to 119 GL/annum, equivalent to 326 ML/day, for the Expansion).

2) Unreliability of water supply: in-pit bores have relatively low utilisation rates due to constraints on bore operating hours imposed by blasting, mining and power supply. The B4 Revised Proposal will only need to employ a small number of bores which will be located primarily in-pit; in contrast to the Expansion there is therefore unlikely to be a reliable base load supply of surplus water to support a business case for management through development of beneficial use, or transfer via a purpose-built pipeline. The majority of the dewatering volume will be used to supply the operational water demands, and while dewatering volumes at the B4 Revised Proposal may peak at over 16 ML/day, surplus volumes during normal operation are expected to average about 4-5 ML/day over the operational life.

Table 6-2: Alternatives considered for the management of surplus water at the B4 Revised Proposal

No.	Options	Advantages	Disadvantages
1.	**Transfer to another site or industrial use**		
a	Transferring surplus water to third party users	• Beneficial use of water.	• Any nearby third party user identified in the future would likely source water from a mine with larger, more reliable volumes such as Nammuldi-Silvergrass or Marandoo. • Contractual difficulties associated with inability to guarantee supply to a third party (e.g. if less water or unreliable supply of water is available from dewatering). • Difficulties attracting a third party user as the water supply will not be available in the long-term. • No third party user of such volumes of water in proximity, therefore transfer to a third party would require that water be moved a significant distance resulting in high piping and pumping costs for a relatively small volume of water.
b	Transfer off-site for secondary use by the Proponent's other operations	• Beneficial use of water. • As water is transferred to the Proponent's own operations there are no contractual difficulties. • Avoids the need for other operations to source water locally.	• Currently the Proponent has no local operation that cannot meet its own water demand. • Capex and Opex associated with piping and pumping further afield would be significant for a relatively small volume of water.
c	Transfer for incorporation into the West Pilbara Water Supply Scheme (WPWSS)	• Water can be used for public water supply.	• The Proponent's Bungaroo borefield is closer, can supply significantly more water, has a longer supply life and is already approved under Part IV. • Significant additional clearing footprint for pipeline, across tenure that the Proponent currently does not have access to. • High Capex and Opex associated with piping and pumping for a relatively small volume of water.
d	Transfer off-site for secondary use by the Proponent agricultural operations	• Beneficial use of water. • As water is transferred to different the Proponent's operations there are no contractual difficulties.	• Nearest agriculture project is at Nammuldi. Supply from B4 Revised Proposal to the agriculture project would offset surplus water from the Nammuldi-Silvergrass Expansion and result in additional discharge to Duck Creek. • Volume of water available from B4 Revised Proposal is insufficient to warrant cost and complexity of approvals for a new agriculture project (e.g. on the Proponent's Rocklea Station). • Additional clearing of Pastoral Station required. • High Capex and Opex associated with piping and pumping for a relatively small volume of water.
e	Supply Tom Price town	• Water can be used as public water supply.	• A portion of the surplus water volume from dewatering of the Proponent's Marandoo operation is currently used to meet Tom Price mine and town demand using existing infrastructure and an existing Part IV approval. Therefore, there is no demand for water from B4 Operation at Tom Price. • Significant additional clearing for a pipeline between B4 Operation and Tom Price. • High Capex and Opex associated with piping and pumping for a relatively small volume of water for a short period of time.
2.	**Reintroduction to aquifer(s)**		
a	Passive recharge via a disused pit	• Water can be returned to local groundwater system.	• No pits at the B4 Operation have yet been mined-out and therefore no pit will be available to accept surplus water at the commencement of dewatering. • Use of a mined out pit for passive recharge would prevent potential backfilling and increase external waste dumps. • All pits within the deposit are hydrogeologically connected which would result in recycling of water and an overall increase in dewatering volumes. • Discharge within extent of drawdown would result in recycling of water and greater pumping required to lower watertable. • Mining is currently occurring in the mineralised Joffre and Dales Gorge Members of the Brockman Iron Formation. Although there are several significant faults and dolerite dykes dissecting the deposits, some of which are thought to have an impact on groundwater flow, these do not isolate any areas where water could be passively reinjected without adversely affecting current mining operations within the Brockman Iron Formation, or potential future mining within the Marra Mamba Formation.
b	Aquifer reinjection	• Water can be returned to local groundwater system.	• Investigations into the permeability and storage potential of the formations present identify only the Paraburdoo Member of the Wittenoom Formation as being a realistic target for re-injection (Rio Tinto 2011b) and would require a large number of boreholes to be successful. • Not considered to be possible to locate required number of boreholes on the Proponent's tenure. • Significant additional clearing for drilling and location of pipeline infrastructure. • Uncertainty over finding sufficient appropriate formations within reasonable distance and timeframe. • Capacity of Paraburdoo Member to accommodate the full amount of surplus water is unknown. • Paraburdoo Member in proximity to the B4 Operation is in hydraulic connection with future Brockman Syncline 4 Marra Mamba deposits and in poor connection with the Brockman Iron deposits currently being mined, compromising current and future mining. • High Capex associated with drilling enough investigative and reinjection boreholes.
c	Reinjection into creek alluvium	• NA	• Boolgeeda Formation creek alluviums are generally shallow and underlain by low permeability basement units, resulting in low water storing capacity. Reinjected water may surface in Boolgeeda Creek. • Capex of reinjection into alluvium is relatively high for the small volume of water involved.

No.	Options	Advantages	Disadvantages
3	**Controlled discharge to single natural watercourse:**		
a	Duck Creek (regional option)	• Not constrained by demand. • Comparatively wetter than other creeks in the area (e.g. contains more pools); therefore, natural system is more adapted to presence of water. • No locations with exceptional environmental value, such as areas included in the EPA Red Book listings. • Culturally significant sites comparatively further away from discharge locations. • No effect on development of iron ore deposits in future.	• Surface expression of water will be further downstream than 'drier' neighbouring creeks. • Periodic discharge to Duck Creek would be changed to continuous discharge by addition of B4 surplus water. • Potential for cumulative impacts from additional, continuous discharge to Duck Creek. • Of options considered, existing Duck Creek discharge location is furthest from B4 Project (>20 km) resulting in comparatively higher piping costs. • High Capex and Opex associated with piping and pumping for a relatively small volume of water for a short period of time.
b	Boolgeeda Creek (local option)	• Not constrained by demand. • Comparatively drier than other creeks, the surface expression of peak discharge volume will not extend as far downstream as it would in the Beasley River. • No locations with exceptional environmental value, such as areas included in the EPA Red Book listings. • Closest creek to B4 Project results in lower piping and pumping costs. • Closest creek to B4 Project simplifies logistics for construction, operation, monitoring and management of impacts. • Smallest clearing footprint of discharge options for 1.36km pipeline and discharge infrastructure. • No effect on development of iron ore deposits in future. • Discharge contained within country of one Traditional Owner group. • Impacts from discharge contained within the same valley/catchment as the B4 Project. • Discharge would be partway down the creek system, allowing greater flushing of system (e.g. with surface runoff and micro and macroinvertebrates) from the upper reaches natural during flow events and post-discharge.	• Potential for relatively greater change to creek ecosystem within discharge footprint. • Potential for surface water to affect existing access tracks that intersect Boolgeeda Creek. • Discharge at moderate volumes potentially extends onto pastoral leases of two third parties.
c	Beasley River tributary (local option)	• Not constrained by demand. • No locations with exceptional environmental value, such as areas included in the EPA Red Book listings. • For lower discharge volumes (< peak volume) the surface expression of water will not travel as far downstream as it would in Boolgeeda Creek. • Discharge potentially extends onto pastoral lease of a third party only at higher volumes.	• Potential for relatively greater change to ecosystem within discharge footprint. • Larger clearing footprint of local discharge options for 3.8km pipeline and discharge infrastructure. • Discharge likely to affect country of two Traditional Owner groups. • Upper reaches of Beasley River already subject to surplus water discharges (from Western Turner Syncline Stage 2). Addition of water from B4 to a second tributary has potential to compound the impacts from existing discharge. • Discharge would be into the top of the tributary, removing the opportunity for replenishment of affected fauna species from flushing (e.g. micro and macroinvertebrates). • Shorter discharge footprint at low volumes potentially concentrates impacts from feral animals (e.g. trampling, grazing, nutrient input). • Furthest local creek to B4 Operation complicates logistics for construction, operation, monitoring and management of impacts. • Potential to have a negative impact on future mining operations of B4 Marra Mambas and Beasley River Limonite Channel Iron Deposit. • Discharge location further from B4 Operation of local options considered resulting in higher piping costs.

No.	Options	Advantages	Disadvantages
4	**Discharge to multiple creeks**		
a	Discharge to multiple creeks with discharge rotated between the creeks, allowing creeks to "dry out" between discharges: using combinations of the above creeks	• Greater flexibility in terms of controlling and temporally spacing discharges, potentially minimising the scale of impacts within each receiving environment. • Potential to have greater capacity to dispose of surplus water.	• Potential for more creeklines to be affected and increased land disturbance. • Use of multiple creeklines complicates logistics for construction, operation, monitoring and management of impacts. • Increased resources required to monitor and manage multiple creeklines. • High costs associated with piping as pipelines and pumps for all discharge locations would need to be built to full capacity to allow flexibility.
5	**Storage and pulsed discharge to creeks**		
a	Containment in purpose built storage dam for pulsed discharge to creeks	• Greater flexibility in terms of controlling and temporally spacing discharges, potentially minimising the scale of impacts to receiving environment.	• Unlikely to identify a suitable location in proximity to Development Envelope. • Dam would be prohibitively large to provide effective spacing of discharges as well as accommodating flood/storm volumes, resulting in high costs and significant additional clearing and earthworks.
6	**Other**		
a	Use of large evaporators	• On-site disposal of water. • Controlled by the Proponent.	• Real-world experience shows that up to 50% of the jetted water does not evaporate but falls to the ground beneath the jet plume, creating runoff and irrigation of uncontrolled areas with potential for weed growth. • High cost, energy and greenhouse gas requirements.
b	Water bottling	• Beneficial use of water. • Local business opportunity, including indigenous business engagement.	• Does not manage a material volume of water relative to the dewatering volumes. • Large scale water bottling operations goes against the Proponent's sustainable development principles due to substantial increase in plastic footprint. • the Proponent's research has shown that Pilbara groundwater quality typically does not meet the profile of minerals necessary to qualify as a marketable bottled water product. • Logistically difficult and expensive due to remote Pilbara location and large volume of water involved.
c	Containment and evaporation from Waste Fines Storage Facility (WFSF)	• On-site disposal of water. • Rio Tinto controlled.	• Risk associated with stability and seepage, WFSF is required to be relatively dry to avoid these problems. • the Proponent's Mineral Waste Standards prohibit the storage of excess water in tailings dams and WFSF's. WFSF's are not designed for the purpose of water storage and rely on a constant cycle of solids beaching, evaporation of supernatant water and desiccation of waste fines to ensure geotechnical integrity of the WFSF contents. • Potential for concentration of salts in the WFSF and affecting potential for saline plume problems at closure. • Significant clearing required for pipeline to Nammuldi. • Closest WFSF is at Nammuldi necessitating high cost of piping and pumping for relatively small volume of water.

Development of the surplus water management strategy involved the consideration of a number of different alternatives in accordance with the DoW list of water use options published in the WA Water in Mining Guidelines (DoW 2013). A number of alternatives considered were excluded due to the prohibitively high costs, potential environmental impacts, or because they represent a substantial technical risk to the Proposal. In general the alternatives that were not preferred involved:

1) Secondary use by the Proponent or a third party was rejected due to the relatively small volumes of water and high costs involved, combined with the unreliability of supply and potential for constraints on demand.

2) Reinjection was rejected due to the technical uncertainty, absence of known suitable geological formations in proximity to the dewatering and the relatively small volumes of water and high costs involved.

3) Containment and/or discharge to regional creeklines was rejected due to the complexity of logistics and high costs involved for relatively small volumes of water in addition to the potential for cumulative impacts resulting from discharge to existing receiving water bodies (e.g. Duck Creek).

In view of the relatively small volumes of water, the unreliability of supply, the logistics and costs associated with transfer and/or use by another site or third party and the flexibility afforded by the absence of user-defined constraints it was concluded that surface discharge to a local natural watercourse (Boolgeeda Creek or a local un-named tributary of the Beasley River to the south of the B4 Operation) was the most appropriate option for further consideration. Comparison of these two options is discussed in further detail in the following section.

6.4 COMPARISON OF LOCAL SURFACE DISCHARGE OPTIONS

This section discusses the rationale for selection of a receiving water body for surplus water from the B4 Revised Proposal. In determining which option to choose, consideration was given to the following:

- hydrological response;
- vegetation and flora;
- aquatic fauna;
- logistics and costs; and
- future iron ore resources.

6.4.1 Hydrological response

The Proponent has developed a surplus water discharge model that it routinely uses to estimate the maximum surface water expression and wetting front that would be expected to result from discharge of water to a specified creek. The model is modified to apply to the particular creek under

consideration and has been used to estimate the likely discharge footprint that would result from discharge of surplus water into a number of Pilbara creeks.

This model was used to estimate the discharge footprints that may develop under steady state conditions in each of Boolgeeda Creek and the un-named tributary of the Beasley River for a hypothetical range of surplus water volumes (Rio Tinto 2013a). The maximum wetting front has been estimated for a range of discharge volumes from 2.5–20 ML/day in 2.5 ML/day increments in order to gauge the relative change in the footprint for increasing discharge volumes (Table 6-3). Wetting fronts were determined on the assumption that steady state conditions were established.

Table 6-3: Estimated Discharge Footprint in Boolgeeda Creek and Beasley River Systems

Discharge Volume (ML/d)	Maximum wetting front (km)	
	Boolgeeda Creek	Beasley River tributary
2.5	12.0	5.0
5	22.0	11.0
7.5	31.0	15.0
10	33.0	19.0
12.5	34.0	31.0
15	35.0	40.0
17.5	**37.0**	**44.0**
20	38.0	48

Beasley River and tributary

The underlying basement of the Beasley River tributary and the Beasley River itself is the Fortescue Group. Aquifers associated with this group are generally of low permeability. Overlying the Fortescue Group is a laterally discontinuous cover of alluvium, colluvium and pisolite of Cainozoic age. Transient pools within the tributary and river are likely to depend on rainfall, surface water and shallow alluvial interflow rather than regional groundwater.

Boolgeeda Creek

Boolgeeda Creek catchment covers an area of approximately 1,650 km^2 and is a tributary of Duck Creek within the regional Ashburton River catchment. The creek extends approximately 106 km and is characterised by a braided, meandering creek dominated by multiple active and inactive flow channels that are likely to be reworked during flow events, within a broad valley. The creek becomes more defined when it enters a gorge system downstream of the B4 Operation, before discharging into Duck Creek at Lawloit Range (Rio Tinto 2013b).

The underlying basement of the Boolgeeda Creek valley comprises Tertiary valley fill and Quaternary alluvial gravels overlying the Hamersley Group (Boolgeeda Iron Formation and Woongarra Volcanics) and Turee Creek Group basement. Aquifers associated with the basement units (Hamersley Group and Turee Creek Group) are generally of low permeability. The valley fill material underlying the alluvium is typically less than 20 m thick with no significant inflow or outflows of groundwater (Aquaterra 2005). Transient pools within the creek bed are likely to depend on rainfall, surface water and shallow alluvial interflow rather than regional groundwater.

The geology of the two systems means that they are considered to be comparable in their capacity to accept surplus water discharge: neither has continuous inflow or outflow of groundwater – and

therefore significantly greater or lesser capacity to "lose' surplus water from its channel. Both systems are known to have ephemeral pools within the modelled discharge footprint and are likely to respond to additional water from discharge by increased surface expression - in particular further pooling and continuous surface flows within the discharge footprint.

At peak discharge rates of 17.5 ML/day the maximum wetting front in Boolgeeda Creek is predicted to extend approximately 37 km from the discharge point. In the Beasley River tributary the footprint distance is predicted to be 7 km further at 44 km. However at lower discharge volumes the discharge footprint is expected to be less for Beasley than for the Boolgeeda system. In each system the velocities of the modelled discharge in the different reaches are not expected to vary significantly, surplus water is likely to be contained within the channel and water will remain relatively shallow throughout the discharge footprint. Each system is naturally dynamic and localised deeper areas would be expected to occur in either system due to changing morphology of the creek bed combined with surplus water discharge.

Therefore Boolgeeda Creek and the Beasley River tributary are expected to have comparable hydrological responses to discharge of surplus water.

6.4.2 Vegetation and Flora

Biota undertook vegetation and flora surveys in the Beasley River tributary valley in 2009 (Biota 2009a) and of Boolgeeda Creek in 2013 (Biota 2013a). Riparian vegetation monitoring transects were set up along Boolgeeda Creek by Biota in 2014 as part of the vegetation monitoring program to support the proposed discharge.

The riparian flora and vegetation of Boolgeeda Creek are described in further detail in Section 8 and Appendix 7. The following summarises the key features of vegetation associated with both creeks.

- Neither system contains any Threatened Ecological Communities (**TECs**) or Priority Ecological Communities (**PECs**).
- The riparian vegetation types of both systems are considered to be of Moderate Conservation Significance, consistent with fringing vegetation of major ephemeral watercourses in the Pilbara. Vegetation types dominated by Eucalypts (in particular *Eucatyptus victrix* and *E. camaldulensis*) are present within each system.
- The riparian vegetation in both systems is considered to be under threat from grazing and invasion by weeds, as is typical of major ephemeral watercourses in the region, with several species of introduced flora present and infestations of weeds (in particular Buffel Grass) considered to be affecting the vegetation condition of each system.
- No Declared Rare Flora (**DRF**) has been found in either system. However Priority Flora occur in the riparian vegetation in both systems

The identified vegetation and flora values within the Boolgeeda Creek and Beasley River tributary are considered to be comparable.

6.4.3 Aquatic Fauna

Aquatic fauna sampling and water quality monitoring has been undertaken in both systems as part of the ongoing monitoring program conducted by Wetland Research and Management (**WRM**) for surplus water discharge from the Nammuldi-Silvergrass Expansion and the West Turner Syncline Stage 2 operations. Limited sites sampled on Beasley River and Boolgeeda Creek have shown that the composition of micro- and macroinvertebrates and fish taxa and overall species richness are similar in these systems to those found in Duck and Caves Creeks and comparable to other creek systems within the region and wider Pilbara.

Based on site inspections, both systems are known to have ephemeral pools and these may act as short-term refugia for fauna.

The identified aquatic fauna values within the Boolgeeda Creek and Beasley River tributary are considered to be comparable.

6.4.4 Logistics and costs

The discharge pipeline to Boolgeeda Creek will be approximately 2.5 km shorter than that which is required to reach the Beasley River tributary. In addition the Boolgeeda Creek pipeline route follows an existing track for much of its length. Therefore less clearing of native vegetation will be required overall for construction of the pipeline and discharge outlet.

6.4.5 Future iron ore resources

The Brockman Syncline 4 Marra Mamba deposit lies along the Marra Mamba ridge to the south of and parallel to, the existing B4 Brockman pits. Drilling has indicated that there is potential for future development of this deposit. A long term pipeline to Beasley River tributary would need to extend across the deposit and has the potential to sterilise part of the resource and/or complicate its mining and/or its associated infrastructure.

The Beasley River Limonite Channel Iron Deposits (**CID**) lies to the south of the B4 Operation, in proximity to the tributary of the Beasley River. The deposits occur on the Proponent's tenure as a series of flat topped mesas occupying a 30 km palaeochannel: the present drainage has dissected the original continuous deposit to leave a series of mesas.

A preliminary drilling program in 2011/2012 indicated that the majority of the resource is above water table, with a groundwater level of 440-445 mRL within the deposit. Further drilling will be required to determine the extent of the deposit and to prove up the resource.

Current understanding of both the B4 Marra Mambas and Beasley River Limonites deposits is insufficiently advanced at this stage to provide confidence in the placement of a discharge pipeline such that it does not compromise and is not compromised by, future mining in this area.

The Proponent is not aware of any potential resource in close association with Boolgeeda Creek and therefore as a measure to protect the ability to investigate and develop both the B4 Marra Mamba deposit and Beasley River Limonites CID in future, discharge to Boolgeeda Creek is preferred over discharge to the Beasley River tributary.

6.5 DISCHARGE WATER QUALITY

At present the Eastern Borefield is used for potable water supply to the B4 camp and office facilities as well as mineral processing and dust suppression. The Western and Southern Strike Valley Bore fields supply water for mineral processing and dust suppression, with some used for potable purposes. The Eastern Borefield is the preferred source for potable water because of its superior water quality compared with that of the Western and Southern Strike Valley Borefield.

Overall, the current groundwater quality at B4 is fresh to brackish with a neutral to slightly basic pH (Table 6-4). The surface water quality measured is not dissimilar to that observed in the existing B4 groundwater bores (Rio Tinto 2013d).

Table 6-4: B4 Water Quality

Groundwater	pH	EC (µS/cm)	TDS (mg/L)
Borefield*			
Eastern Borefield	6.57-8.03	521-849	344-444
Western Borefield	6.71-7.71	946-1452	620-776
Southern Strike Valley Borefield	6.3-8.36	623-2310	576-1580
All	**6.57-8.36**	**521-2310**	**344-1580**
Surface Water**			
Boolgeeda Creek (BC1)***	8.72	1676	1000
Beasley River (BR1 & BR2, BRWC1, BRWC2, BRWC3 & BRWC4)	8.16-9.03	674-3820	650-3820

*Rio Tinto 2013d

**Wetland Research and Management 2011a; 2011b; and 2012

***Only one sample is available, therefore no range is provided

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000) provides a framework for setting of site-specific trigger values, establishing sampling regimes and undertaking decision-making in the event that actions are triggered. This will be adopted as at the Proponent's other sites and site specific trigger values will be established and reviewed in accordance with the ANZECC/ARMCANZ framework. Monitoring and management of water quality is considered to be a surrogate for protection of aquatic faunal communities.

Part V of the EP Act provides an appropriate mechanism to regulate and control the quality of discharge water to a receiving environment.

7 ASSESSMENT OF IMPACT ON HYDROLOGICAL PROCESSES

This Section describes the hydrological systems that exist within the Greater Brockman region, provides details regarding the potential impacts to ground and surface water regimes that may result from the orebody dewatering and the discharge of surplus water that forms part of this Proposal and identifies mitigation and management that will be implemented.

The EPA applies the following objective, in its EAG8 (EPA, 2013) in its assessment of proposals that may affect hydrological processes:

To maintain the hydrological regimes of groundwater and surface water so that the existing and potential uses, including ecosystem maintenance, are protected.

7.1 GROUNDWATER DRAWDOWN

Dewatering of the orebody is now predicted to result in a smaller overall cone of depression than that authorised under the original proposal (MS 717). Therefore it is considered that there is no potential for additional impacts as a result of this Proposal.

7.2 SURFACE DISCHARGE TO BOOLGEEDA CREEK

The Boolgeeda Creek catchment covers an area of approximately 1,650 km2 and is a tributary of Duck Creek within the regional Ashburton River catchment. The headwaters of the Boolgeeda Creek catchment rise from the mountain ranges of Mount Brockman and the Hamersley Range. The creek is approximately 106 km in length and is characterised by a braided, meandering creek dominated by multiple active and inactive flow channels within a broad valley. The creek becomes more defined when it enters a gorge system downstream of the B4 Operation, before discharging into Duck Creek at Lowlait Range. The general absence of permanent and semi-permanent water features suggests it is a relatively dry system, typical of ephemeral creeks in the Pilbara.

The Boolgeeda Creek is characterised by active creek beds of coarse sand and gravel that are likely to be reworked during flow events. There is also evidence of the development of a new secondary flow channel following these flood events which indicates that the system is dynamic and naturally capable of changing course and flow conditions (refer to Appendix 5).

There are no permanent stream gauging stations in the Boolgeeda Creek catchment. The Index Flood method has been used to estimate the ARI design peak flows following rainfall within the area of discharge. The proposed discharge outlet (MGA50 coordinates 521783E; 7504099N) is located at the upper reach of the main stream, requiring approximately 1.4 km extension from the existing pipe network at the B4 Operation. The peak flow of rainfall runoff estimated at this outlet is 148 m^3/s for a 2 year ARI event and 3,310 m^3/s for a 100 year ARI flood. Compared to the peak flows of rainfall runoff, the predicted maximum discharge volume (17.5 ML/day, equivalent to 0.2 m^3/s) would be negligible during a flood event.

Results for the modelled scenario for Boolgeeda Creek discharge are summarised in Appendix 5 and Figure 2-1 depicts the estimated discharge footprint along Boolgeeda Creek. In summary the baseline hydrology modelling (Rio Tinto 2013d) indicated the following:

- The wetting footprint in Boolgeeda Creek would extend approximately 37 km down gradient from the proposed discharge outlet for a modelled volume of 17.5 ML/day.

- The estimated surface water expression footprint was less than the estimated steady state distance which indicates that the water released into the creek is likely to move in and out of the creek bed, creating transient pools into topographical depressions and associated saturated bank conditions within the reach.

- The peak flow volume of water discharging into Boolgeeda Creek is significantly smaller than the peak flow volume generated by the catchment during any flood event. The discharge is likely to result in the development of constant, shallow (on average <7cm) stream flow between flood events and with transient pools in local depressions within the discharge footprint.

- At the peak discharge rate of 17.5 ML/day water released into Boolgeeda Creek is likely to be contained within the channel, hence overtopping of the bank is not expected[5]. While the creek bed will remain saturated, the creek banks are likely to remain unsaturated. However, the increased availability of water in the creek and within the unsaturated zone has the potential to affect the health and vigour of fringing groundwater dependent vegetation.

- The bedrock units underlying the Boolgeeda Creek valley are of low permeability as a result discharge water will be retained within the surface alluvials.

Table 7-1 describes the factor, summarises how the proposal meets the EPA's objective and presents an impact and assessment of significance. Management and mitigation measures are also presented.

[5] Notwithstanding the fact that the natural system is dynamic and evidence shows that the channel can be reworked during flood events.

Table 7-1: Hydrological Processes: Description of Factor, Impact Assessment and Management

EPA Objective	Existing Environment	Potential Impact (without Mitigation)	Management and Outcome
To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	**Groundwater drawdown** The rate of groundwater abstraction to dewater the mine pits will increase as a result of this Proposal. Water for processing, dust suppression, BWT mining and potable water purposes is sourced from groundwater production bores and mine dewatering bores, with dewatering production prioritised over external bore fields. **Dewatering discharge** • Surplus water will be discharged into Boolgeeda Creek from a pipeline north of the B4 deposit (refer to Figure 2-1). • A maximum predicted discharge of 6.4 GL/a (17.5 ML/day) will be required. The predicted water demand will remain steady at approximately 8 ML/day and the proposed surface discharge will average at 4 ML/day however peaks of up to 17.5 ML/day are expected. **Boolgeeda Creek** • B4 lies on the divide between the Boolgeeda Creek and Beasley River catchments. Boolgeeda Creek lies approximately 2.5 km north (at is closest point) from the B4 Central Pit. • Boolgeeda Creek catchment covers an area of approximately 1,650 km^2 and is a tributary of Duck Creek within the regional Ashburton River catchment. The creek becomes more defined when it enters a gorge system downstream of B4 operation, before discharging into Duck Creek at Lawloit Range. • A total of six pools were observed in 2013. Reconnaissance of Boolgeeda creek in November 2009 and April 2010 revealed no surface water present in the area currently modelled for this Proposal (WRM 2011a). One control site was sampled in Boolgeeda Creek 70 km downstream from the proposed B4 discharge point. Pools in Boolgeeda Creek are likely to be transient and ephemeral and water quality will vary with the season. They are likely to be dependent on rainfall, surface water and shallow alluvial interflow rather than regional groundwater. The pools noted by Biota during the August 2013 survey have not been identified in previous studies. However, they are likely to be a result of the unseasonably high rainfall recorded at B4 in May and June 2013 (32.8 mm and 52.8 mm respectively, compared with 8.8 mm and 16.4 mm in 2011 and 0 mm and 12.4 mm in 2012). • An updated hydrological model was completed in June 2013 (Rio Tinto, 2013a) to predict the hydrological reaction of Boolgeeda Creek to the release of surplus dewater from the B4 Project. An extra 1.36 km discharge pipe is required to be extended from the existing B4 discharge pipe network to the proposed outlet. The response of the creek systems through the continual discharge for a range of discharge options varying from 2.5 ML/day to 20 ML/day was investigated (the estimated peak	**Groundwater drawdown** Dewatering of the orebody at an increased rate is predicted to result in a smaller overall cone of depression than that authorised under the original proposal (MS 717). Therefore no impacts from drawdown (different from, or additional to, the approved B4 Operation) will occur as a result of implementation of this Proposal. Groundwater levels through the B4 Project area are naturally deep and do not support phreatophytic vegetation (with the exception of C1 – Coolibah *Eucalyptus victrix* woodlands mainly along Boolgeeda Creek, and possibly P1 – the Mulga woodlands in the broad drainage area within the valley south of the B4 Range), and there is no indication of shallow water table aquifers within the B4 Operation area. **Discharge of surplus water** • The wetting footprint in Boolgeeda Creek is expected to extend approximately 37 km down gradient from the proposed discharge outlet for a modelled volume of 17.5 ML/day. • Water released into the creek is likely to move in and out of the creek bed, creating transient pools in topographical depressions and associated saturated bank conditions within the reach. • The peak flow volume of water discharging into Boolgeeda Creek is significantly smaller than the peak flow volume generated by the catchment during any flood event, however creek flows will change from episodic to continuous within the discharge footprint. • The bedrock units underlying the Boolgeeda Creek valley are of low permeability as a result discharge water will not be "lost" to groundwater. Therefore the discharge is likely to result in the development of constant, shallow (on average <7 cm) stream flow between flood events and with transient pools in local depressions within the discharge footprint. At the peak discharge rate of 17.5 ML/day water released into Boolgeeda Creek is likely to be contained within the channel, hence overtopping of the bank is not expected[6]. While the creek bed will remain saturated, the creek banks are likely to remain unsaturated. However, the increased availability of water in the creek and within the unsaturated zone has the potential to affect the health and vigour of fringing groundwater dependent vegetation.	**Management** Impacts to groundwater will continue to be managed in accordance with existing B4 Operation EMP. The following key management measures for surface water will be implemented and, where applicable, have been implemented during Proposal design and operation of the B4 Operation to date: • Surface water management is included within the existing B4 Operation EMP which will continue to be implemented with the objective of minimising the adverse impacts to water courses, water quality and the downstream environment. • Proposal design has incorporated consideration of surface water management, including minimising disruption to watercourses. The discharge outfall will be designed and constructed so as to reduce the velocity of the water at discharge and thereby minimise erosion of the channel. • A discharge water quality management and monitoring strategy (including site specific water quality trigger values) will be developed in accordance with the ANZECC/ARMCANZ (2000) water quality management framework to manage the potential impacts of discharge water on the downstream environment. This will be managed under Part V of the EP Act. • The Discharge Monitoring and Management Plan will be implemented to ensure that the associated environmental and conservation values are maintained (Appendix 6). • Management of weeds will be carried out in accordance with commitments made in the Discharge Monitoring and Management Plan. **Outcome** The Proposal can be managed to meet the EPA environmental objective for this factor, as detailed in adjacent columns: • Groundwater from the B4 orebody aquifer that will be discharged is fresh to brackish with a neutral to slightly basic pH. • Monitoring and management of riparian vegetation, weeds and feral herbivores will be undertaken in accordance with the Discharge MMP • Appropriate monitoring and management of discharge water quality will be undertaken in accordance with the

[6] Notwithstanding the fact that the natural system is dynamic and evidence shows that the channel can be reworked during flood events.

EPA Objective	Existing Environment	Potential Impact (without Mitigation)	Management and Outcome
	watering demand is 17.5 ML/d). **Pipeline Corridor** Modelling of surface hydrology in the vicinity of the discharge pipeline corridor indicates the following outcomes: • All potential water movement is likely to be confined within the channel, hence overtopping of the creek banks is not anticipated. While the creek bed will remain saturated, the creek banks are likely to remain unsaturated such that bank vegetation should be largely unaffected by the flow. However, the continuous flow will increase the water availability close to the creek. Thus the content of water in unsaturated zones moving away from the saturated creek bed may increase vegetation vigour and/or encourage sapling growth. The peak flow volume of water discharged into Boolgeeda Creek is significantly smaller than the peak flow volume generated by the catchment during any flood events; a 2 year ARI flood event would deliver 148 m^3/s at the proposed discharge outlet, compared with peak modelled discharge rates of 17.5 ML/ day which is equivalent to 0.2 m^3/s (Rio Tinto 2013a, 2013d). **Surface water flows** Modelling of surface hydrology indicates the following outcomes (Rio Tinto 2013e): • No 'overland flow' is likely to occur as discharge will be confined to the creek bed. • Creek banks will remain unsaturated. • The bedrock units of Boolgeeda Creek valley are low permeability so discharge water will be retained within the surface alluvials.		ANZECC/ARMCANZ (2000) water quality management framework. • The spatial and temporal extent of dewatering discharge is relatively limited, and substantial areas of similar watercourses occur outside the discharge extent within the Boolgeeda Creek sub-catchment. • The discharge pipeline corridor is unlikely to impact overland flow. Appropriate management measure to avoid and minimise potential impacts of the Revised Proposal on surface water will be implemented (and where applicable have been implemented during Proposal design).

8 ASSESSMENT OF IMPACT ON FLORA AND VEGETATION

This Section describes the flora and vegetation within the proposed Development Envelope and within the discharge footprint of Boolgeeda Creek. It provides details regarding the potential impacts to flora and vegetation from the 950 ha of additional clearing of native vegetation and the potential impacts on riparian vegetation of Boolgeeda Creek from the discharge of surplus water that forms part of this Proposal.

The EPA applies the following objective, in EAG8 (EPA, 2013), in its assessment of proposals that may affect flora and vegetation:

> *To maintain representation, diversity, viability and ecological function at the species, population and community level.*

8.1 FLORA AND VEGETATION STUDIES

Multiple flora and vegetation surveys have been conducted on behalf of the Proponent since the 1980s in the Greater Brockman/Greater Nammuldi region (covering in excess of 58,600 hectares). Table 8-1 summarises the key surveys within the Development Envelope.

In addition, the Proponent has conducted a number of targeted searches for DRF and Priority Flora in the area that provides a considerable reference for the distribution of these species.

The combined coverage of these surveys has enabled a detailed understanding of the existing vegetation and flora in the Greater Brockman/Greater Nammuldi region. However the evolution of vegetation mapping codes used since the 1980's has increased the complexity of the vegetation mapping and therefore interpretation and presentation of the dataset.

In 2012 Biota (2012a) reviewed the previous studies in the Greater Nammuldi/Greater Brockman region and developed an integrated vegetation mapping system covering the majority of the area from the Proponent's Homestead deposit at Caves Creek, through Silvergrass West and East, Nammuldi, Nammuldi Irrigated Agriculture Area, Brockman 2 to and including Brockman 4. This work was undertaken to support the environmental impact assessment for the Nammuldi-Silvergrass Expansion PER (Strategen 2012).

Coverage of this integrated vegetation mapping includes most of the proposed Development Envelope, specifically Areas 1 and 2 North , therefore this system has been presented here in respect of these areas. The remainder of the Development Envelope is covered by other surveys, in terms of coverage these are primarily *A Vegetation and Flora Survey of the White Quartz Road Corridor near Tom Price* (Biota 2007b) and *Brockman Syncline 4 Marra Mamba Vegetation and Flora Survey* (2013b) (Table 8-1 and Appendix 7).

The integrated mapping units that are relevant to the Development Envelope are presented in Appendix 7. Biota 2012a lists the corresponding vegetation codes from the previous included mapping.

Land Systems are shown in Figure 8-1 and vegetation mapping is shown in Figure 8-2, Figure 8-3 and Figure 8-5. Where multiple surveys and therefore mapping overlap within the Development Envelope, a decision has been made to present one set of mapping. Given the extent of its coverage Biota 2012a has been selected as a preference with spatial information from other surveys used to cover the remainder of the Development Envelope.

Table 8-1: Summary of Key Flora and Vegetation Studies

Report Title and Author	Summary of Study
A Vegetation and Flora Survey of the Brockman Syncline 4 Project Area, near Tom Price Biota Environmental Sciences (2005a) RTIO HSE 0014404	Desktop review, rare flora searches and a single phase field survey: • Rare flora searches – February to June 2003 • Flora and Vegetation Survey – October 2004 EPA Position Statement No.3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.
Rare Flora Searches of B4 Rail Loop Extension, Airport Extension and Plant Sites Biota Environmental Sciences (2007a) RTIO HSE 0030036	Rare flora searches – January 2007. EPA Position Statement No.3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.
A Vegetation and Flora Survey of the White Quartz Road Corridor near Tom Price Biota Environmental Sciences (2007b) RTIO HSE 0043584	Botanical survey within a corridor surrounding the White Quartz Road. • description and mapping of vegetation types; • establishment of 20 floristic survey quadrats; • recording of populations of flora of conservation significance and weeds; and • collation of a list of all vascular flora observed in the study area. 30th of May 2005 and the 23rd of June 2006.
A Flora Survey of the Brockman Syncline 4 Rail and infrastructure Corridor. Biota Environmental Sciences (2007c) RTIO HSE 0036363	Wet season flora survey to supplement 2005a and comply with MS717 Condition 7-1. Incorporates findings of Biota 2006a above. Late May – late June 2006 January 2007 EPA Position Statement No.3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.

Report Title and Author	Summary of Study
Vegetation and Rare Flora of the BS4 33kV Powerline Corridor through the Boolgeeda Valley *Biota Environmental Sciences (2008a)* *RTIO HSE 0046368*	Desktop review of recent botanical studies conducted in the area were reviewed to identify vegetation types and flora species of conservation significance which had previously been recorded from the area of the new power line corridor and that may occur based on habitats apparent on aerial photography. March 2008
A Vegetation and Flora Survey of Beasley River Biota Environmental Sciences (2009a) RTIO HSE 0086518	Single phase vegetation and flora survey: May and September 2009 Western Australian Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) and EPA Position Statement No 3 (EPA 2002).
Brockman Syncline 4 *Water Pipeline Corridor Biological Review* Biota Environmental Sciences (2010) RTIO-HSE-0095889	Desktop review and a NVCP level biological assessment including rare flora searches and a compilation of existing survey data Rare flora searches – June 2010. EPA Position Statement No.3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.
Nammuldi-Silvergrass Vegetation Mapping Integration Biota Environmental Sciences (2012a) RTIO-HSE-0204864	Desktop review and integration of vegetation mapping conducted for Rio Tinto in the Greater Nammuldi/Greater Brockman Region to produce a single vegetation map. April 2012
Brockman 4 Camps Vegetation and Flora Survey Biota Environmental Sciences (2012b) RTIO HSE 0156020	Desktop review and NVCP level vegetation assessment including conservation significant flora searches 5-7 July 2012 Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey.
Brockman 4 Riparian Vegetation Mapping Biota Environmental Sciences (2013a) RTIO HSE 0205968	Desktop Review, Level 2 vegetation and flora survey: 21-28 August 2013. Western Australian Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) and EPA Position Statement No 3 (EPA 2002).
Brockman Syncline 4 Marra Mamba Vegetation and Flora Survey Biota Environmental Sciences (2013b) RTIO HSE 0180207	Single phase, Level 2 vegetation and flora survey: 30 August – 4 September 2012. Western Australian Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004a) and EPA Position Statement No 3 (EPA 2002).

Report Title and Author	Summary of Study
Marra Mamba West (AR-13-11158) Native Vegetation Clearing Permit Report Biota Environmental Sciences (2013d) RTIO HSE 0201775	Desktop review and Level 1 flora and fauna survey Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) and EPA Position Statement No 3 (EPA 2002) and the Technical guidance - Terrestrial Fauna Surveys for Environmental impact Assessment (EPA and DEC 2010)
Brockman Syncline 4 East Biological Assessment Eco Logical (2013a) RTIO HSE 0197495	Desktop review and NVCP level vegetation assessment including conservation significant flora searches July 2013 Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey
Brockman 4 Syncline 1 East Biological Assessment Eco Logical (2013b) RTIO HSE 0197496	Desktop review and NVCP level vegetation assessment including conservation significant flora searches July 2013 Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a) level 1 survey

8.2 VEGETATION OF THE PROPOSED DEVELOPMENT ENVELOPE

8.2.1 IBRA Bioregions and Subregions

The proposed Development Envelope is located within the Pilbara (PIL) bioregion as defined in the Interim Bio Regionalisation of Australia (**IBRA**) Report. The Pilbara bioregion has been divided into 4 subregions: Chichester (PIL1); Fortescue Plains (PIL2); Hamersley (PIL3); and Roebourne (PIL4). The Development Envelope falls within the Hamersley (PIL3) sub-region and is described as:

> '*Mountainous area of Proterozoic sedimentary ranges and plateaux, 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 (to the north), the Ashburton to the south or the Robe to the west*.'

8.2.2 Beards Vegetation Mapping

The Development Envelope lies entirely within the Fortescue Botanical District of the Eremaean Botanical province as defined by Beard (1975). The vegetation of this province is typical of arid landscapes including bunch grasslands, spinifex, wattles and occasional Eucalypts.

According to Beard the predominant vegetation associations in the Development Envelope are:

- Snappy Gum *Eucalytptus leucphloia* scattered trees over *Triodia wiseana* hummock grassland on the hills of the Brockman ridge at B4 in Area 1 and the stony undulating plains of Area 2 North; and hills and stony plains in Area 2 South.
- An area of Mulga *Acacia aneura* continuous low woodland on the broad stony plain to the north of the Brockman ridge at B4 in Area 1.
- Small areas of Mulga *Acacia aneura* continuous low woodland on clay plains in Area 2 South.
- *Acacia aneura*, *A. inaequilatera* scattered shrubs over *T. epatica*, *T. basedowii* hummock grassland over the majority of Area 2 South.

Beard mapped these units at 1:1,000,000 therefore these mapping units correlate only broadly with the vegetation mapping that has been conducted specifically for the B4 Operation and surrounds.

8.2.3 Land systems

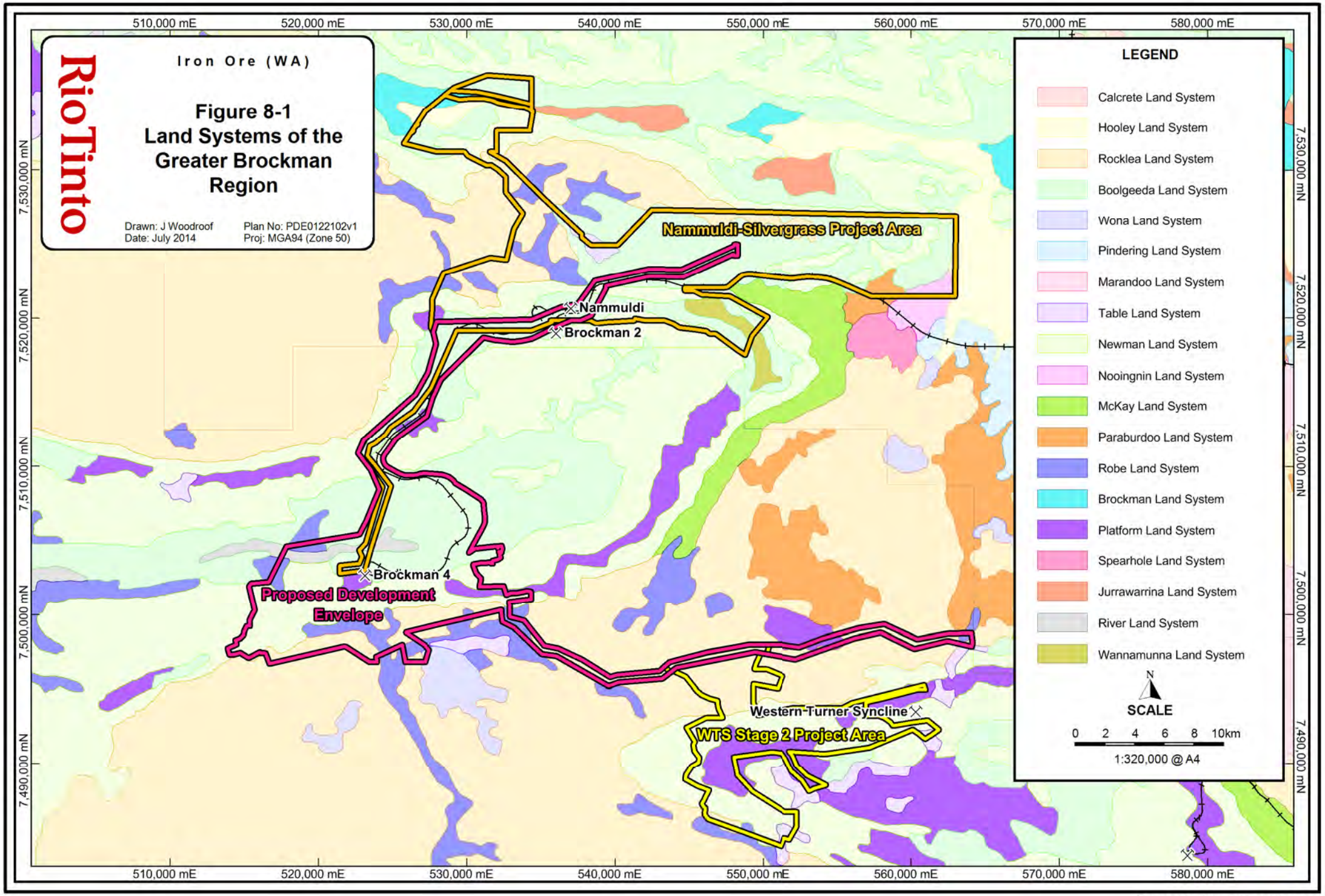
Land Systems (Rangelands) mapping covering the Development Envelope has been prepared by the Western Australian Department of Agriculture (Payne et al. 1988, Department of Agriculture 2002) (Table 8-2). Land systems comprise a series of 'land units' that occur on characteristic physiographic types within the land system. Of the one hundred and seven Land Systems that have been identified in the Pilbara, eight occur within the Development Envelope.

With the exception of the Table Land System all of those units occurring within the Development Envelope are extensive within the Pilbara bioregion. The Development Envelope comprises 0.29% of the total extent of Land Systems in the Pilbara, with 18,506 ha of the 20,046 ha Development Envelope being Boolgeeda, Newman, Rocklea and Robe (Table 8-3). However a small portion of the Land System mapped by Payne et al (1988) in the north-western part of Area 1 is considered by Biota to represent the less common Table Land System.

Figure 8-1 shows the distribution and extent of Land Systems within the proposed Development Envelope (from Biota 2005a (using Payne *et al*.1988) and 2007 (using van Vreeswyk *et al*. 2004)).

Table 8-2: Land Systems in the B4 Development Envelope

Land System	Description
Boolgeeda	Stony lower slopes and plains found below hill systems supporting hard and soft spinifex grasslands and mulga shrublands: occupies the north-eastern section of Area 1 as well as the majority of the northern infrastructure corridor (Area 2 North)
Newman	Rugged jaspolite plateaux, ridges and mountains supporting hard spinifex grasslands: coincides with the authorised Brockman orebodies (Area 1) and a small section of the northern infrastructure corridor (Area 2 North) and the western end of the southern infrastructure corridor Area 2 South
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands: occurs as a small area within the centre and eastern edge of Area 1, within the northern infrastructure corridor (Area 2 North) and at the western end and centre of the southern infrastructure corridor (Area 2 South)
River	Active floodplains and major rivers supporting grassy Eucalypt woodlands, tussock grasslands and soft spinifex grasslands: common throughout the Pilbara in major river systems such as the Yule, de Grey and Fortescue river systems and Weeli Wolli Creek: only one occurrence has been mapped in the northern section of Area 1 within Boolgeeda Creek
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands: occurs as narrow areas in the southern section of Area 1 and at both ends of the southern infrastructure corridor (Area 2 South)
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (occasionally soft spinifex) grasslands; small occurrences in the southern section of Area 1 and dominating the majority of Area 2 South
Table	Low calcrete plateaux, mesas and lower plains supporting mulga and cassia shrublands and minor spinifex grasslands: occurs as two small areas in the north-western section of Area 1 and at the eastern end of Area 2 South
Wona	Level to gently undulating upland basaltic plains with gilgai microrelief and clay soils, relief up to 30m. Self-mulching clay plains on top of basalt hills; cassia short grass forb pastures in poor to excellent condition; no erosion: occurs in a small area in the south of Area 1 near the Beasley River tributary



Geospatial Information and Mapping

Table 8-3: Distribution of Land Systems within the B4 Development Envelope and wider Pilbara Bioregion

Land System	Total Area in the Pilbara Bioregion (Rank)	Number of Mapping Polygons in the Pilbara Bioregion	General Distribution through the Pilbara Bioregion	Amount of Land System within the proposed Development Envelope	
				Hectares	% of Total in Pilbara Bioregion
Boolgeeda	961,634 ha (103rd)	588	Widespread with a large number of occurrences, particularly through the Hamersley range subregion	8,312	0.9
Newman	1,993,741 ha (106th)	321	Relatively widespread through the Hamersley Range subregion, also occurring as a band along the Chichester range to the north of the Fortescue Marsh: numerous occurrences	5,229	0.3
Platform	236,335 ha (92nd)	169	Occurs predominantly in the Hamersley Range with small occurrences also in the Chichester Range	809	0.3
River	482,175 ha (101st)	126	Widespread in major river systems	698	0.1
Robe*	128,859 ha (76th)	251	Occurs within the central and western regions of the Hamersley Range subregion, with a few occurrences within the Chichester subregions	1,389	1.1
Rocklea	2,881,199 ha (107th)	385	Widespread through both the Hamersley and Chichester Range	3,576	0.1
Table*	20,645 ha (31st)	47	Few scattered occurrences in the south and east of the Hamersley Range subregion	7	0.03
Wona	19,4821 ha (88th)	203	Occurring as a band along the Chichester Range, north of the Fortescue River, with few scattered occurrences in the Hamersley Range	25	0.01
Total	**17,800,478 ha**	**5636**		**20,046 ha**	**0.29**

*According to Biota 2005a ground-truthing showed that two polygons assigned to the Robe Land System by Payne et al (1988) actually represent the Table Land System.

Vegetation types

Multiple flora and vegetation surveys have been conducted within the proposed Development Envelope. The spatial mapping data has been rationalised and is presented in Figure 8-2, Figure 8-3, Figure 8-4, Figure 8-5 and. A description of each vegetation type is included at Appendix 8.

Vegetation types mapped within the Development Envelope can be classified broadly into the following types:

- Hummock grasslands of *Triodia* species (mainly *T. wiseana*) within a variable shrub overstorey on low stony.
- Tall shrublands of mixed species, usually dominated by *Acacia* often with an overstorey of *Eucalyptus* or *Corymbia* in creeklines.
- Hummock grasslands of *Triodia longiceps* and/or *T. angusta* on calcaereous plains.
- Open woodlands of Coolibah *Eucalyptus victrix* over herblands in the gravelly bed of Boolgeeda Creek.
- Mulga *Acacia aneura* and Snakewood *A. xiphophylla* tall shrublands over spinifex on plains and stony hills.

Iron Ore (WA)

Figure 8-2
Area 1 Vegetation

Drawn: A. Coulson
Date: July, 2014

Plan No: PDE0122102v1
Proj: MGA94 Zone 50

Location Map

LEGEND

- Area 1 - Proposed Development Envelope
- Proposed New Clearing
- Authorised Disturbance
- Proposed Discharge Location
- Boolgeeda Creek Discharge

N

SCALE

0 0.5 1 1.5 2 2.5km

1:60 000 @ A3

Discharge Location

515,000 mE 520,000 mE 525,000 mE 530,000 mE 535,000 mE

7,510,000 mN

7,505,000 mN

7,500,000 mN

Geospatial Information and Mapping

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

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

RioTinto

Iron Ore (WA)

Figure 8-3
Area 2 Vegetation

Drawn: A. Coulson
Date: July, 2014

Plan No: PDE0122102v1
Proj: MGA94 Zone 50

LEGEND

- Area 2 - Proposed Development Envelope
- Authorised Disturbance
- Proposed New Clearing
- Proposed Discharge Location
- Boolgeeda Creek Discharge

N

SCALE

0 1 2 3 4 5km

1:120 000 @ A3

Location Map

Discharge Location

Geospatial Information and Mapping

Figure 8-4
Vegetation Legend for the Brockman 4 Development Envelope - Page 1 of 4

AaAbTe
Acacia ancistrocarpa, A. bivenosa shrubland to open heath over Triodia epactia hummock grassland

AaAbTlo
Acacia ancistrocarpa, A bivenosa shrubland to open heath over Triodia longiceps hummock grassland

AanAkAexTwTe
Acacia aneura open woodland over Acacia kempeana, Acacia exilis open shrubland over Triodia wiseana, Triodia epactia very open hummock grassland

AanAprTe
Acacia aneura (A. pruinocarpa) low open forest over Triodia epactia hummock grassland

AanAprTe/AxAanT

AanAprTe/AxAanTe
Acacia aneura (A. pruinocarpa) low open forest over Triodia epactia hummock grassland / Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia epactia open hummock grassland

AanAprTe/AxAanTloTa
Acacia aneura (A. pruinocarpa) low open forest over Triodia epactia hummock grassland / Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia longiceps, T. angusta open hummock grassland

AanCEc
Acacia aneura (various forms) tall open scrub over *Cenchrus ciliaris tussock grassland

AanReTwTbr
Acacia aneura tall open shrubland over Rhagodia eremaea open shrubland over Triodia wiseana, T. brizoides open hummock grassland

AanTe
Acacia aneura low open forest over Triodia epactia very open hummock grassland and mixed bunch grassland

AanTlo
Acacia aneura tall open shrubland to open scrub over Triodia longiceps open hummock grassland

AanTlo/AxAanTlo

AanTlo/AxAanTloTa
Acacia aneura tall open shrubland to open scrub over Triodia longiceps open hummock grassland / Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia longiceps, T. angusta open hummock grassland

AanTw
Acacia aneura tall open shrubland to open scrub over Triodia wiseana open hummock grassland

AanTw/AxAanTloT

AanTw/AxAanTloTa
Acacia aneura tall open shrubland to open scrub over Triodia wiseana open hummock grassland / Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia longiceps, T. angusta open hummock grassland

AaTw
Acacia ancistrocarpa shrubland over Triodia wiseana hummock grassland

AciAanTeTloCEc
Acacia citrinoviridis, A. aneura (various forms) tall open shrubland to tall open scrub over Triodia epactia, T. longiceps open hummock grassland and *Cenchrus ciliaris open tussock grassland to tussock grassland

AiAmTbrTe
Acacia inaequilatera scattered tall shrubs over Acacia maitlandii open shrubland over Triodia brizoides, T. epactia hummock grassland

AiERcERfrTw
Acacia inaequilatera scattered tall shrubs over Eremophila cuneifolia, E. fraseri open shrubland over Triodia wiseana hummock grassland

AiTe
Acacia inaequilatera scattered tall shrubs over Triodia epactia hummock grassland

AiTw
Acacia inaequilatera scattered tall shrubs over Triodia wiseana hummock grassland

AkAexAiAbTw
Acacia kempeana, Acacia exilis, Acacia inaequilatera, Acacia bivenosa tall open shrubland over Triodia wiseana hummock grassland

AmoAmAatTeTw
Acacia monticola, A. maitlandii, A. atkinsiana tall open shrubland over Triodia epactia, T. wiseana open hummock grassland

ElCdAtuTeTw
Eucalyptus leucophloia, Corymbia deserticola scattered low trees over Acacia tumida var. pilbarensis tall open scrub over Triodia epactia, T. wiseana open hummock grassland

ElGOrDpAmTe
Eucalyptus leucophloia scattered low trees over Gossypium robinsonii, Dodonaea pachyneura (Acacia maitlandii) open shrubland over Triodia epactia hummock grassland

ElGwTp
Eucalyptus leucophloia subsp. leucophloia low open woodland over Acacia citrinoviridis, Grevillea wickhamii and Gossypium robinsonii shrubland over Triodia pungens hummock grassland.

ElMeAeTloTa
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Melaleuca eleuterostachya, Acacia exilis scattered shrubs over Triodia longiceps, T. angusta hummock grassland

ElTe
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Triodia epactia hummock grassland

ElTw
Eucalyptus leucophloia scattered low trees over Triodia wiseana hummock grassland

ElTw/ElAbTloTa
Eucalyptus leucophloia scattered low trees over Triodia wiseana hummock grassland / Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia bivenosa scattered shrubs over Triodia longiceps, T. angusta hummock grassland

ElTwTm
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Triodia wiseana, T. melvillei hummock grassland

EsMeAeTlo
Eucalyptus socialis scattered low mallees over Melaleuca eleuterostachya, Acacia exilis scattered shrubs over Triodia longiceps hummock grassland

ExGr
Eucalyptus xerothermica, Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana low open woodland over Gossypium robinsonii and Acacia tumida var. pilbarrensis shurbland over Triodia pungens open hummock grassland and Paraneurachne muell

F1: ChAciAtuGOrCEcTe
Corymbia hamersleyana open woodland over Acacia citrinoviridis low open woodland over A. tumida, Gossypium robinsonii scattered tall shrubs over *Cenchrus ciliaris very open tussock grassland over Triodia epactia scattered hummock grasses

F2: AciApyTErTHtCEcTe
Acacia citrinoviridis low open woodland over A. pyrifolia tall open shrubland over Tephrosia rosea low open shrub over Themeda triandra, *Cenchrus ciliaris tussock grassland over Triodia epactia very open hummock grassland

F3: AciApyEUaTHtCEcTe
Acacia citrinoviridis low open woodland over A. pyrifolia tall open shrubland over Eulalia aurea, Themeda triandra, *Cenchrus ciliaris tussock grassland over Triodia epactia very open hummock grassland

F4: ChAciApyCEcTe
Corymbia hamersleyana scattered trees over Acacia citrinoviridis low woodland over A. pyrifolia tall shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia open hummock grassland

F5: AciApyCEcTe
Acacia citrinoviridis open woodland over A. pyrifolia tall open shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia very open hummock grassland

G1: CfDpAprTHmTe
Corymbia ferriticola open forest over Dodonaea pachyneura, Acacia pruinocarpa tall open shrubland to tall open scrub over Themeda sp. Mt Barricade very open tussock grassland and Triodia epactia very open hummock grassland

H1
Acacia aneura low open woodland over Triodia wiseana, T. epactia hummock grassland

H10: ElAmTwTm
Eucalyptus leucophloia scattered low trees over Acacia maitlandii open shrubland over Triodia wiseana, T. melvillei hummock grassland

H11
Acacia sibirica low open woodland over Eremophila exilifolia scattered shrubs over Triodia epactia hummock grassland

H11: ElTw
Eucalyptus leucophloia scattered low trees over Triodia wiseana hummock grassland

H12
Acacia bivenosa, A. exilis, A. synchronicia scattered shrubs to open shrubland over Triodia longiceps, T. wiseana open hummock grassland

H12: ElAiTw
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera scattered tall shrubs over Triodia wiseana hummock grassland

H14
Eucalyptus leucophloia scattered low trees over Triodia epactia and/or T. wiseana hummock grassland

H1: ElAprAatTw
Eucalyptus leucophloia scattered low trees over Acacia pyrifolia, A. atkinsiana tall open shrubland over Triodia wiseana hummock grassland

Vegetation Legend for the Brockman 4 Development Envelope - Page 2 of 4

AxAanTbrTe
Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia brizoides, T. epactia open hummock grassland

AxAanTloTa
Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia longiceps, T. angusta open hummock grassland

AxAanTw
Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Eremophila cuneifolia, Rhagodia eremaea low open shrubland over Triodia wiseana open hummock grassland

AxSCdTa
Acacia xiphophylla low woodland over Sclerostegia disarticulata low open shrubland over Triodia angusta very open hummock grassland

C1: ChAciAtuGOr
Corymbia hamersleyana open woodland over Acacia citrinoviridis low open woodland over Acacia tumida, Gossypium robinsonii scattered tall shrubs

C1: EvGOOlPLd
Eucalyptus victrix scattered low trees to open woodland over Goodenia lamprosperma, Pluchea dentex very open herbland

C2: EvAciAtuApyTHtTe
Eucalyptus victrix open woodland over Acacia citrinoviridis scattered low trees over Acacia tumida, A. bivenosa, A. pyrifolia tall open shrubland over Themeda triandra very open tussock grassland over Triodia epactia very open hummock grassland

C2: ExAciSsPToTHtCHfCEc
Eucalyptus xerothermica scattered low trees over Acacia citrinoviridis, Stylobasium spathulatum tall shrubland over Ptilotus obovatus var. obovatus scattered shrubs over Themeda triandra, Chrysopogon fallax, *Cenchrus ciliaris very open tussock grass

C3: EvEcAciApyTErEUa
Eucalyptus victrix, E. camaldulensis open woodland over Acacia citrinoviridis low open woodland over A. pyrifolia tall open shrubland over Tephrosia rosea low open shrubland over very open mixed herbland over Eulalia aurea open tussock grassland

C4: EvEcAciEUa
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Eulalia aurea very open tussock grassland over very open mixed herbland

CD
Eucalyptus xerothermica, Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana low open woodland over Gossypium robinsonii and Acacia tumida var. pilbarrensis shurbland over Triodia pungens open hummock grassland and Paraneurachne muell

CD10
Acacia aneura low open forest to tall open shrubland over mixed open tussock grassland and Triodia epactia open hummock grassland

CD11
Eucalyptus xerothermica low open woodland over Acacia pyrifolia, Gossypium sturtianum var. sturtianum, Petalostylis labicheoides tall shrubland over Triodia epactia hummock grassland

CD12
Eucalyptus xerothermica, Corymbia hamersleyana scattered low trees over Acacia bivenosa, A. cowleana, A. elachantha, A. exilis tall shrubland over Triodia epactia hummock grassland and Eulalia aurea open tussock grassland

CD15
Corymbia hamersleyana, Eucalyptus xerothermica scattered trees over Acacia bivenosa open heath over Triodia angusta open hummock grassland and Themeda triandra very open tussock grassland

CD16
Eucalyptus xerothermica low woodland over Acacia bivenosa, A. atkinsiana, A. maitlandii shrubland to closed heath over Triodia epactia hummock grassland

CD17
Eucalyptus xerothermica scattered low trees over Gastrolobium grandiflorum open heath over Chrysopogon fallax, Eulalia aurea tussock grassland

CD19
Eucalyptus leucophloia low woodland over Acacia citrinoviridis, Acacia monticola, Dodonaea pachyneura tall shrubland over Triodia epactia hummock grassland

CD20
Eucalyptus leucophloia low woodland over Gossypium robinsonii, Acacia maitlandii, A. monticola, A. bivenosa tall shrubland over Triodia wiseana, T. epactia very open hummock grassland

CD22
Eucalyptus leucophloia, Corymbia deserticola scattered low trees over Acacia tumida var. pilbarensis tall open scrub over Triodia epactia, T. wiseana open hummock grassland

CD24
Corymbia hamersleyana, Eucalyptus leucophloia low woodland over Grevillea wickhamii tall shrubland over Gossypium robinsonii open shrubland over Themeda sp. Mt. Barricade, Eulalia aurea, Paraneurachne muelleri open tussock grassland or Triodia epacti

CD25
Corymbia hamersleyana low open woodland over Triodia epactia hummock grassland and Eriachne tenuiculmis, E. mucronata, Themeda sp. Mt. Barricade open tussock grassland

CD27
Corymbia hamersleyana, Eucalyptus gamophylla low open woodland over Acacia monticola, A. ancistrocarpa, A. bivenosa, Rulingia luteiflora tall closed scrub over Triodia epactia hummock grassland

CD28
Corymbia hamersleyana scattered low trees over Acacia bivenosa, Petalostylis labicheoides shrubland over Triodia epactia hummock grassland

H2
Acacia aneura low woodland over Triodia epactia hummock grassland

H2: ElAexAprTw
Eucalyptus leucophloia scattered low trees over Acacia exilis, A. pruinocarpa open shrubland over Triodia wiseana open hummock grassland

H3
Acacia aneura, Corymbia ferriticola low woodland over Triodia epactia hummock grassland or Cymbopogon ambiguus, Themeda triandra open tussock grassland

H3: AanAprTe
Acacia 'aneura' woodland over A. pyrifolia scattered tall shrubs over Triodia epactia open hummock grassland

H3: ElAmoAmTbrTe
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia monticola, A. maitlandii tall open shrubland over Triodia brizoides, T. epactia open tussock grassland

H4: AanGtTbrTlo
Acacia 'aneura', Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) low open woodland over Triodia brizoides, T. longiceps very open hummock grassland

H4: ElTe
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Triodia epactia open hummock to hummock grassland

H5
Eucalyptus leucophloia scattered low trees over Acacia maitlandii shrubland over Triodia wiseana hummock grassland

H5: AanTbrTe
Acacia 'aneura' low open woodland over Triodia brizoides, T. epactia scattered hummock grasses

H6
Acacia hamersleyensis tall open shrubland over Triodia wiseana closed hummock grassland

H6: AanTaTe
Acacia 'aneura' woodland over Triodia angusta, T. epactia scattered hummock grasses

H7
Eucalyptus leucophloia scattered low trees over Acacia pruinocarpa open shrubland over Triodia epactia or T. wiseana hummock grassland

H7: AanTbr
Acacia 'aneura' woodland over Triodia brizoides very open hummock grassland

H7: ElAiTw
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia inaequilatera scattered tall shrubs over Triodia wiseana hummock grassland

H8
Eucalyptus leucophloia scattered low trees over Acacia atkinsiana, A. exilis, A. bivenosa, A. ancistrocarpa open shrubland over Triodia wiseana or T. epactia hummock grassland

H8: ElAanAciGbTe
Eucalyptus leucophloia, Acacia 'aneura', A. citrinoviridis, Grevillea berryana woodland over Triodia epactia very open hummock grassland

H9
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera tall shrubland over Triodia wiseana hummock grassland

H9: ElAmAexTw
Eucalyptus leucophloia scattered low trees over Acacia maitlandii, A. exilis open shrubland over Triodia wiseana hummock grassland

HG1
Corymbia ferriticola, Eucalyptus leucophloia low open woodland over Acacia hamersleyensis, A. pruinocarpa scattered tall shrubs over Dodonaea pachyneura open shrubland over Triodia epactia or T. wiseana open hummock grassland and mixed open tussock grassland

HG2
Eucalyptus leucophloia low open woodland over Acacia hamersleyensis open shrubland over Triodia brizoides, T. epactia hummock grassland and Themeda triandra, Eriachne mucronata open tussock grassland

HG3
Eucalyptus leucophloia low open woodland over Acacia bivenosa open shrubland over Triodia brizoides, T. epactia hummock grassland and Themeda sp. Mt. Barricade, Cymbopogon ambiguus open tussock grassland

HG4
Eucalyptus leucophloia scattered low trees to low open woodland over Astrotricha hamptonii, Ficus brachypoda scattered tall shrubs over Themeda sp. Mt Barricade, Eriachne mucronata open tussock grassland and Triodia brizoides, T. epactia open hummock

P10: AxAanTaTe
Acacia xiphophylla, A. 'aneura' low open woodland over Triodia angusta, T. epactia scattered hummock grasses

P11: AxTaTe
Acacia xiphophylla low open woodland over Triodia angusta, T. epactia scattered hummock grasses

Vegetation Legend for the Brockman 4 Development Envelope - Page 3 of 4

CD29
Corymbia hamersleyana scattered low trees over Acacia atkinsiana tall shrubland over Triodia epactia hummock grassland

CD30
Acacia pyrifolia, A. ancistrocarpa, Petalostylis labicheoides shrubland over Triodia epactia hummock grassland and Themeda triandra tussock grassland

CD31
Acacia monticola, A. maitlandii, A. atkinsiana, A. exilis, A. ancistrocarpa tall shrubland over Triodia epactia, T. wiseana open hummock grassland

CD32
Petalostylis labicheoides shrubland over Triodia epactia hummock grassland

CD33
Stylobasium spathulatum shrubland over Triodia epactia hummock grassland

CD4
Eucalyptus victrix scattered low trees to open woodland over Goodenia lamprosperma, Pluchea dentex very open herbland

CD4/CD22
MOSAIC of vegetation codes CD4 and CD22 (see report)

CD5
Eucalyptus victrix, E. xerothermica open woodland over Acacia citrinoviridis tall open scrub over mixed tussock grassland

CD6
Eucalyptus xerothermica low open woodland over Acacia citrinoviridis tall open scrub over Triodia epactia open hummock grassland and/or mixed tussock grassland

CD7
Acacia citrinoviridis tall shrubland over mixed tussock grassland or Triodia epactia hummock grassland

CD8
Eucalyptus xerothermica, Acacia aneura open forest over Triodia epactia open hummock grassland over Chrysopogon fallax very open tussock grassland

CD9
Acacia citrinoviridis, A. aneura tall open shrubland over mixed open hummock grassland

CdAkAaTwTe
Corymbia deserticola scattered low trees over Acacia kempeana, Acacia ancistrocarpa open shrubland over Triodia wiseana, Triodia epactia very open hummock grassland

CdTw
Corymbia deserticola subsp. deserticola scattered low trees over Triodia wiseana and Triodia schinzii very open hummock grassland.

ChAiAexTwTe
Corymbia hamersleyana scattered low trees over Acacia inaequilatera tall open shrubland over Acacia exilis scattered shrubs over Triodia wiseana, Triodia epactia open hummock grassland

ChCdAaAexAkTeTw
Corymbia hamersleyana, Corymbia deserticola scattered low trees over Acacia ancistrocarpa, Acacia exilis, Acacia kempeana open shrubland over Triodia epactia, Triodia wiseana open hummock grassland

ChGorAaAbApyTeTw
Corymbia hamersleyana scattered low trees over Gossypium robinsonii scattered tall shrubs over Acacia ancistrocarpa, Acacia bivenosa, Acacia pyrifolia var pyrifolia open shrubland over Triodia epactia, Triodia wiseana very open hummock grassland

D1: ExAciAbPlTHtCEc
Eucalyptus xerothermica, Acacia citrinoviridis scattered low trees over A. bivenosa, Petalostylis labicheoides tall open shrubland over Themeda triandra, *Cenchrus ciliaris open tussock grassland

D2: ExAciPlAbTHtTe
Eucalyptus xerothermica, Acacia citrinoviridis low open woodland over Petalostylis labicheoides scattered tall shrubs over Acacia bivenosa open shrubland over Triodia epactia very open hummock grassland with Themeda triandra scattered tussock grasses

D3: ElAciPlSsGOrTe
Eucalyptus leucophloia, Acacia citrinoviridis scattered low trees over Petalostylis labicheoides, Stylobasium spathulatum, Gossypium robinsonii tall shrubland over T. epactia very open hummock grassland

D4: ElAmoGOrTe
Eucalyptus leucophloia scattered low trees over Acacia monticola, Gossypium robinsonii tall open shrubland over Triodia epactia scattered hummock grasses

D5: AciAbTHtCEc
Acacia citrinoviridis, A. bivenosa tall open shrubland over Themeda triandra, *Cenchrus ciliaris open tussock grassland

D6: AciPlGOrApyTe
Acacia citrinoviridis scattered low trees over Petalostylis labicheoides, Gossypium robinsonii, A. pyrifolia tall open shrubland over Triodia epactia very open hummock grassland

D7: PlAmoTe
Petalostylis labicheoides, Acacia monticola tall open shrubland over Triodia epactia very open hummock grassland

P12: AxTbr
Acacia xiphophylla low woodland over Triodia brizoides scattered hummock grasses

P13: AxTlo
Acacia xiphophylla low woodland over Triodia longiceps scattered hummock grasses

P14: EsMeTaTw
Eucalyptus socialis low open mallee woodland over Melaleuca eleuterostachya low open shrubland over Triodia angusta, T. wiseana hummock grassland

P1: AaAbAsTe
Acacia ancistrocarpa, A. bivenosa, A. synchronicia open shrubland over Triodia epactia hummock grassland

P1: ElAiTwTeTbrTaTlo
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera scattered tall shrubs over Triodia wiseana, T. epactia, T. brizoides, T. angusta, T. longiceps open hummock grassland

P2: ElAiTwTbrTloTa
Eucalyptus leucophloia scattered low trees over Acacia inaequilatera scattered tall shrubs over Triodia wiseana, T. brizoides, T. longiceps, T. angusta open hummock grassland

P3
Eucalyptus leucophloia scattered low trees over Acacia aneura (various forms), Acacia ayersiana tall open shrubland over Triodia epactia, Triodia wiseana hummock grassland

P3: ElTloTaTe(Tw)
Eucalyptus leucophloia scattered low trees over Triodia longiceps, T. angusta, T. epactia, (T. wiseana) hummock grassland

P4: ElTeTwTaTlo
Eucalyptus leucophloia scattered low trees over Triodia epactia, T. wiseana, T. angusta, T. longiceps very open hummock grassland

P5: ElTwTloTa
Eucalyptus leucophloia scattered low trees over Triodia wiseana, T. longiceps, T. angusta open hummock grassland

P6: ElAexTloTbrTw
Eucalyptus leucophloia scattered low trees over Acacia exilis scattered shrubs over Triodia longiceps, T. wiseana hummock grassland

P7: ElAbAexTaTw
Eucalyptus leucophloia scattered low trees over Acacia bivenosa scattered tall shrubs over A. exilis open shrubland over Triodia angusta, T. wiseana open hummock grassland

P8: ElMeTaTw
Eucalyptus leucophloia scattered low trees over Melaleuca eleuterostachya open shrubland over Triodia angusta, T. wiseana open hummock grassland

P9: AanAxTeTw
Acacia 'aneura', A. xiphophylla low open woodland over Triodia epactia, T. wiseana very open hummock grassland

PC5
Eucalyptus leucophloia scattered low trees over Acacia tetragonophylla, A. bivenosa, A. synchronicia, A. tenuissima open shrubland over Triodia basedowii hummock grassland with mixed herbs

PL1
Eucalyptus repullulans scattered low mallees over Melaleuca eleuterostachya, A. maitlandii scattered shrubs over Triodia wiseana hummock grassland

PL2
Eucalyptus socialis and/or E. leucophloia low open woodland over Acacia bivenosa, A. exilis scattered shrubs over Triodia wiseana, T. angusta hummock grassland

PL3
Eucalyptus leucophloia scattered low trees over Acacia bivenosa scattered shrubs over Triodia longiceps, T. wiseana hummock grassland

PL5
Melaleuca eleuterostachya open shrubland over Triodia wiseana, (T. angusta) hummock grassland

PL6
Acacia synchronicia scattered shrubs over Triodia angusta hummock grassland on calcareous plains

PlAbTlo
Petalostylis labicheoides tall open shrubland over Acacia bivenosa shrubland over Triodia longiceps open hummock grassland

PlTe
Petalostylis labicheoides shrubland over Triodia epactia hummock grassland

PS1
Acacia aneura, A. ayersiana tall open shrubland over Triodia epactia, T. wiseana hummock grassland

PS1/PS6
MOSAIC of vegetation codes PS1 and PS6 (see report)

Vegetation Legend for the Brockman 4 Development Envelope - Page 4 of 4

D8: AtuPlApyAbTe
Acacia tumida, Petalostylis labicheoides, A. pyrifolia, A. bivenosa tall shrubland over Triodia epactia very open hummock grassland

D9: ElAbTe
Eucalyptus leucophloia scattered low trees over Acacia bivenosa scattered shrubs over Triodia epactia hummock grassland

Disturbed
Disturbed

EcAciMgCv
Eucalyptus camaldulensis var. obtusa open forest over Acacia citrinoviridis, Melaleuca glomerata tall open scrub over Cyperus vaginatus very open sedgeland

ElAa
Eucalyptus leucophloia subsp. leucophloia low open woodland over Acacia sp. aff. acradenia low open shrubland over Triodia wiseana open hummock grassland.

ElAbsTe
Eucalyptus leucophloia scattered low trees over Acacia bivenosa (spindly variant) tall shrubland over Triodia epactia hummock grassland

ElAbsTw
Eucalyptus leucophloia scattered low trees over Acacia bivenosa (spindly variant) tall shrubland over Triodia wiseana hummock grassland

ElAbTbr
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia bivenosa scattered shrubs over Triodia brizoides hummock grassland

ElAbTloTa
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia bivenosa scattered shrubs over Triodia longiceps, T. angusta hummock grassland

ElAbTw
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia bivenosa scattered shrubs over Triodia wiseana hummock grassland

ElAmTw
Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia maitlandii shrubland to open heath over Triodia wiseana hummock grassland

PS10
Acacia synchronicia, A. bivenosa, Senna spp. shrubland over Triodia brizoides hummock grassland

PS11
Acacia inaequilatera open shrubland to shrubland over Triodia brizoides hummock grassland

PS13
Eucalyptus leucophloia scattered low trees over Acacia exilis open shrubland to shrubland over Triodia brizoides hummock grassland

PS16
Eucalyptus leucophloia scattered low trees over Triodia longiceps, T angusta hummock grassland

PS3
Acacia xiphophylla, A. aneura low woodland to tall open shrubland over Triodia wiseana, (T. epactia) open hummock grassland

PS4
Acacia xiphophylla tall open shrubland over Triodia epactia, T. longiceps hummock grassland

PS5
Acacia xiphophylla, A. aneura tall shrubland over Triodia brizoides, T. epactia open hummock grassland

PS6
Eucalyptus leucophloia, (E. gamophylla, Corymbia deserticola, C. hamersleyana) scattered low trees over Acacia atkinsiana, A. exilis, A. bivenosa, A. ancistrocarpa, Senna spp. shrubland over Triodia epactia and/or T. wiseana hummock grassland

PS7
Eucalyptus leucophloia, (Corymbia hamersleyana) scattered low trees over Acacia inaequilatera scattered shrubs to tall open shrubland over Triodia wiseana, (T. epactia) hummock grassland

PS9
Eucalyptus xerothermica low open woodland over Eremophila fraseri scattered shrubs over Triodia wiseana hummock grassland

Iron Ore (WA)

Figure 8-5
Boolgeeda Creek
Riparian Vegetation

Drawn: A. Coulson
Date: July, 2014

Plan No: PDE0122102v1
Proj: MGA94 Zone 50

LEGEND

- Area 1 - Proposed Development Envelope
- Proposed New Clearing
- Proposed Discharge Location
- Boolgeeda Creek Discharge

N

SCALE

0 1 2 3 4 5km

1:110 000 @ A3

490,000 mE
495,000 mE
500,000 mE
505,000 mE
510,000 mE
515,000 mE
520,000 mE
525,000 mE

7,515,000 mN
7,510,000 mN
7,505,000 mN
7,500,000 mN
7,495,000 mN
7,490,000 mN

Discharge Location

Discharge 12.5ML/d
Footprint 34 km

Discharge 10ML/d
Footprint 33 km

Discharge 17.5ML/d
Footprint 37 km

Location Map

Geospatial Information and Mapping

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Boolgeeda Creek Riparian Vegetation Legend

C4: EvEcAciEUa
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Eulalia aurea very open tussock grassland over very open mixed herbland

C5: EvEcAciCEc
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over *Cenchrus ciliaris scattered tussock grasses

C6: EvEcAciMgAco
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Melaleuca glomerata, Acacia ampliceps tall shrubland

C7: EvEcAciMgCEcTe
Eucalyptus victrix, E. camaldulensis woodland over Acacia citrinoviridis low open woodland over Melaleuca glomerata tall shrubland over *Cenchrus ciliaris scattered tussock grasses over Triodia epactia scattered hummock grasses

F3: AciApyEUaTHtCEcTe
Acacia citrinoviridis low open woodland over A. pyrifolia tall open shrubland over Eulalia aurea, Themeda triandra, *Cenchrus ciliaris tussock grassland over Triodia epactia very open hummock grassland

F4: ChAciApyCEcTe
Corymbia hamersleyana scattered trees over Acacia citrinoviridis low woodland over A. pyrifolia tall shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia open hummock grassland

F5: AciApyCEcTe
Acacia citrinoviridis open woodland over A. pyrifolia tall open shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia very open hummock grassland

F6: PlAsclTe
Petalostylis labicheoides, Acacia sclerosperma tall open shrubland over Triodia epactia very open hummock grassland

F7: ChAciPlAsclCEcTe
Corymbia hamersleyana scattered trees over Acacia citrinoviridis low woodland over A. pyrifolia, Petalostylis labicheoides, A. sclerosperma tall shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia scattered hummock grasses

F8: AciApyPlCEcTe
Acacia citrinoviridis open woodland over A. pyrifolia, Petalostylis labicheoides tall open shrubland over *Cenchrus ciliaris open tussock grassland over Triodia epactia very open hummock grassland

8.2.4 Vegetation condition

The B4 area has been extensively grazed for over 100 years, by sheep and more recently by cattle. Grazing, periodic wildfires and exploration activities in the area have had a negative impact on the flora and vegetation health over time in some areas. At the time that the vegetation surveys were carried out, the majority of the vegetation in the Development Envelope was in Good or better condition, with the main signs of disturbance comprising exploration tracks, grazing by cattle and the presence of weeds.

The stony plains (particularly in the northern third of the rail corridor) and hills habitats typically show less weed invasion than the remainder of the Development Envelope. These areas are not preferred grazing habitat for stock, and the stony, relatively dry substrates also tend to discourage germination and growth of weed species. The main disturbance noted in such areas has been clearing of access tracks for mining exploration, and condition was generally considered to be Very Good to Excellent.

In contrast, introduced species have been recorded frequently within the larger flowlines and on floodplains. These environments have loose and mesic substrates that are favourable for germination and growth of weed species, which may also be spread by stock movement and/or encouraged by grazing. Dense weed infestations (largely Buffel Grass) are generally restricted to drainage areas that have been subject to heavy grazing and such areas are considered to be in Very Poor to Poor condition. Where only scattered weeds were recorded, the vegetation associated with creeklines is considered to be in Good to Excellent condition overall.

Appendix 8 lists all of the vegetation types that will be cleared under this Proposal. In all instances the vegetation is considered to be in Good to Excellent Condition.

8.2.5 Vegetation of Elevated Significance in the Development Envelope

No Threatened Ecological Communities (**TECs**) occur within the Development Envelope. The nearest mapped TEC is the '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)' located adjacent to Caves Creek at Silvergrass, approximately 25 km north of the Development Envelope. The Development Envelope does not encompass suitable habitat for this TEC to occur.

No Priority Ecological Communities (**PECs**) are known to occur within the Development Envelope. The nearest mapped PEC, is the 'Brockman Iron cracking clay communities of the Hamersley Range' and is co-located with the TEC to the north of the Development Envelope. This PEC is also unlikely to occur within the Development Envelope due to the absence of suitable habitat.

Several vegetation types have been identified as being of elevated significance in the original survey reports. Of these, only two are considered to be of High Significance whilst 39 have been classed as having Moderate Significance (Table 8-4, Figure 8-6 and Figure 8-7). The majority of the vegetation of Moderate significance within the Development Envelope is located north of the B4 Operation and is associated with and/or lying north of Boolgeeda Creek and in the headwaters of the Beasley River tributary to the south of the B4 Operation. Of the proposed 950 ha of additional clearing within the 20,046 ha Development Envelope, 61.29 ha of vegetation with elevated conservation significance is expected to be disturbed.

Table 8-4 Vegetation of Elevated Significance within Development Envelope and Discharge Footprint

Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
High Significance						
P11	Biota 2005a	Calcareous Plains	*Acacia synchronicia* scattered shrubs over *Triodia angusta* mid-dense hummock grassland Not restricted, but main vegetation type for *Ptilotus* sp. Brockman. Occurs extensively outside immediate mining area and along White Quartz Road.	Area 1, Area 2 South	**PL6**	**11.33**
EcAciMgCv	Biota 2007b	Creeklines	*Eucalyptus camaldulensis var. obtusa* open forest over *Acacia citrinoviridis*, *Melaleuca glomerata* tall open scrub over *Cyperus vaginatus* very open sedgeland	Area 2 South	-	0
Moderate Significance – within Development Envelope						
C1: EvGOOlPLd	Biota 2005a, 2013d	Moderate creeklines	*Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma*, *Pluchea dentex* very open herbland	Boolgeeda Creek	CD4	0
C1: ChAciAtuGOr	Biota 2013a	Creeklines	*Corymbia hamersleyana* open woodland over *Acacia citrinoviridis* low open woodland over *Acacia tumida, Gossypium robinsonii* scattered tall shrubs	Boolgeeda Creek	-	0
C2	Biota 2005a	Minor flowlines	*Acacia pyrifolia, A. ancistrocarpa, Petalostylis labicheoides* shrubland over *Bonamia rosea*, *Tephrosia rosea var. glabrior* low open shrubland over *Triodia epactia* hummock grassland and *Themeda triandra* very open tussock grassland	Drainage features, Boolgeeda Creek	CD30	0
C2: EvAciAtuApyTHtTe	Biota 2013a	Creeklines	*Eucalyptus victrix* open woodland over *Acacia citrinoviridis* scattered low trees over *Acacia tumida, A. bivenosa, A. pyrifolia* tall open shrubland over *Themeda triandra* very open tussock grassland over *Triodia epactia* very open hummock grassland	Boolgeeda Creek	-	0

Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
C3	Biota 2005a	Minor creeklines	*Eucalyptus xerothermica* scattered low trees over A*cacia citrinoviridis, Stylobasium spathula*tum tall shrubland over *Ptilotus obovatus var. obovatus* scattered shrubs over *Themeda triandra, Chrysopogon fallax* very open tussock grassland. Occurs in habitats that are of value as surface drainage features. Floristic group is not apparently widespread within the region	Drainage features, Boolgeeda Creek	CD6	2.35
C3: EvEcAciApyTErEUa	Biota 2013a	Creeklines	*Eucalyptus victrix, E. camaldulensis* open woodland over *Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Tephrosia rosea* low open shrubland over very open mixed herbland over *Eulalia aurea* open tussock grassland	Boolgeeda Creek	-	0
C4: EvEcAciEUa	Biota 2013a	Creeklines	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Eulalia aurea* very open tussock grassland over very open mixed herbland	Boolgeeda Creek	-	0
C18	Biota 2005a	Moderate creeklines	*Eucalyptus victrix, E. xerothermica* low open woodland over *Acacia citrinoviridis* tall open shrubland over *Themeda triandra Chrysopogon fallax* tussock grassland	Boolgeeda Creek	CD5	0
C6	Biota 2005a	Minor flowlines	*Eucalyptus xerothermica* scattered low trees over *Gastrolobium grandiflorum* open heath over *Chrysopogon fallax, Eulalia aurea* tussock grassland	Boolgeeda Creek	CD17	0
C17	Biota 2005a	Minor Creeklines	*Acacia aneura* low woodland to low open forest over *Chrysopogon fallax*, *Triodia epactia* open tussock / hummock grassland	Drainage features, Boolgeeda Creek	CD10	0
C20	Biota 2005a	Minor Creeklines	*Acacia aff. aneura* (narrow fine veined; site 1259) low open forest over *Acacia citrinoviridis* tall open shrubland over *Triodia epactia* open hummock grassland Unit is likely to be restricted in terms of areal extent in the Hamersley subregion and would also be susceptible to degradation by fire.	Drainage features, Boolgeeda Creek	CD9	1.52
AanTe	Biota 2007b	Creeklines	*Acacia aneura* low open forest over *Triodia epactia* very open hummock grassland and mixed bunch grassland	Area 2 South		0

Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
AanReTwTbr	Biota 2007b	Stony Hills	*Acacia aneura* tall open shrubland over *Rhagodia eremaea* open shrubland over *Triodia wiseana, T. brizoides* open hummock grassland	Area 2 South	-	0
AxSCdTa	Biota 2007b	Stony Plains	*Acacia xiphophylla* low woodland over *Sclerostegia disarticulata* low open shrubland over *Triodia angusta* very open hummock grassland	Area 2 South	-	0
ElAbTloTa	Biota 2007b	Stony Plains	*Eucalyptus leucophloia subsp. leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia longiceps, T. angusta* hummock grassland	Area 2 South	-	0
ElMeAeTloTa	Biota 2007b	Stony Plains	*Eucalyptus leucophloia subsp. leucophloia* scattered low trees over *Melaleuca eleuterostachya, Acacia exilis* scattered shrubs over *Triodia longiceps, T. angusta* hummock grassland	Area 2 South	-	0
EsMeAeTlo	Biota 2007b	Stony Plains	*Eucalyptus socialis* scattered low mallees over *Melaleuca eleuterostachya, Acacia exilis* scattered shrubs over *Triodia longiceps* hummock grassland	Area 2 South	-	0
P1	Biota 2005a	Stony Plains	*Acacia aff. aneura* (narrow fine veined; site 1259), *A. ayersiana, A. tetragonophylla* tall shrubland over *Eremophila forrestii, Acacia bivenosa* shrubland over *Triodia epactia* mid-dense hummock grassland Restricted within Area 1 to a single broad drainage area within a valley and may be poorly represented in the locality: whilst is does not belong to a restricted floristic group, floristically similar Mulga woodlands in drainage habitats appear to be uncommon in the region	Area 1	PS1	8.12
P2	Biota 2005a	Stony Plains	*Acacia ayersiana* low open forest/woodland over *Eremophila forrestii* open shrubland over *Triodia epactia, T. wiseana* hummock grassland Belongs to a floristic group that is apparently not widespread within the region.	Area 1	PS1	
P3	Biota 2005a	Stony Plains	*Eucalyptus leucophloia* scattered low trees over *Acacia aneura* (various forms), *A. ayersiana* tall open shrubland over *Triodia epactia, T. wiseana* mid-dense hummock grassland	Area 1	PS1	

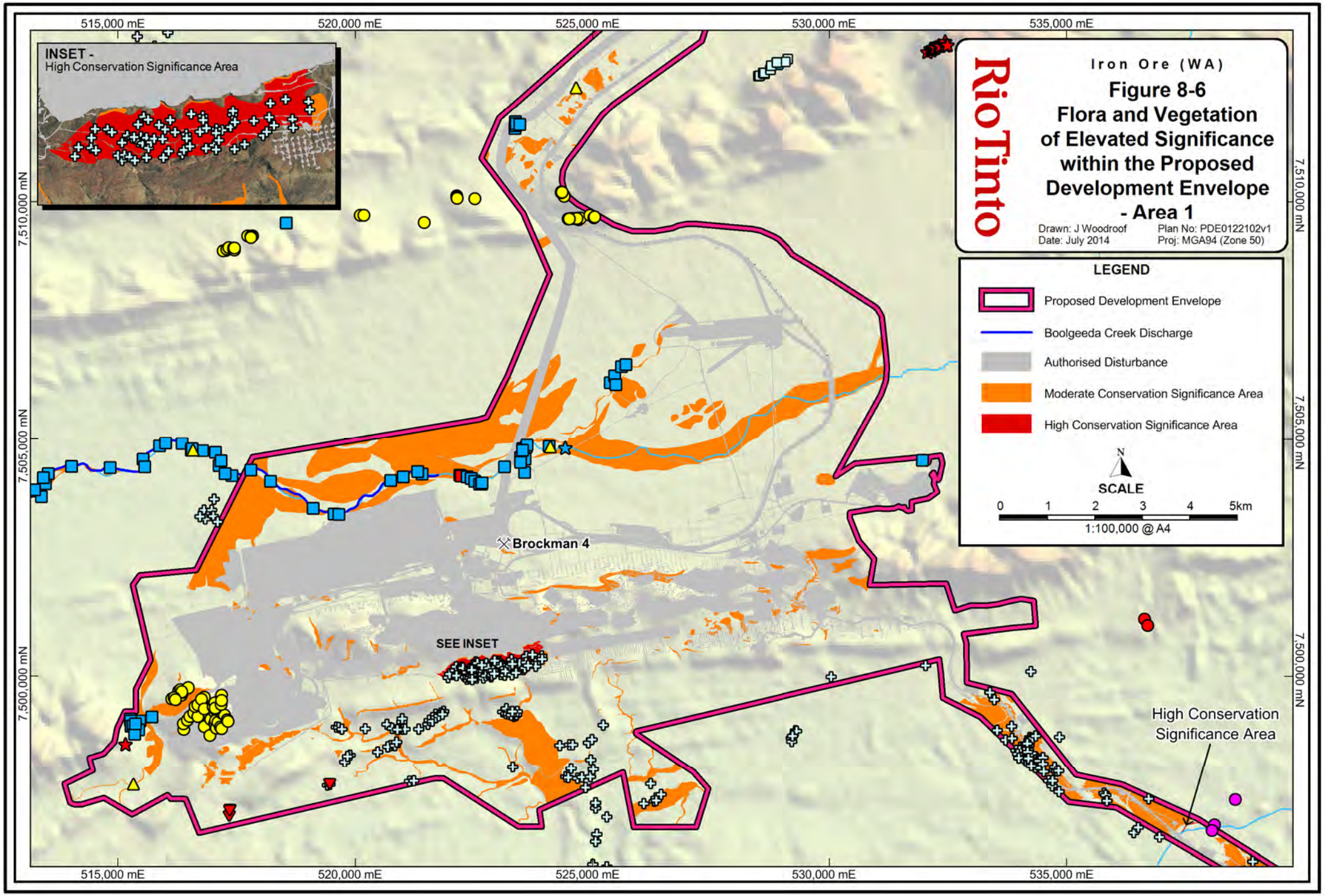
Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
			Belongs to a floristic group that is apparently not widespread within the region.			
P8	Biota 2005a	Stony plains	*Eucalyptus xerothermica* low open woodland over *Eremophila fraseri* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland	Area 1	PS9	0
P9	Biota 2005a	Calcareous Plains	*Eucalyptus socialis* low open woodland over, *T. wiseana* open hummock grassland Belongs to a floristic group that is apparently not widespread within the region: calcrete areas in particular are not well represented in the Hamersley subregion and this vegetation type may have restricted distribution.	Area 1	PL2	4.16
P10	Biota 2005a	Calcareous Plains	*E. leucophloia, E. xerothermica* scattered low trees over over *Acacia bivenosa, A. exilis* open shrubland to tall opens shrubland over *Triodia wiseana, T. angusta* mid-dense hummock grassland Belongs to a floristic group that is apparently not widespread within the region: calcrete areas in particular are not well represented in the Hamersley subregion and this vegetation type may have restricted distribution.	Area 1	PL2	
H10	Biota 2005a	Gorges	*Eucalyptus leucophloia* low open woodland over *Acacia bivenosa* open shrubland over *Triodia brizoides, T. epactia* hummock grassland and *Themeda sp.* Mt. Barricade, *Cymbopogon ambiguus* open tussock grassland Vegetation of narrow gorges belonging to a floristic group apparently restricted within the region and supporting species restricted to rocky habitats. Whilst widespread within the Hamersley subregion the "HG" vegetation units are small in areal extent.	Area 1	HG3	27.59
H11	Biota 2005a	Rocky Gorges	*Eucalyptus leucophloia* scattered low trees over Go*ssypium robinsonii, Dodonaea pachyneura (Acacia maitlandii)* open shrubland over *Triodia epactia* mid-dense hummock grassland Vegetation of narrow gorges belonging to a floristic group apparently restricted within the region and supporting species restricted to rocky habitats. Whilst widespread within the	Area 1	HG1	1.39

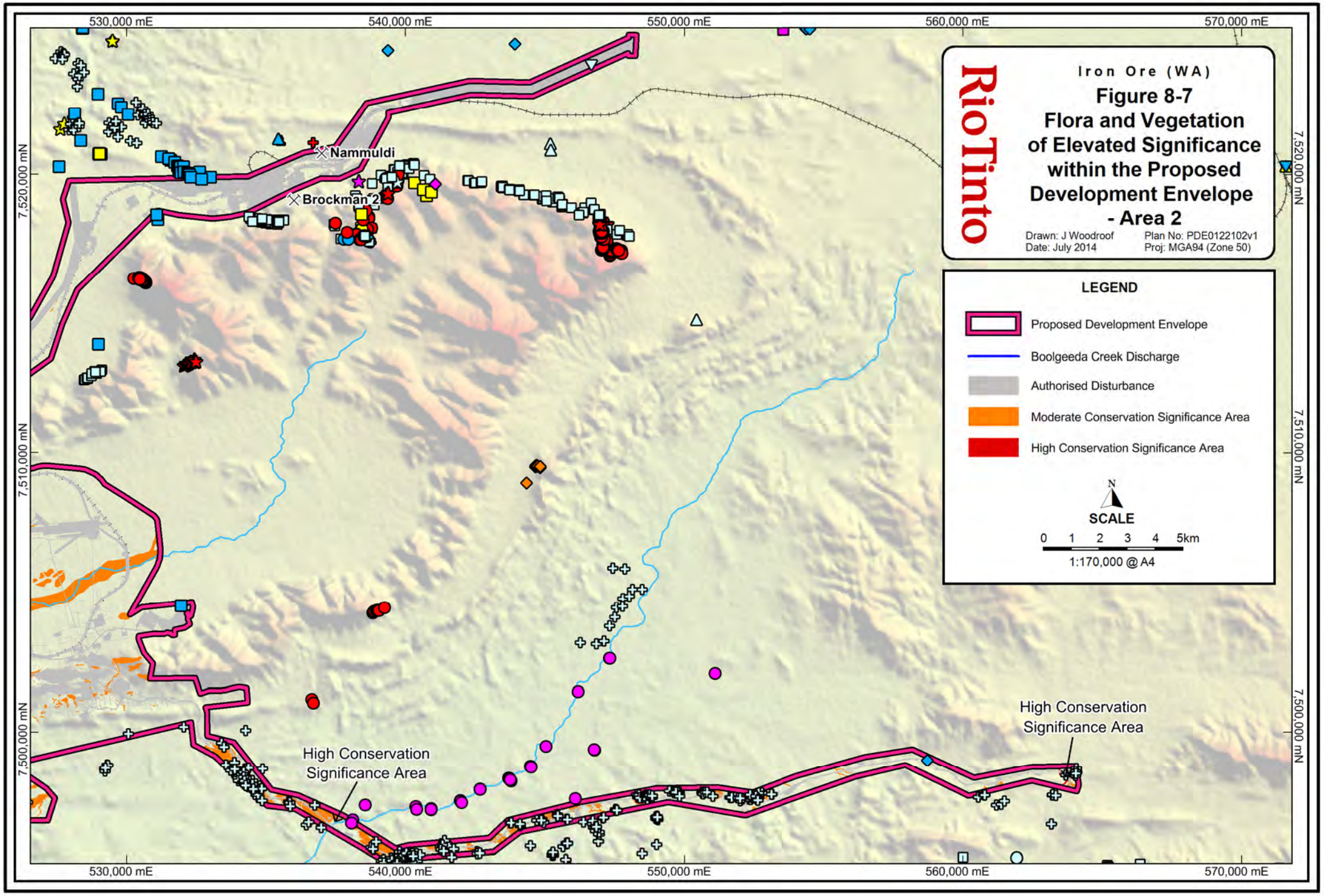
Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
			Hamersley subregion the "HG" vegetation units are small in areal extent.			
H13	Biota 2005a	Rocky Gorges	*Corymbia ferriticola, Eucalyptus leucophloia* scattered low trees over *Acacia hamersleyensis* scattered tall shrubs over *Dodonaea pachyneura* open shrubland over *Eriachne mucronata*, *E. tenuiculmis, Cymbopogon ambiguous* open tussock grassland and *Triodia epatica* open hummock grassland Vegetation of narrow gorges belonging to a floristic group apparently restricted within the region and supporting species restricted to rocky habitats. Whilst widespread within the Hamersley subregion the "HG" vegetation units are small in areal extent.	Area 1	HG1	
H12	Biota 2005a	Gorges	*Eucalyptus leucophloia* low open woodland over *Acacia hamersleyensis* open shrubland over *Triodia brizoides, T. epactia* hummock grassland and *Themeda triandra, Eriachne mucronata* open tussock grassland Vegetation of narrow gorges belonging to a floristic group apparently restricted within the region and supporting species restricted to rocky habitats. Whilst widespread within the Hamersley subregion the "HG" vegetation units are small in areal extent.	Area 1	HG2	0.84
H16	Biota 2005a	Breakaways	*Eucalyptus leucophloia* scattered low trees to low open woodland over *Astrotricha hamptonii, Ficus brachypoda* scattered tall shrubs over *Themeda sp*. Mt Barricade, *Eriachne mucronata* open tussock grassland and *Triodia brizoides, T. epatica* open hummock grassland Vegetation of breakways belonging to a floristic group apparently restricted within the region and supporting species restricted to rocky habitats. Whilst widespread within the Hamersley subregion the "HG" vegetation units are small in areal extent.	Area 1	HG4	2.63

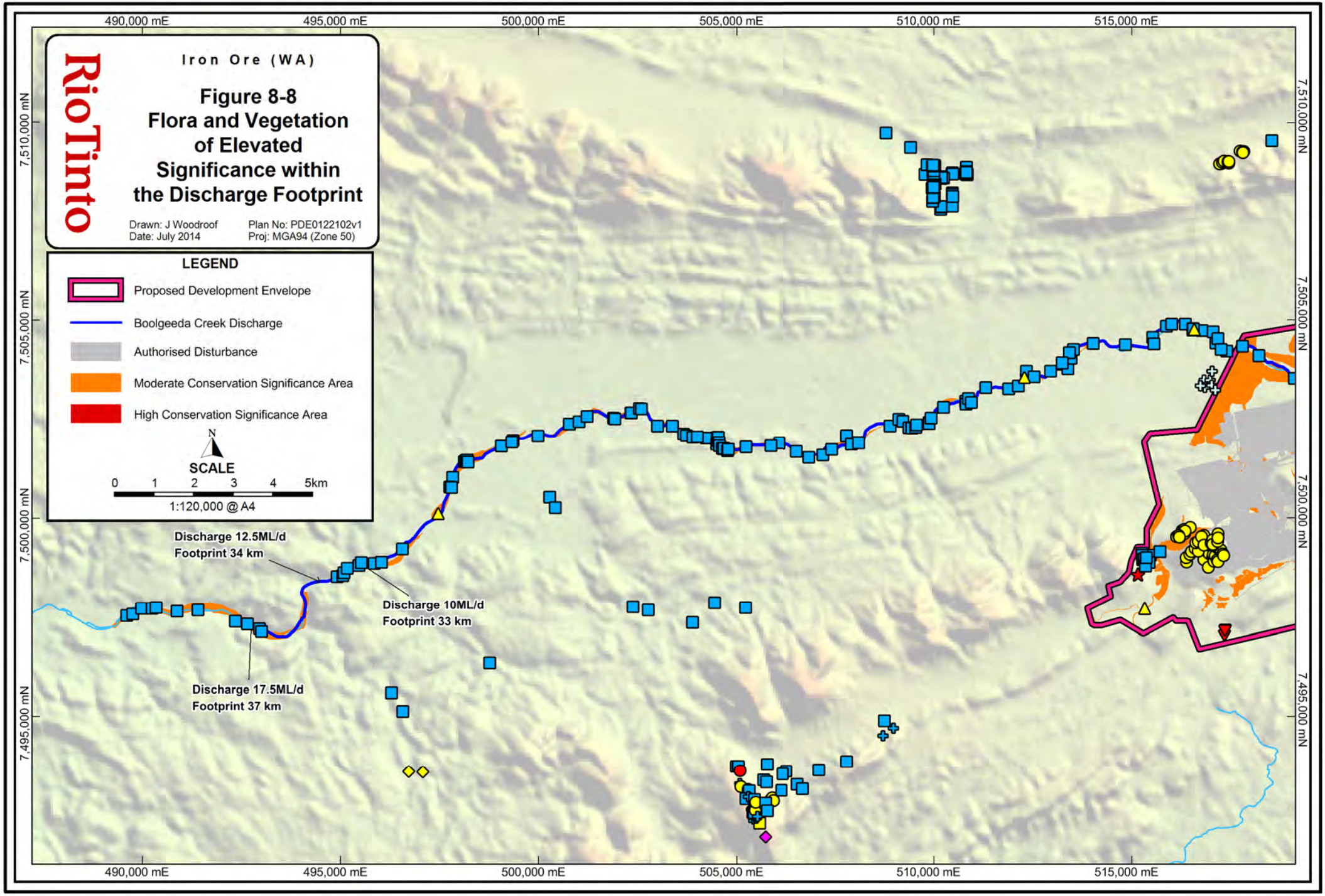
Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
AanElTe	Biota 2009a	Hills	*Acacia aneura, Eucalyptus leucophloia subsp. leucophloia* low open forest over *Triodia epatica* hummock grassland	Upper Beasley River tributary	H2	0
AciThtCEc	Biota 2009a	Minor Creeklines	*Acacia citrinoviridis* tall shrubland over *Themeda triandra, *Cenchrus ciliaris* tussock grassland Occurs in the upper reaches of the main creekline. Condition rating of Poor to Very Poor due to heavy Buffel Grass infestation	Upper Beasley River tributary	CD7	1.36
ExApyGOsPlTeCEc	Biota 2009a	Minor Creeklines	*Eucaluptus xerothermica* low open woodland over *Acacia pyrifolia, Gossypium sturtianum var. sturtianum, Petalostylis labicheoides* tall shrubland over *Triodia epactia* hummock grassland and "*Cenhrus cillaris* closed tussock grassland	Upper Beasley River tributary	CD11	0
EvExAciCEc	Biota 2009a	Minor Creeklines	*Eucalyptus victrix, E. xerothermica* open woodland over *Acacia citrinoviridis* tall closed scrub over **Cenchrus ciliaris* closed tussock grassland	Upper Beasley River tributary	CD5	0
C1: ChAciAtuGOr[7]	Biota 2013a	Creekline	*Corymbia hamersleyana* open woodland over *Acacia citrinoviridis* low open woodland over *Acacia tumida, Gossypium robinsonii* scattered tall shrubs	Boolgeeda Creek	-	0
C2: EvAciAtuApyTHtTe[7]	Biota 2013a	Creekline	*Eucalyptus victrix* open woodland over *Acacia citrinoviridis* scattered low trees over *Acacia tumida, A. bivenosa, A. pyrifolia* tall open shrubland over *Themeda triandra* very open tussock grassland over Triodia epactia very open hummock grassland	Boolgeeda Creek	-	0

[7] Also present within Development Envelope (above)

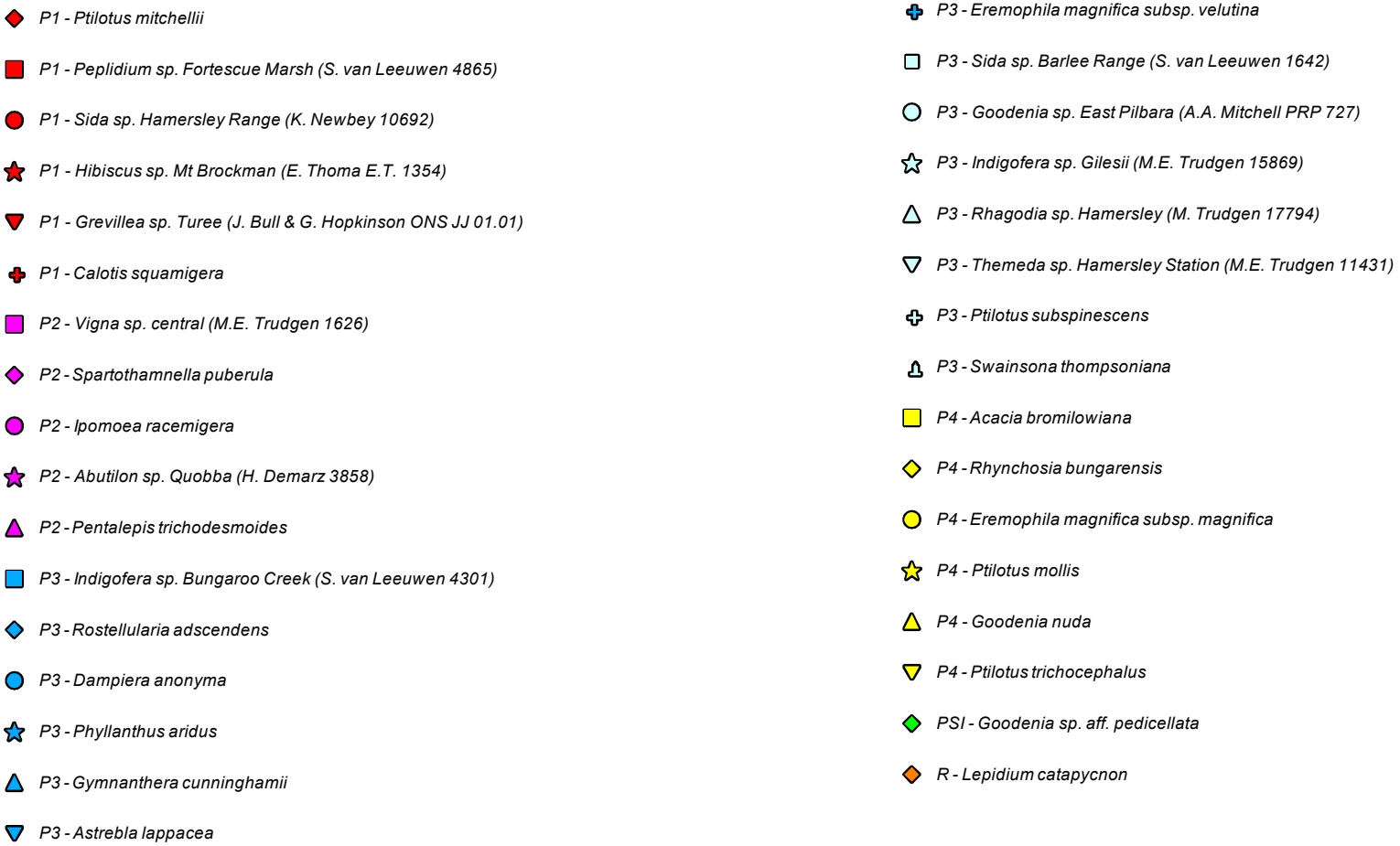
Original Vegetation Unit Code	Source	Habitat	Original vegetation description	Location	Integrated Code (Biota, 2012a)	Extent to be cleared (ha's)
C3: EvEcAciApyTErEUa[7]	Biota 2013a	Creekline	*Eucalyptus victrix, E. camaldulensis* open woodland over *Acacia citrinoviridis* low open woodland over *A. pyrifolia* tall open shrubland over *Tephrosia rosea* low open shrubland over very open mixed herbland over *Eulalia aurea* open tussock grassland	Boolgeeda Creek	-	0
C4: EvEcAciEUa[7]	Biota 2013a	Creekline	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Eulalia aurea* very open tussock grassland over very open mixed herbland	Boolgeeda Creek	-	0
C5:EvEcAciCEc	Biota 2013a	Creekline	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over **Cenchrus ciliaris* scattered tussock grasses	Boolgeeda Creek	-	0
C6:EvEcAciMGAam	Biota 2013a	Creekline	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Melaleuca glomerata, Acacia ampliceps* tall shrubland	Boolgeeda Creek	-	0
C7: EvEcAciMgCEcTe	Biota 2013a	Creekline	*Eucalyptus victrix, E. camaldulensis* woodland over *Acacia citrinoviridis* low open woodland over *Melaleuca glomerata* tall shrubland over **Cenchrus ciliaris* scattered tussock grasses over *Triodia epactica* scattered hummock grasses	Boolgeeda Creek	-	0
					TOTAL	**61.29**


INSET -
High Conservation Significance Area
Iron Ore (WA)
Figure 8-6
Flora and Vegetation of Elevated Significance within the Proposed Development Envelope - Area 1
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
LEGEND
Proposed Development Envelope
Boolgeeda Creek Discharge
Authorised Disturbance
Moderate Conservation Significance Area
High Conservation Significance Area
N
SCALE
0 1 2 3 4 5km
1:100,000 @ A4
Brockman 4
SEE INSET
High Conservation Significance Area
515,000 mE
520,000 mE
525,000 mE
530,000 mE
535,000 mE
7,510,000 mN
7,505,000 mN
7,500,000 mN


Iron Ore (WA)
Figure 8-7
Flora and Vegetation of Elevated Significance within the Proposed Development Envelope - Area 2
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
LEGEND
Proposed Development Envelope
Boolgeeda Creek Discharge
Authorised Disturbance
Moderate Conservation Significance Area
High Conservation Significance Area
N
SCALE
0 1 2 3 4 5km
1:170,000 @ A4
Nammuldi
Brockman 2
High Conservation Significance Area
High Conservation Significance Area
530,000 mE
540,000 mE
550,000 mE
560,000 mE
570,000 mE
7,520,000 mN
7,510,000 mN
7,500,000 mN


Iron Ore (WA)
Figure 8-8
Flora and Vegetation of Elevated Significance within the Discharge Footprint
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
LEGEND
Proposed Development Envelope
Boolgeeda Creek Discharge
Authorised Disturbance
Moderate Conservation Significance Area
High Conservation Significance Area
N
SCALE
0 1 2 3 4 5km
1:120,000 @ A4
Discharge 12.5ML/d
Footprint 34 km
Discharge 10ML/d
Footprint 33 km
Discharge 17.5ML/d
Footprint 37 km
490,000 mE
495,000 mE
500,000 mE
505,000 mE
510,000 mE
515,000 mE
7,510,000 mN
7,505,000 mN
7,500,000 mN
7,495,000 mN

LEGEND


P1 - Ptilotus mitchellii
P1 - Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865)
P1 - Sida sp. Hamersley Range (K. Newbey 10692)
P1 - Hibiscus sp. Mt Brockman (E. Thoma E.T. 1354)
P1 - Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)
P1 - Calotis squamigera
P2 - Vigna sp. central (M.E. Trudgen 1626)
P2 - Spartothamnella puberula
P2 - Ipomoea racemigera
P2 - Abutilon sp. Quobba (H. Demarz 3858)
P2 - Pentalepis trichodesmoides
P3 - Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)
P3 - Rostellularia adscendens
P3 - Dampiera anonyma
P3 - Phyllanthus aridus
P3 - Gymnanthera cunninghamii
P3 - Astrebla lappacea
P3 - Eremophila magnifica subsp. velutina
P3 - Sida sp. Barlee Range (S. van Leeuwen 1642)
P3 - Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)
P3 - Indigofera sp. Gilesii (M.E. Trudgen 15869)
P3 - Rhagodia sp. Hamersley (M. Trudgen 17794)
P3 - Themeda sp. Hamersley Station (M.E. Trudgen 11431)
P3 - Ptilotus subspinescens
P3 - Swainsona thompsoniana
P4 - Acacia bromilowiana
P4 - Rhynchosia bungarensis
P4 - Eremophila magnifica subsp. magnifica
P4 - Ptilotus mollis
P4 - Goodenia nuda
P4 - Ptilotus trichocephalus
PSI - Goodenia sp. aff. pedicellata
R - Lepidium catapycnon

8.3 FLORA OF CONSERVATION SIGNIFICANCE

Three Threatened Flora species (*Thryptomene wittweri, Lepidium catapycnon* and *Aluta quadrata*) are known from the Pilbara bioregion. *Thryptomene wittweri* and Hamersley *Lepidium catapycnon* are listed as Threatened flora under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**) as well as the WA *Wildlife Conservation Act 1950*. *Aluta quadrata* is listed as a Threatened species in WA and is recognised as such under the Wildlife Conservation Act 1950. None of these species has been recorded within the Development Envelope.

T. witteri is less common than *L. catapycnon* and within the Pilbara bioregion it occurs only on hilltops at high altitude further east in the Hamersley subregion. It has also been recorded from the Gascoyne and Great Victoria Desert bioregions. There is no suitable habitat for this species within the Development Envelope and therefore it would not be expected to occur.

L. catapycnon occurs in hummock grasslands on low stony hills and occasionally stony plains in the Hamersley subregion. It is thought to be short-lived and is generally found on recently disturbed ground. Whilst this species has been recorded approximately 10 km to the east of the B4 Operation, extensive searches by qualified botanists over several years has not located any populations within the Development Envelope.

A. quadrata occurs mainly in rocky gullies and sometimes also along the creeklines downstream or on adjacent ridge slopes and crests. Recorded only on the southern side of hills at Paraburdoo, this species has not been recorded in the Development Envelope.

Eleven Priority Flora species have been recorded as occurring within the Development Envelope (Table 8-5). Of these, two Priority Flora are expected to be disturbed by the proposed clearing: *Ptilotus subspinescens* (P3) and *Eremophila magnifica subsp. Magnifica* (P4).

Table 8-6 describes how the proposal meets the EPA's objectives with respect to flora and vegetation and summarises the potential impacts and assessment of significance. Management and mitigation measures are also presented.

Table 8-5 Priority Flora Recorded or Potentially Occurring within the Development Envelope

Species	Priority	Description
Peplidium sp. *Fortescue March* (S.van Leeuwen 4865)	1	One specimen was recorded from a location in the open creek bed of Boolgeeda Creek (C3: EvEcAciApyTErEUa vegetation type) immediately upstream of the proposed discharge point, within the Development Envelope. One other record of this species exists – from a saline flat on the northern apron of Fortescue Marsh (approximately 270 km east of Boolgeeda Creek. The proposed clearing does not intersect with the known location of this species. Therefore the Revised Proposal is not expected to adversely affect the representation or viability of the species.
Hibiscus sp. Mt Brockman (E. Thoma E.T.1354)	1	This species has been recorded from a single location within the westernmost portion of the DE. Several records exist outside of the Development Envelope at Nammuldi/Brockman 2 and near Mt Brockman. Its current known distribution extends over a radius of approximately 35 km centred on B4. This species is commonly found in rocky habitat including gorges and gullies. The proposed clearing does not intersect with the known location of this species. Therefore the Revised Proposal is not expected to adversely affect the representation or viability of the species.
Grevillea sp. *Turee* (J. Bull & G. Hopkinson ONS JJ 01.01)	1	This species has been recorded in four locations on the tops of small rocky hills in H4 *Acacia aneura* vegetation type in the south western portion of the Development Envelope. The proposed clearing does not intersect with the known locations of this species. Therefore the B4 Revised Proposal is not expected to adversely affect the representation or viability of this species.
Sida sp. Hamersley Range (K. Newbey 10692)	1	This species has not been recorded within the Development Envelope, although it has been recorded at Vivash to the south west of the Development Envelope. Recorded from a broad range of 326 km from Hope Downs to Metawandy . It is typically found on rocky hill slopes and in gorges and suitable habitat may occur within the Development Envelope. Due to the absence of records in the Development Envelope, the Revised Proposal is not expected to adversely affect the representation or viability of this species.

Species	Priority	Description
Pentalepis trichodesmoides subsp. hispida	2	Collected from a floodplain associated with Boolgeeda Creek (F5: AciAPyCEcTe vegetation type) This species has been found over a broad range of over 200 km from Roeburne to Tom Price and also at Western Turner. Records exist for Millstream-Chichester National park, and Karijini National Park. The proposed clearing does not intersect with the known location of this species. Therefore the Revised Proposal is not expected to adversely affect the representation or viability of the species.
Ipomoea racemigera	2	Recorded within Area 2 South occurring along Beasley River as two of eighteen records in that locality. The proposed clearing does not intersect with the known locations of this species. Therefore the Revised Proposal is not expected to adversely affect the representation or viability of this species.
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	3	Multiple records exist within the Development Envelope and along Boolgeeda Creek both upstream and downstream of the discharge point. Recorded outside of the Development Envelope in several locations from Bungaroo Creek to West Turner (approximately 208 km, range). Populations are known from the Greater Brockman/Greater Nammuldi region (including Brockman 2, Silvergrass, Pinarra, Mt Farqhuar, Beasley River and Vivash). Occurs in drainage lines, floodplains and rocky gullies. The Revised Proposal is not expected to adversely affect the representation or viability of this species.
Gymnanthera cunninghamii	3	This species has not been recorded in the Development Envelope; however it has been recorded at Nammuldi and also at West Turner. Recorded also in the Great Sandy Desert and Carnarvon regions. Usually found growing along drainage lines. Due to the absence of records in the Development Envelope, the Revised Proposal is not expected to adversely affect the representation or viability of this species.
Rostullaria adscendens var. latifolia	3	Broadly distributed across the Pilbara bioregion (approximately 400 km), with several records within the Greater Brockman area and five known populations in Karijini National Park. Occurs in a variety of habitats. The Revised Proposal is not expected to adversely affect the representation or viability of this species.

Species	Priority	Description
Phyllanthus aridus	3	Recorded from the broad gravelly bed of Boolgeeda Creek from one location upstream of the discharge point. Infrequently recorded in the Pilbara, typically from creeklines but also from rocky outcrops. There is potential for it to be poorly collected due its inconspicuous habit. The Revised Proposal is not expected to adversely affect the representation or viability of this species.
Eremophila magnifica subsp velutina	3	This species has not been recorded within the Development Envelope, although it has been recorded at Vivash to the south west of the Development Envelope. Populations are also known from as close as Silvergrass West, West Turner, from Karijini National Park and as far away a Newman. Due to the absence of records in the Development Envelope, the Revised Proposal is not expected to adversely affect the representation or viability of this species
Sida sp. Barlee Range (S.van Leeuwen 1642)	3	This species has not been recorded within the Development Envelope, although it there are numerous records along the Brockman ridge at Brockman 2 and at West Turner. It has a known broad distribution from Barlee Range Nature Reserve to near Newman (approximately 370 km). Commonly occurs on pockets of deep red soil on steep rocky slopes and along the base of rock faces. This species may occur in rocky gorges within the Development Envelope. However due to the absence of records in the Development Envelope (despite several targeted flora searches) the Revised Proposal is not expected to adversely affect the representation or viability of this species.
Themeda sp. Hamersley Station (M. E. Trudgen 11431)	3	Recorded from one location in the Development Envelope within the footprint of the Nammuldi Irrigated Agriculture Area. The Revised Proposal does not involve any ground disturbance at that location and therefore will not adversely affect the representation or viability of this species.

Species	Priority	Description
Ptilotus mollis		This species has not been recorded within the Development Envelope although it has been recorded at Nammuldi as well as north north-west and east south-east of the B4 Operation. It has a broad distribution throughout the Pilbara with a known range measuring approximately 300 km by 640 km including one known population within Karijini National Park. Suitable hill habitat exists however due to the absence of records in the Development Envelope (despite several targeted flora searches) the Revised Proposal is not expected to adversely affect the representation or viability of this species.
Ptilotus subspinescens	3	Large populations of this species occur in the southern half of the Development Envelope: to the south of the Brockman pits, along White Quartz Road (Area 2 South) and in the headwaters of the Beasley River tributary. This species has been recorded from the Robe, Newman and Rocklea Land Systems which are well represented in the Pilbara bioregion, although at a finer scale this species is commonly found in areas with fine silt/clay substrate and *Triodia angusta* and/or *T. longiceps* hummock grasslands. A portion of the population immediately south of the existing B4 pits that is located within the vegetation community: P11 (PL16 Biota 2012a) will be partially disturbed by the proposed clearing (11.33 ha of P11). However several large populations exist nearby and therefore the Revised Proposal is not expected to adversely affect the representation or viability of this species.
Eremophila magnifica subsp. magnifica	4	This species occurs in several locations within the Development Envelope and a small proportion of the population at B4 will be affected by the proposed clearing. However it has been recorded in a number of locations within and surrounding the Development Envelope that will not be affected by the proposed clearing. Nine populations are known to occur in Karijini National Park exist, with additional populations recorded at Vivash East, West Turner and Silvergrass West. It typically occurs in rocky areas such as steep rocky hill slopes, gorges and gullies. The Revised Proposal is not expected to adversely affect the representation or viability of this species.
Goodenia nuda	4	This species occurs along Boolgeeda Creek downstream of the discharge point and in the western portion of the Development Envelope; however it has not been recorded frequently in the Greater Brockman area. The species has broad distribution and has been recorded over a range of approximately 450 km within the Pilbara bioregion, including populations in Karijni and Millstream-Chichester National Parks. It has also been recorded from the Gascoyne bioregion. Appears to be widespread but uncommon. Typically restricted to creeklines and wet areas. The Revised Proposal is not expected to adversely affect the representation or viability of this species.

Table 8-6: Flora and Vegetation: Description of Factor, Impact Assessment and Management

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
To maintain representation, diversity, viability and ecological function at the species population and community level.	**Additional Clearing** B4 requires up to 950 ha of additional clearing to support ongoing operations, including pit expansion and waste dump optimisation. Figure 2-1 depicts the proposed clearing within the Development Envelope. **Vegetation – additional clearing** Vegetation mapping for the Development Envelope has been completed (Figure **8-2**) and does not indicate the presence of any vegetation types that qualify for specific legislative protection (i.e. TECs). Similarly, no PECs have been identified within the Development Envelope. The additional clearing areas intersect with the following vegetation types previously identified by Biota as being of Elevated Significance (refer to Figure 8-6 and Table 8-4): • **P11 - *Acacia synchronicia* scattered shrubs over *Triodia angusta* hummock grassland.** This vegetation type does not belong to a restricted floristic group, but is the main associated vegetation type for a significant sized population of the Priority 3 species *Ptilotus subspinescens*. Although this vegetation type is considered unlikely to be well represented in the Hamersley subregion, it does occur extensively outside the Development Envelope and on similar substrates along White Quartz Road. • **H10, H11, H12, H13 and H16 - Mixed shrublands over hummock grasslands dominated by suites of species preferring rocky habitats.** These vegetation types of narrow gorges, gullies and breakaways belong to a floristic group apparently restricted in the region, and support cryptic species restricted to such rocky habitats. These habitats, while widespread within the Hamersley subregion, comprise a small proportion of the total area. • **P1, P2, P3, P9 and P10 - *Triodia wiseana / T. angusta* hummock grasslands with variable overstoreys occurring on stony plains.** These vegetation types belong to floristic groups that are apparently not widespread in the region; calcrete areas in particular are not well represented in the Hamersley subregion and these vegetation types may have a somewhat restricted distribution. These communities are however, relatively abundant in the habitats present within the vast valley stretching between the B4 and Western Turner Syncline ranges. The P3 represents potential habitat for the *Rhagada* sp. "Mt Brockman" snail. • **C20 – Creekline vegetation dominated by Mulga.** This vegetation type is likely to be restricted in terms of area of extent in the Hamersley subregion. • **C3 and AciThtCEc – vegetation of minor creeklines dominated by *A.citriniviridis* over *Themeda triandra*, **Cenchrus ciliaris* tussock grasslands**	**Vegetation and Flora – Clearing** This Proposal will result in the clearing up to 950 ha of native vegetation (in addition to the 2,610 ha approved under MS 717). Some of the Priority 3 species, *Ptilotus subspinescens,* will potentially be impacted by this Proposal. The effect of the proposed change to flora and vegetation values is not considered significantly different or additional to that of the approved B4 Operation as the potential impacts to flora and vegetation values are considered to remain unchanged from that assessed in the PER. This is because the proposed changes will: • Not affect any new vegetation communities that have not been previously assessed. • Not affect any known TEC's or PEC's in the area. • Not affect any known occurrences of DRF and will minimise impacts to known locations of the Priority 3, *Ptilotus subspinescens* where practicable. **Vegetation – Surplus Water Discharge** No TECs or PECs occur in proximity to the Boolgeeda Creek watercourse; however seven vegetation units of elevated conservation significance occur in proximity. Hydrological modelling was performed along a 52km section downstream of the proposed discharge point. The creek was divided into three different reaches with unique morphology, soil conditions and vegetation types. For each of these reaches, the modelling suggests that the water discharged into the creek is likely to be contained in the existing channel; hence no overtopping of the creek banks is anticipated (Appendix 5). Therefore the potential impact due to waterlogging is expected to be confined to vegetation growing within or immediately adjacent to the low flow channel, and the root systems of trees growing on the banks of these watercourses are likely to be partially, rather than completely waterlogged. The key species within vegetation units are considered tolerant (*E. Camaldulensis* subsp. *refulgens*) or relatively tolerant (*E. Victrix*) to waterlogging based on a review of previous studies and observations in the Pilbara. Detrimental impacts due to waterlogging may range from reduced growth and health to tree death, with the degree of impact dependent on the species tolerance, complete or partial waterlogging of the root system, and the duration of waterlogging. Based on these considerations, for the scattered populations of *E.victrix* on the banks of the discharge watercourse, reduced growth and health, and some tree death, is considered possible. For *E. camaldulensis* subsp. *refulgens* some reduced growth and health is possible but widespread tree death is unlikely. The vegetation communities would be expected to recover after cessation of discharge (as only the areas/individuals immediately adjacent to the low flow channel may be detrimentally affected), with timeframe to recovery dependent on the degree of detrimental impact. Potential detrimental impact to these vegetation units due to dewatering	The following key management measures for vegetation and flora will be implemented (and where applicable have been implemented during Proposal design and operation of the B4 Operation to date): • Proposal design has minimised planned vegetation clearing to areas necessary for safe construction and operation. • Proposal design has, and will continue to, avoid and minimise clearing of elevated conservation significance vegetation and flora, including the Priority 3 *Ptilotus subspinescens*. • Ground truthing will be conducted prior to clearing to identify DRF. • The Rio Tinto Iron Ore (WA) internal ground disturbance authorisation procedure will be implemented, including internal assessment and authorisation prior to any clearing of vegetation. • Management of weeds will be carried out in accordance with the Rio Tinto Iron Ore (WA) Weed Management Strategy, Equipment Hygiene Expectations Procedure, the and the Soil Resource Management Procedure, including the following actions: o Weed monitoring will be undertaken at the discharge point and management implemented as appropriate. o The existing B4 Project weed action plan will be updated to include activities within this Proposal. o All earth engaging equipment brought onto site will be inspected to ensure they are clean and free of built up mud, rock, soil, vegetation. o Areas to be cleared will be assessed for weeds; topsoil cleared from weed infested areas will be separated from other stockpiles and/or managed to prevent the spread of weeds. • Proposal design has incorporated consideration of surface water management, including minimising disruption to watercourses where possible. • A discharge water management and monitoring strategy (including site specific water quality trigger values) will be developed in accordance with ANZECC/ARMCANZ (2000) water quality management framework, to manage the potential impacts of discharge water on the downstream environment. This will be implemented and managed under Part V of the EP Act. • Prior to discharging water to Boolgeeda Creek the Discharge Monitoring and Management Plan (MMP)(Appendix 6) will be finalised and implemented to

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
	Occur in habitats that are of value as surface drainage features. Floristic groups are not apparently widespread within the region. **Flora – additional clearing** Figure 8-6 and Figure 8-7 depict recorded Priority Flora within the Proposal area. Numerous biological surveys have been completed over the broader B4 Operation area, vegetation mapping has been extrapolated over a small area at the western edge of the Development Envelope based on existing vegetation information in adjacent areas and aerial imagery. • ***Ptilotus subspinescens* Priority 3** *P. subspinescens* has been recorded from multiple locations on rocky plains within the wider B4 area. The additional clearing areas intersect with four records of this species. However, as the area has not been systematically traversed for Priority Flora, more individuals may be present within the vicinity of these records and also within the wider B4 area. The small population located within the additional clearing area is not considered to be of significance due to the number, and wide distribution, of records in the vicinity. Populations of this species have also been recorded nearby at Brockman 2, Silvergrass, Western Turner Syncline and Beasley River. • ***Eremophila magnifica* subsp*. magnifica* Priority 4** *Eremophila magnifica* subsp. *magnifica* has been recorded 25 times from the broader B4 Project area. All records were from the stony hill slopes associated with Mt West which represents typical habitat for this species. The additional clearing areas intersect five records of this species on Mt West. Given that the habitat present in this area is now heavily fragmented due to disturbance associated with the approved B4 Project, these records are considered to be of low value. *Eremophila magnifica* subsp. *magnifica* is distributed through the central-eastern Hamersley Ranges, and nearby records exist from the Tom Price and Silvergrass localities. **<u>Surplus Water Discharge</u>** In order to make up for lost dewatering and to continue to meet production requirements, the rate of pit dewatering will need to increase over the remainder of the life of the mine. Under the Revised Proposal water that is surplus to requirements will be discharged to Boolgeeda Creek at a rate of up to 6.4 GL/annum. **Vegetation – Pipeline Corridor** Six previously mapped vegetation units are located within the study area. Three units are considered to be of moderate conservation significance (Biota 2005a): • C1: EvGOOIPLd – comprising *Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma*, *Pluchea dentex* very open herbland is considered. This unit occurs in habitats that are of value as surface drainage features and support species restricted to such habitat (Biota 2005a). • C2 – comprising *Acacia pyrifolia*, *Acacia ancistrocarpa*, *Petalostylis labicheoides* shrubland over *Bonamia rosea*, *Tephrosia rosea* var. *glabrior*	discharge is not considered significant, based on the following: • These vegetation units are widespread regionally (Biota 2013a). • On a local scale, the area of these creekline vegetation units in the vicinity of the maximum discharge extent comprises the following extent (ha) and as a % of the riparian study area (Figure 8-2): o C1: ChAciAtuGOr – 10.52 ha (0.81%) o C2:EvAciAtuAPyTHtTe – 6.48 ha (0.5%) o C3:EvEcAciAPyTErEUa – 30.28 ha (2.33%); o C4:EvEcAciEUa – 26.29 ha (2.02%); o C5:EvEcAciCEc – 179.90 ha (13.83%); o C6:EvEcAciMGAam – 46.85 ha (3.6%); o C7:EvEcAciMgCEcTe – 152.74 ha (11.74%). Based on helicopter and ground reconnaissance, and examination of aerial photography, extensive areas of Eucalypt woodland occur locally on the Beasley and Hardey Rivers outside the extent of current vegetation surveys, and therefore the area of eucalypt woodland potentially impacted is relatively minor on a local scale. • The total length of Boolgeeda Creek is approximately 106km and the modelled maximum discharge extent is approximately 37km for the highest discharge volume scenario – this equates to approximately 30% of the creek being within the maximum extent of discharge. **Vegetation – Pipeline Corridor** • Modelling of surface hydrology indicates no 'overland flow' is likely in the vicinity of the infrastructure corridor from the current B4 operations to the pipeline outlet (Rio Tinto 2013a).	ensure that the associated environmental and conservation values are maintained. • The Discharge MMP includes provision for monitoring of weeds within the riparian vegetation associated with Boolgeeda Creek that may be attributed to discharge of surplus water. The Discharge MMP includes triggers associated with increases in the representation (extent or species) of weeds and management actions that will follow • The Discharge MMP includes provision for monitoring of increases in impacts due to grazing and/or trampling of riparian vegetation by feral herbivores that may be attributed to the discharge of surplus water. Triggers relate to increases in evidence of damage caused by feral herbivores and identify actions to be taken in the event that management is required. **Outcome** The Proponent considers that this Proposal can be managed to meet the EPA Objective for this factor, in summary: • No new or potentially significant environmental features have been recorded within the Development Envelope • Flora and vegetation potentially affected by the Proposal is well represented outside the Development Envelope, on a local and regional scale. • Clearing will be restricted to within the Development Envelope. • Appropriate management measures to avoid, minimise and mitigate potential impacts of the Proposal on flora and vegetation will be implemented (and where applicable have been implemented during Proposal design and operation of the B4 Project). • The predicted spatial extent of groundwater drawdown of the B4 deposit is less than that assessed and approved for the original B4 Project (MS 717). • The spatial and temporal extent of discharge is limited. • A Discharge MMP has been developed and will be implemented in order to monitor, manage the potential impacts of discharge to Boolgeeda Creek including: waterlogging of riparian vegetation, spread of weeds and potential impacts from feral herbivores.

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
	low open shrubland over *Triodia epactia* hummock grassland and *Themeda triandra* very open tussock grassland. This unit occurs in habitats that are of value as surface drainage features and support species restricted to such habitat. This unit also appeared to be in a floristic group that did not appear to be widespread in the region (Biota 2005a). • P3 – comprising *Eucalyptus leucophloia* scattered low trees over *Acacia aneura* (various forms), *Acacia ayersiana* tall open shrubland over *Triodia epactia*, *Triodia wiseana* mid-dense hummock grassland. Biota (2005a) reported that this unit appeared not to be widespread across the region. In addition, C1: EvGOOIPLd contains *Eucalyptus victrix* and *Eucalyptus camaldulensis*, which may behave as a phreatophyte and thus be influenced by groundwater drawdown (Biota 2005a). Impacts to groundwater dependent vegetation were assessed for the approved B4 Project and are not considered a key environmental factor for this Proposal as the predicted extent of groundwater drawdown is predicted to reduce in lateral extent. **Vegetation – Riparian Impact Zone** • The riparian study area is located on the Hamersley Plateau, which is within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The riparian study area intersects two of Beard's vegetation units (Biota 2013a). • Fifteen (15) vegetation units were identified within the riparian study area which were grouped into 5 broad categories: o Creekline dominated by *Corymbia hamersleyana* (C1:ChAciAtuGOr); o Creekline dominated by *Eucalyptus victrix* and/or *E. camuldulensis* (C2:EvAciAtuApyTHteTe, C3:EvEcAciApyTerEUa, C4:EvEcAciEUa, C5:EvEcAciCEc, C6:EvEcAciMGAam and C7:EvEcAciMgCEcTe); o Floodplains with *Corymbia hamersleyana* (F1, F4 and F7); o Floodplains dominated by *Acacia citrinoviridis* and *A. pyrifolia* (F2, F3, F5 and F8); o Floodplains supporting *Acacia sclerosperma* subsp. *sclerosperma* (F6 and F7). • No vegetation comprising TECs or PECs were recorded within the riparian study area. • Seven vegetation units (C1:ChAciAtuGOr, C2:EvAciAtuApyTHteTe, C3:EvEcAciApyTerEUa, C4:EvEcAciEUa, C5:EvEcAciCEc, C6:EvEcAciMGAam and C7:EvEcAciMgCEcTe) recorded in the riparian study area were considered to be of elevated significance as they are equally at risk from a number of threats (including grazing and invasion by weeds) known to impact on the vegetation of major ephemeral watercourses. The vegetation condition of the creek bed was ranked as being Very Good overall despite the presence of **Cenchrus ciliaris*, which was found to be growing both as scattered grasses and very open tussock grasslands. The vegetation conditions of surrounding floodplains was categorised as Good due to the higher degree of invasion of **Cenchrus ciliaris*. **Flora - Riparian Impact Zone** • No threatened flora species protected under the *Wildlife Conservation Act 1950* (WC Act) were recorded, or expected to occur within the riparian		

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
	impact zone (Biota 2013). • One Priority 1 (P1) Species – *Peplidium sp*. Fortescue Marsh (S. Van leeuwen 4865) was recorded in the riparian survey area. • One Priority 2 (P2) Species – *Pentalepis trichodesmoides subsp. hispida* was recorded in the riparian survey area. • One Priority 3 (P3) Species – *Indigofera sp*. Bungaroo Creek (S. Van Leeuwen) was recorded in the riparian survey area. • One Priority 4 (P4) Species – *Goodenia nuda* was recorded in the riparian survey area. • The vegetation condition of the creek bed was ranked as being Very Good despite the presence of **Cenchrus ciliaris,* which is growing both as scattered grasses and very open tussock grasslands. The creek line supports a healthy and diverse range of flora species.		

9 ASSESSMENT OF IMPACT ON TERRESTRIAL FAUNA

This Section describes the terrestrial fauna and fauna habitats that occur within the proposed Development Envelope and provides details regarding the potential impacts to terrestrial fauna and conservation significant fauna habitats from 950 ha of additional clearing of native vegetation that forms part of this Proposal.

The EPA applies the following objective, in its EAG8 (EPA, 2013) in its assessment of proposals that may affect terrestrial fauna:

> *To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.*

9.1 TERRESTRIAL FAUNA STUDIES

A number of terrestrial fauna studies have been conducted in the B4 Operation area. Summaries of the keys findings of the findings of the main terrestrial fauna surveys (in the Development Envelope and adjacent nearby areas) is provided in Table 9-1.

Database searches conducted as part of these fauna surveys have indicated a total of 18 species of conservation significance for the locality (two avifauna species, six migratory avifauna species, two reptile species and eight mammal species). Of these only seven species have been recorded in previous surveys in the vicinity or are considered likely to occur.

Table 9-3 lists the conservation significant vertebrate species that have the potential to occur in the Development Envelope.

Table 9-1: Summary of Terrestrial Fauna Studies

Report Title and Author	Summary of Study
Fauna Habitats and Fauna Assemblage of the B4 Project, near Tom Price. Biota Environmental Sciences (2005b) RTIO HSE 0014405	Baseline fauna survey between 18/10/2004 and 30/10/2004 and between 12/04/2005 and 21/04/2005 (including White Quartz Road). The survey was planned and implemented in accordance with the following: • Environmental Protection Authority (EPA) Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002); and • Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004b). Size of study area = 11,796 ha. Two Priority 4 fauna species were recorded within the study area. Further details are provided in Table 9-3
Beasley River Limonites - Baseline Fauna Survey. Biota Environmental Sciences (2009b) RTIO HSE 0086993	Single phase baseline survey between 21/05/2009 and 31/05/2009. The survey was planned and implemented in accordance with the following: • Environmental Protection Authority's (EPA) Guidance Statement 20, "Sampling Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009); • Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002); and • Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004b). Size of study area = 4,162 ha. The following four vertebrate fauna species of conservation significant were recorded in the study area: two Schedule 1; one Schedule 3; and one Priority 4 species. Further details are provided in Table 9-3.

Report Title and Author	Summary of Study
Brockman Syncline 4 Marra Mamba - Targeted Fauna Survey. Biota Environmental Sciences (2013c) RTIO HSE 0179976	Desktop review, targeted fauna survey between 28 August and 4 September 2012. The survey was planned and implemented in accordance with the following: • Environmental Protection Authority's (EPA) Guidance Statement 20, "Sampling Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009); • Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002); and • Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004b). Size of study area = 1,921 ha. The study area comprised four fauna habitats: stony plains; creeklines and floodplains; stony hillslopes; and rocky gorges. Targeted surveys using systematic sampling in specific habitats was conducted for vertebrate fauna: Northern Quoll (*Dasyurus hallucatus*), Orange Leaf-nosed Bat (*Rinonicteris aurantius*) and Ghost Bat (Macroderma gigas) and for invertebrate groups known to support short-range endemic (SRE) taxa: Mygalomorphae (trapdoor spiders), Diplopoda (millipedes), Pulmonata (land snails) and Pseudosorpiones. Although no Schedule or Priority Fauna were recorded within the study area, Biota (2013c) considered that ten conservation significant species were considered likely to occur or having the potential to occur in the study area. These included three Schedule 1 species; two Schedule 3 (Migratory) species; and five Priority 4 listed species. Details are provided in Table 9-3. On the basis of the field assessment and results of the targeted survey Biota concluded that the study area is unlikely to have elevated conservation significance for any of the species listed in Table 9-3.
Marra Mamba West (AR-13-11158) - Native Vegetation Clearing Permit Report. Biota (2013d) RTIO-HSE-0201775	Desktop review and Level 1flora and fauna survey between 14 and 18 September 2013. Size of study area = 324 ha. This survey was planned and implemented in accordance with the following: • Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA 2004a); and • EPA Position Statement No 3 (EPA 2002) and the Technical Guidance – Terrestrial Fauna Surveys for Environmental impact Assessment (EPA and DEC 2010). Five mammal species, two reptiles' species and one invertebrate species were recorded from the study area. One Priority 4 species was recorded in the study area. Further details are provided in Table 9-3.

9.2 RHAGADA

MS 717 included a condition relating to land snails at site BROMD, which identified the requirement for the preparation of a Snail Management Plan. A Snail Management Plan was completed and approved by the DPaW in August 2007.

The Snail Management Plan suggested that that the apparent uniqueness of the snails from BROMD was an artefact of limited samples across few locations. This statement was based on findings from subsequent molecular studies carried out by Biota from a number of localities across the Pilbara bioregion.

Furthermore, the Snail Management Plan considered that if additional and similar populations of *Rhagada sp* "Mt Brockman" to those occurring at BROMD were located elsewhere, then the requirement to commence or continue monitoring the BROMD location would be extinguished.

The Snail Management Plan further highlighted that the valley supporting the P1 vegetation unit from which the BROMD haplotype was recorded is broadly connected with other valleys and is therefore unlikely to support a genetically isolated population of *Rhagada.*

Based on this, additional sampling was undertaken along the contiguous drainages features (including Beasley River West) to the south of the BROMD site. The BROMD haplotypes was found at eight additional sites, of which six are outside of the Development Envelope.

Biota (2008) considered that the data from this work strongly supported the notion that the taxon collected at BROMD occurs more widely and at least as far as 24 km to the south. The data also suggested that the specimen from the BROMD site are part of a population that has a broader distribution that follows the West Beasley River (near the Paraburdoo – Nanuatarra Rd) north along a minor tributary to the BROMD location, a total distance of more than 25 km.

Throughout this distribution, evidence suggested that snails occur in Triodia dominated habitat along drainage features irrespective of the over storey component. In other words it is not restricted to the P1 vegetation type identified at BROMD.

On this basis, the Proponent proposed to the OEPA and DPaW that the monitoring of the BROMD population and its habitat (the P1 vegetation unit) at the BROMD site cease. However, in recognition of the complex evolutionary histories of Rhagada in the Brockman area and the Pilbara region in general, the Proponent committed to funding a three year research project titled "Genetic structure, phylogenetic relationships and systematics of endemic snails of the Pilbara, Western Australia". The project was funded with the University of Western Australia (**UWA**) and covered several taxonomic studies and PhD's. The project completed its funding in 2012 and several Journal articles have been produced.

This proposal was accepted by DPaW and the OEPA in March 2009 with confirmation that the Snail Management Plan required to address Condition 8 of MS 717 was considered redundant and that the proponent had met the obligations under Condition 8 and proponent Commitment 14 of MS 717. The Proponent therefore considers that the Revised Proposal does not require a specific condition to manage potential impacts to the Rhagada as a result of the Proposal.

9.3 FAUNA HABITAT CONSERVATION SIGNIFICANCE ASSESSMENT

The following assessment utilises the Land Systems framework and the vegetation types to extrapolate the distribution of the fauna habitats within the broader region.

In addition, comment is made as to whether the habitats linked with particular land systems are known, or likely, to support fauna of conservation significance.

9.3.1 Assessment Based on Land Systems

Boolgeeda Land System

The Boolgeeda Land System occurs widely through the Hamersley Range subregion, with scattered occurrences through the Chichester Range subregion. The Development Envelope is located centrally in relation to the primary extent of the coverage of the Boolgeeda Land System and includes only 0.9% (8,312 ha) of the Land System representation in the region.

No fauna species of conservation significance have been recorded from this Land System within the Development Envelope.

Newman Land System

The Newman Land System is widespread throughout the Hamersley Range, with relatively few occurrences in the Chichester Range. The Development Envelope lies almost centrally within the core area of occurrence of this Land System type and includes less than 0.3% (5,229 ha) of its overall representation in the Pilbara.

With the exception of the undescribed *Rhagada* (Section 9.2), no fauna species of conservation significance have been recorded from this Land System within the Development Envelope.

Platform Land System

The Platform Land System occurs predominantly in the Hamersley Range, though there are also isolated occurrences in the Chichester Range. Approximately 0.3% (809 ha) of the Platform Land System within the Pilbara occurs within the Development Envelope.

No fauna species of conservation significance have been recorded from this Land System within the Development Envelope.

River Land System

The River Land System is widespread throughout the Pilbara bioregion in major river systems. Some 698 ha of this Land System is mapped within the Development Envelope, which is approximately 0.1% of the total area mapped as this Land System in the Pilbara bioregion. .

The Priority 4 species *Notoscincus butleri* and Australian Bustard *Ardeotis australis* have been recorded from vegetation types within this Land System for this Proposal.

Robe Land System

The Robe Land System occurs within the central and western sections of the Hamersley subregion, with a few occurrences in the Chichester subregion. The occurrences within the Development Envelope are part of an extensive area in the central Hamersley Range.

Approximately 1,389 ha of Robe Land System occurs within the Development Envelope, which represents 1.1% of the total area of this Land System within the Pilbara bioregion.

No fauna species of conservation significance have been recorded from this Land System within the Development Envelope.

Rocklea Land System

The Rocklea Land System is the most extensive Land System in the Pilbara bioregion. It is widespread throughout the Chichester Range subregion, and also relatively frequent in the Hamersley Range subregion.

The occurrences within the Development Envelope are part of a large area in the central Hamersley Range.

Approximately 3,576 ha of Rocklea Land System occurs within the Development Envelope, which is 0.1% of the total representation of this Land System within the Pilbara bioregion.

No fauna species of conservation significance have been recorded from this Land System within the Development Envelope.

Table Land System

This Land System occurs as isolated dispersed occurrences in the south of the Pilbara bioregion and also within the Gascoyne bioregion. The 47 ha occurring within the Development Envelope comprises only 0.03% of that mapped for the Pilbara bioregion. Calcrete outcroppings have been identified as important for stygal, troglobitic and land snail communities. All these groups can and do support taxa with narrow distributions.

While the Table Land System thus has a high conservation significance rating within the Development Envelope, current mine planning does not impact this Land System.

Wona Land System

The Wona Land System occurs primarily in the Chichester Range subregion and as scattered occurrences in the Hamersley subregion.

Only 25 ha of this Land System occurs within the Development Envelope, at the northern end of the Beasely River tributary valley. This represents only 0.01% of the Pilbara occurrence of this Land System.

No fauna species of conservation significance have been recorded from this Land System within the Development Envelope.

9.3.2 Assessment Based on Vegetation Types

Most of the vegetation types identified within the Development Envelope have been previously recorded outside the Development Envelope in widespread landforms and with common dominant species.

However three vegetation types were considered unlikely to be widespread in the region and it follows that aspects of these fauna habitats may therefore also have a limited distribution:

- gorge vegetation types H10, H11, H12, H13 and H16 (mixed shrublands over hummock grasslands dominated by suites of species preferring rocky habitats);
- vegetation types of stony plains (equivalent to the *Acacia* over *Triodia* fauna habitat): P1 (*Acacia* aff. *aneura* (narrow fine veined; site 1259), *A. ayersiana*, *Acacia tetragonophylla* tall shrubland over *Eremophila forrestii*, *Acacia bivenosa* shrubland over *Triodia epactia* mid-dense hummock grassland); P9 and P10 (*Triodia wiseana / T. angusta* hummock grasslands with variable overstoreys occurring on stony calcrete plains); and P11 (*Acacia synchronicia* scattered shrubs over *Triodia angusta* hummock grassland); and
- creekline vegetation types C2, C6, C13, C17 and C20 (variously dominated by Mulga, *Eucalyptus xerothermica, Acacia pyrifolia, A. citrinoviridis* or *Gastrolobium grandiflorum*) (Biota 2005a).

Table 9-2 Summary of Conservation Significant Fauna Habitats occurring in the Development Envelope

Fauna Habitat	Habitat features
Hummock Grasslands and Acacia Shrublands	Grasses e.g. *Triodia* forming mound-like tussocks on relatively flat plains. Spinifex with emergent Acacia species on relatively flat plains.
Mulga Woodlands and Shrublands	*A. aneura* (Mulga) dominated overstorey (including woodlands) with mixed shrubland and grassland understorey, on relatively flat plains. Mulga Groves – stands of Acacia species forming a closed canopy on relatively flat plains.
Gorges and Gullies	Deeply incised gorges or gullies including breakaways.
Rock Piles	Distinct, massive piles of rocks, often found on plains or other landforms.
Major Drainage	Vegetation in or along major rivers, including permanent pools. Creeklines (with or without flowing water) with Coolibahs present.
Minor Drainage	Creeklines (with or without flowing water) that are dominated by Acacia species, usually *Acacia citrinoviridis*. Small drainage lines that flow in wet periods and have vegetation that is distinct from the surrounding areas.

9.3.3 Fauna Species of Conservation Significance

Conservation significant vertebrate fauna species indicated in desktop searches as potentially occurring within the Development Envelope are summarised in Table 9-3. An assessment was conducted of the likely occurrence of those species within the Development Envelope. The assessment also considered potential impacts to Matters of National Environmental Significance (**MNES**) as listed under the EPBC Act which concluded that the Proposal did not require referral under this EPBC Act.

Figure 9-1 and Figure 9-2 depict the known records of conservation significant fauna within the Development Envelope.

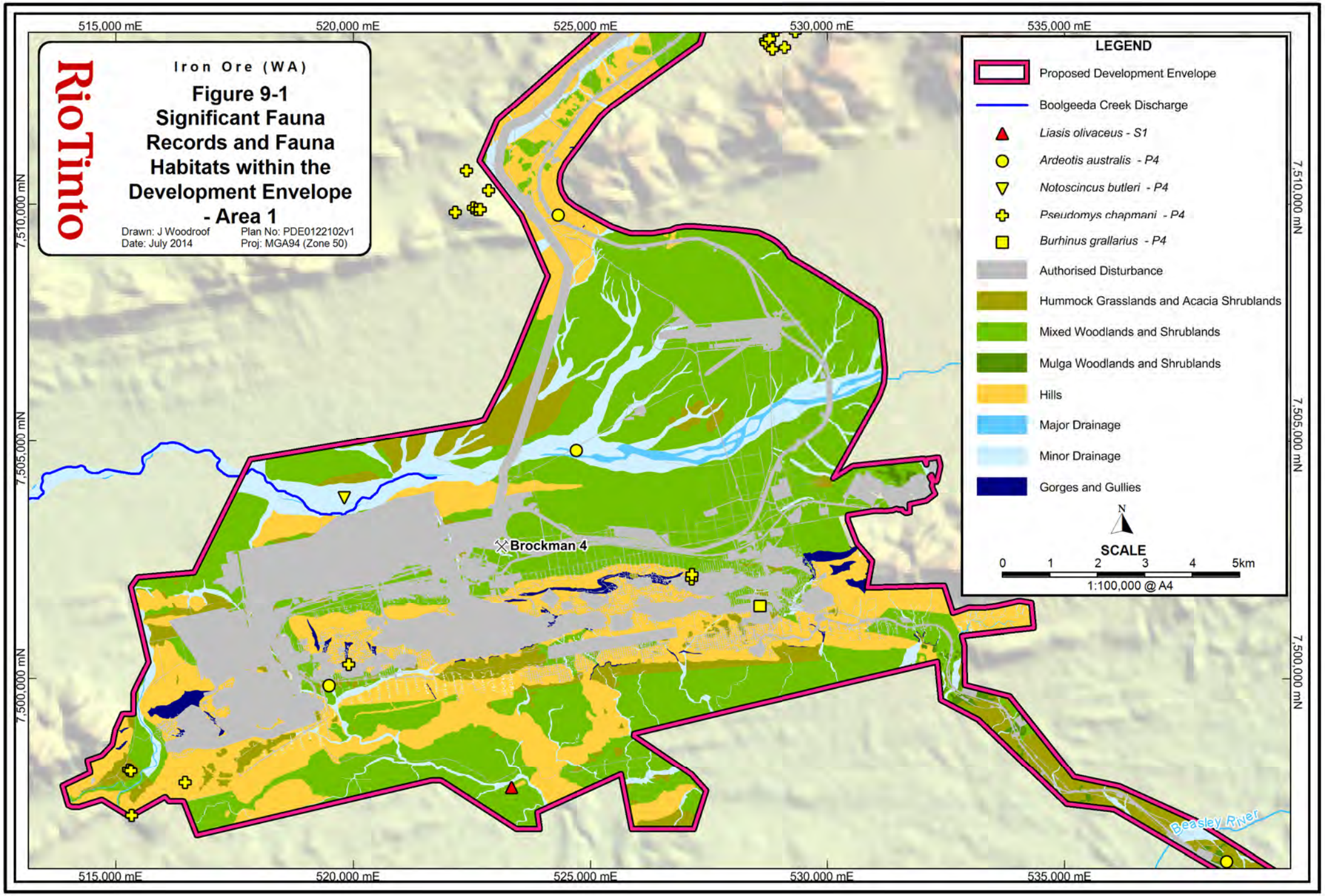
Table 9-3: Conservation Significant Species potentially occurring within the Development Envelope

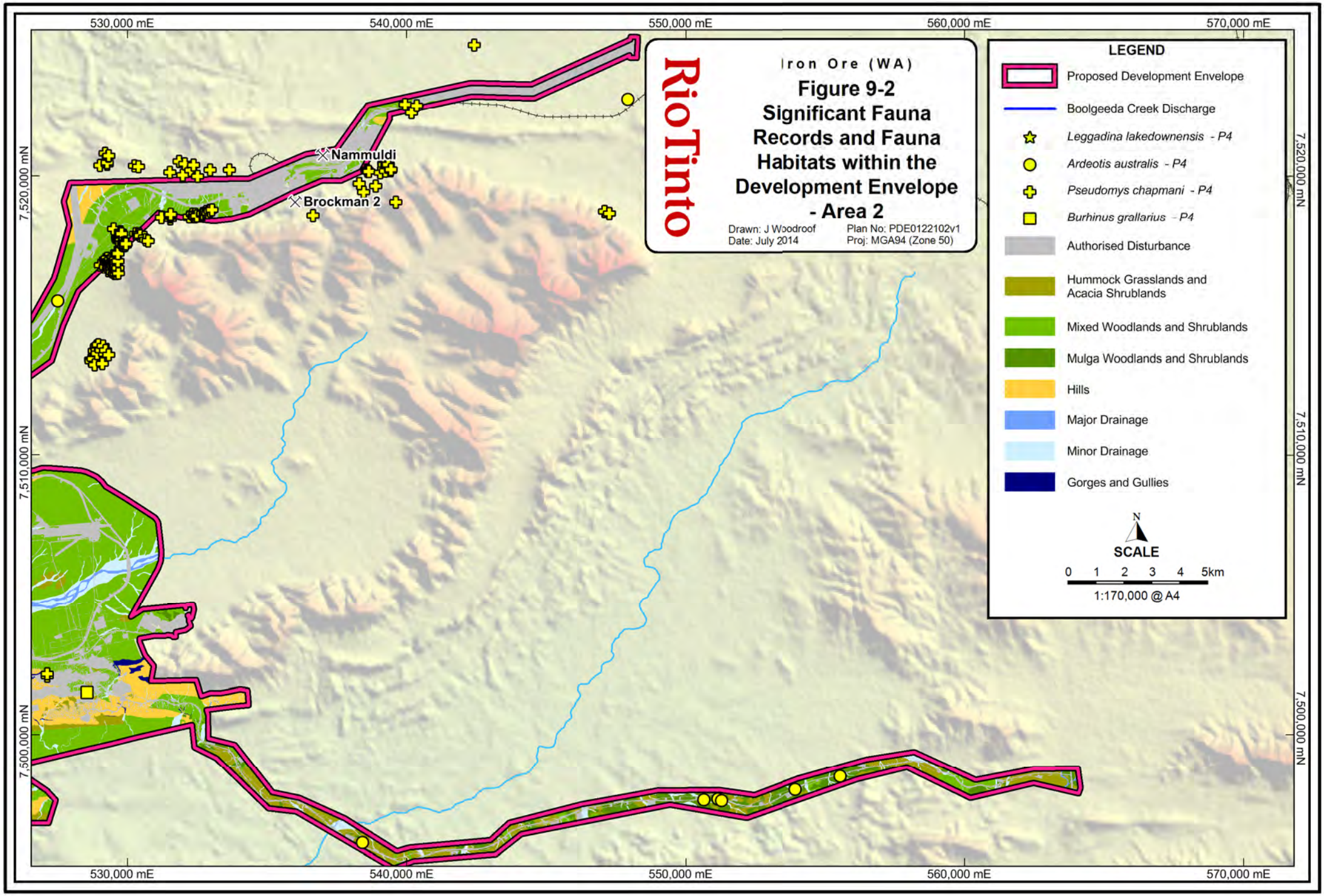
Species	Conservation status WA	EPBC Act status	Likelihood of occurrence within Development Envelope
Northern Quoll *Dasyurus hallucatus*	Schedule 1	Endangered	Whilst the Northern Quoll has not been recorded within the Development Envelope there is suitable core habitat for this species in the broader area (Biota 2013d). The closest record of Northern Quoll to the Revised Proposal is from Marandoo which is 100 km to the east. It is considered that this species may potentially occur within the Development Envelope (rather than likely to occur) and that it would more likely use the area for foraging than denning. Given the absence of core habitat within the area of additional clearing and the lack of records from the locality, no significant impact is expected to the Northern Quoll from clearing within the Development Envelope.
Pilbara Olive Python *Liasis olivaceus barroni*	Schedule 1	Vulnerable	A skin slough believed to belong to this species was recorded at a site within the Development Envelope but approximately 2.5 km south of the additional clearing. Given the absence of core habitat within the area of additional clearing no significant impact is expected to the Pilbara Olive Python from clearing within the Development Envelope.
Orange Leaf-nosed Bat *Rhinonicteris aurantius*	Schedule 1	Vulnerable	Records of this species were made approximately 22 km south of the proposed new clearing and outside of the Development Envelope. Due to lack of suitable habitat within the Development Envelope it is considered that no significant impact is expected to the Orange Leaf-nosed Bat from clearing within the Development Envelope.

Species	Conservation status WA	EPBC Act status	Likelihood of occurrence within Development Envelope
Peregrine Falcon *Falco peregrinus*	Schedule 4	-	Whilst this species has not been recorded within the Development Envelope it is considered likely to occur as suitable prey species, such as parrots, are common in the area. The Revised Proposal is unlikely to affect the conservation status of this species.
Ghost Bat *Macrodermis gigas*	Priority 4	-	The Ghost Bat has been recorded from Brockman 2 which is approximately 18 km northeast of the B4 Operation. As for the Orange Leaf-nosed Bat, the Ghost Bat is reliant on deep caves to roost and no suitable roosting sites are present within the additional clearing area. Individuals may potentially forage within the broader Development Envelope, but given their mobile nature and nocturnal habits, clearing of vegetation within the Development Envelope will not have an impact on the conservation status of this species.
Western Pebble-mound Mouse *Pseudomys chapmani*	Priority 4	-	No active mounds have been recorded within the Development Envelope. Therefore the conservation status of this species will not be affected as a result of the Revised Proposal.
Australian Bustard *Ardeotis australis*	Priority 4	-	Several sightings and recordings of this species have been made within the Development Envelope. However, given their mobile nature clearing of vegetation within the Development Envelope will not have an impact on the conservation status of this species.
Bush Stonecurlew Burhinus grallarius	Priority 4	-	This species has been recorded sheltering beneath mulga within the Development Envelope. However, given the species mobility the Revised Proposal will not affect the conservation status of this species.
A skink *Notoscincus butleri*	Priority 4	-	This species has previously been recorded within Boolgeeda Creek. Clearing within the Development Envelop is unlikely to impact the conservation status of this species, should it occur, given the broad occurrences of this species in the locality and broader bioregion.

9.4 IMPACT ASSESSMENT ON TERRESTRIAL FAUNA

Table 9-4 describes how the proposal meets the EPA's objectives in respect of terrestrial fauna and presents an impact assessment of significance. Management and mitigation measures are also presented.


Rio Tinto
Iron Ore (WA)
Figure 9-1
Significant Fauna Records and Fauna Habitats within the Development Envelope - Area 1
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
515,000 mE
520,000 mE
525,000 mE
530,000 mE
535,000 mE
7,510,000 mN
7,505,000 mN
7,500,000 mN
Brockman 4
Beasley River
LEGEND
Proposed Development Envelope
Boolgeeda Creek Discharge
Liasis olivaceus - S1
Ardeotis australis - P4
Notoscincus butleri - P4
Pseudomys chapmani - P4
Burhinus grallarius - P4
Authorised Disturbance
Hummock Grasslands and Acacia Shrublands
Mixed Woodlands and Shrublands
Mulga Woodlands and Shrublands
Hills
Major Drainage
Minor Drainage
Gorges and Gullies
N
SCALE
0 1 2 3 4 5km
1:100,000 @ A4


530,000 mE
540,000 mE
550,000 mE
560,000 mE
570,000 mE
7,520,000 mN
7,510,000 mN
7,500,000 mN
Nammuldi
Brockman 2
RioTinto
Iron Ore (WA)
Figure 9-2
Significant Fauna Records and Fauna Habitats within the Development Envelope - Area 2
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)
LEGEND
Proposed Development Envelope
Boolgeeda Creek Discharge
Leggadina lakedownensis - P4
Ardeotis australis - P4
Pseudomys chapmani - P4
Burhinus grallarius - P4
Authorised Disturbance
Hummock Grasslands and Acacia Shrublands
Mixed Woodlands and Shrublands
Mulga Woodlands and Shrublands
Hills
Major Drainage
Minor Drainage
Gorges and Gullies
N
SCALE
0 1 2 3 4 5km
1:170,000 @ A4

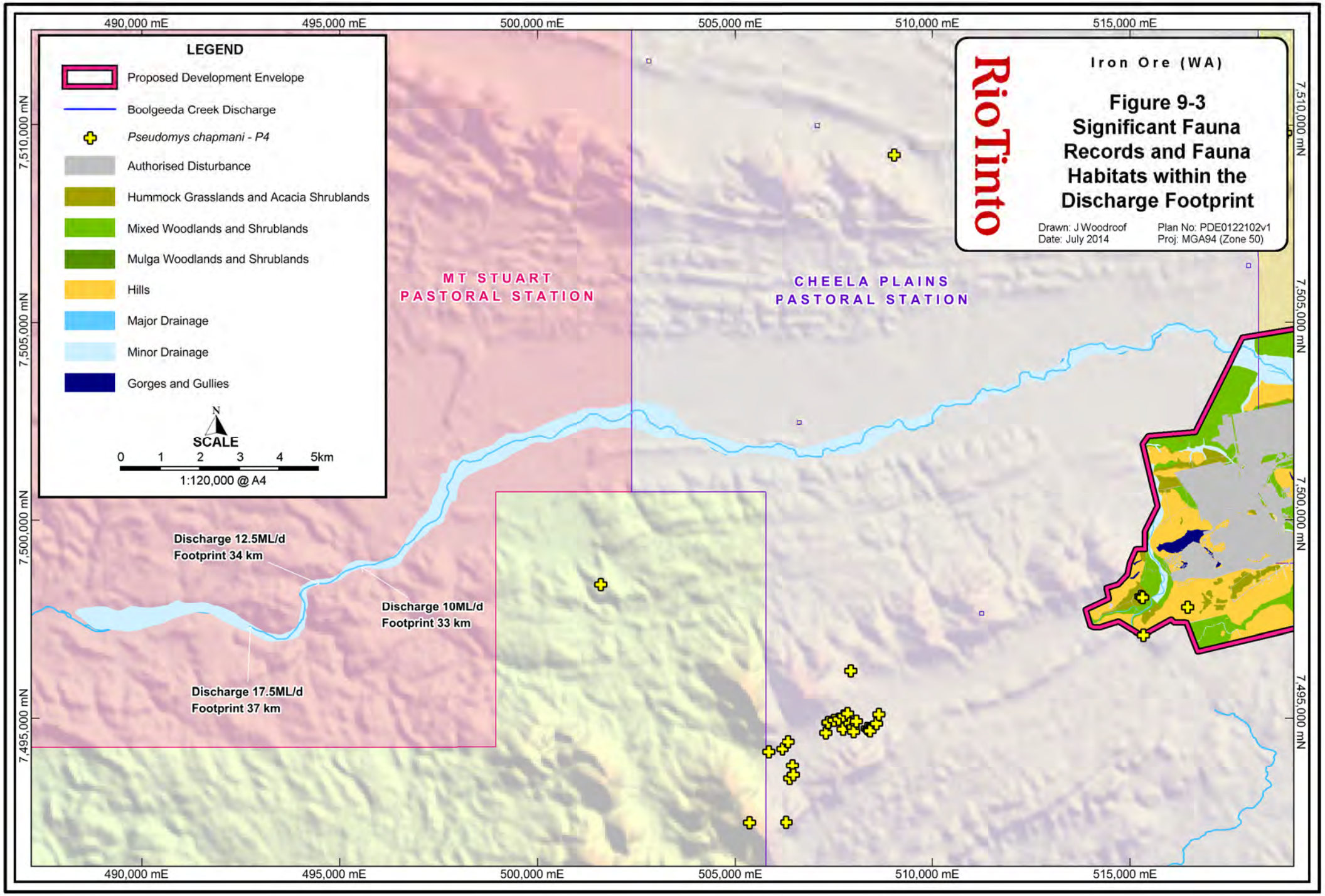

LEGEND
Proposed Development Envelope
Boolgeeda Creek Discharge
Pseudomys chapmani - P4
Authorised Disturbance
Hummock Grasslands and Acacia Shrublands
Mixed Woodlands and Shrublands
Mulga Woodlands and Shrublands
Hills
Major Drainage
Minor Drainage
Gorges and Gullies
N
SCALE
0 1 2 3 4 5km
1:120,000 @ A4
490,000 mE
495,000 mE
500,000 mE
505,000 mE
510,000 mE
515,000 mE
7,510,000 mN
7,505,000 mN
7,500,000 mN
7,495,000 mN
MT STUART
PASTORAL STATION
CHEELA PLAINS
PASTORAL STATION
Discharge 12.5ML/d
Footprint 34 km
Discharge 10ML/d
Footprint 33 km
Discharge 17.5ML/d
Footprint 37 km
RioTinto
Iron Ore (WA)
Figure 9-3
Significant Fauna
Records and Fauna
Habitats within the
Discharge Footprint
Drawn: J Woodroof
Date: July 2014
Plan No: PDE0122102v1
Proj: MGA94 (Zone 50)

Table 9-4: Terrestrial Fauna: Description of Factor, Impact Assessment and Management

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	**Vertebrate terrestrial fauna and fauna habitat** Fauna surveys have been undertaken over approximately most of the Development Envelope. Summaries of the findings of the three main surveys (in the Development Envelope and adjacent, nearby areas) that are relevant to the additional clearing areas are provided below. Figure 9-1 and Figure 9-2 depicts the conservation fauna that have been recorded within the Development Envelope. • **Fauna Habitats and Fauna Assemblage of the B4 Project Area** Biota (2005b) recorded 159 taxa of terrestrial vertebrate fauna belonging to 54 families comprising two frogs, 54 reptiles, 83 birds, seven bats and 13 non-volant mammals. Six primary habitats were identified within the Development Envelope, largely based on vegetation structure and landforms. Four priority vertebrate fauna species were recorded (Biota 2005b): ○ Western Pebble –mound Mouse *Pseudomys chapmani* ○ Australia Bustard *Ardeotis australis* ○ Bush Stonecurlew *Burhinus grallarius* ○ A skink *Notoscincus butleri* • **Brockman Syncline 4 Marra Mamba Targeted Fauna Survey** The Marra Mamba deposit is located immediately south of the current mining area and comprises an area of approximately 1,921 ha. No vertebrate fauna of conservation significance were recorded during systematic trapping, or encountered opportunistically during traverses of the Marra Mamba survey area (Biota 2013c). A variety of fauna habitats were sampled including rocky breakaways, gorges, stony hills, Triodia plains, and broad drainage lines. These habitats are all well represented throughout the Hamersley subregion, and are not restricted to the Marra Mamba survey area. There was very limited core (preferred) habitat for Northern Quolls or Pilbara Olive Pythons observed within the Development Envelope. • **Beasley River Limonites Fauna Survey** The Beasley River is located approximately 10 km south-east of the Development Envelope. Biota (2009b) recorded the following three species that are considered to be of conservation significance: • The Pilbara Orange Leaf-nosed Bat (*Rhinonicteris aurantius*), listed as a Schedule 1 species under the State WC Act and 'Vulnerable' under the EPBC Act. • The Short-tailed Mouse (*Leggadina lakedo wnensis*), listed as Priority 4 species under the WC Act. • The Pilbara Olive Python (*Liasis olivaceus barroni*), listed as a Schedule 1 species under the WC Act and the EPBC Act.	**Terrestrial fauna – additional clearing** This Proposal will result in the new clearing of 950 ha of potential fauna habitat (in addition to the 2,610 ha approved under MS 717), therefore habitat loss is likely to continue to be the biggest threat to fauna, including several Priority 4 fauna species (namely: the Western Pebble-mound Mouse; the Australian bustard, the Bush Stone curlew; and the *Notoscincus butleri* skink). Habitat fragmentation also has the potential to disrupt the movement of fauna. However the potential impacts to fauna populations from the Proposal are considered to remain unchanged from that assessed in the PER for the approved B4 Operation, given the proposed changes in this Proposal will: • Not affect regional population levels of any fauna species. • Not contribute to new/additional fragmentation of habitat. • Not affect any new fauna species or habitat types that have not been previously assessed. • Not contribute a new or additional threat to conservation significant fauna species. The detection of both the Pilbara Orange Leaf-nosed Bat and Pilbara Olive Python at the Beasley River Study area represent the most significant faunal findings to the overall environmental value of the Development Envelope. However, the Pilbara Olive Python record was the result of finding a skin slough believed to belong to this species, and was recorded at a site approximately 2.5 km south of the proposed clearing. In addition, the Pilbara Orange Leaf-nosed Bat records were made at a site approximately 22km south of the Development Envelope. The presence of the Pilbara Olive Python in the south of the Development Envelope suggests that populations of this species may exist in the area. However, the lack of suitable habitat combined with the lack of additional records from the other two surveys nearer the B4 project area suggests that their presence is unlikely within the Proposal area. The failure to detect the Pilbara Orange Leaf-nosed Bat during other fauna surveys conducted throughout the wider Development Envelope, combined with the 22 km separation between the Beasley River records and the Development Envelope, suggests this species is unlikely to be roosting in the vicinity. Whilst it is possible that this species may use parts of the Development Envelope for foraging, it is highly unlikely that development of these areas would have any impact on the conservation status of this species. While there is some chance of conservation significant fauna such as the Pilbara Olive Python, Orange Leaf-nosed Bat, and the Northern Quoll, existing in the Proposal area, the lack of previous records, combined with the lack of suitable habitat within these areas, suggests that their presence is unlikely. Consequently, it is considered highly unlikely that the	The key potential impacts of the Proposal on terrestrial fauna (e.g. loss of habitat due to clearing) will be minimised via management measures to reduce potential impacts on flora and vegetation, as detailed in Table 8-6. In addition, the following key management measures will be implemented to manage potential impacts on fauna (and where applicable have been implemented in Proposal design and operation of the B4 Operation to date): • Ensure sightings of conservation significant fauna species (primarily species listed under the EPBC Act) encountered by the B4 Operation workforce are reported to site Environmental Advisors. • Proposal design has, and will continue to, avoid and minimise clearing of higher value fauna habitat. • Food wastes appropriately disposed of in bins/waste facilities to discourage scavenging by both feral and native animals, and bin lids securely closed. • Internal reporting of incidents involving native fauna. • Implementing and enforcing appropriate vehicular speed limits on site access roads. • Monitoring of feral herbivores and predators will be undertaken along the Boolgeeda Creek wetting front and management measures will be put in place to reduce the risk of significant increases in feral herbivores being attracted by the supply of discharge water. It is not proposed to fence the 37km creekline along Boolgeeda Creek. The Discharge MMP will be implemented to ensure that the associated environmental and conservation values are maintained during discharge of surplus water to Boolgeeda Creek. **Outcome** The Revised Proposal can be managed to meet the EPA environmental objective for this factor, as detailed in the adjacent columns: • Fauna habitats potentially impacted by the Proposal (including habitat of higher value for conservation significant fauna species) are well represented outside of the Proposal boundary, on a local and regional scale. • Of the four conservation significant vertebrate fauna species recorded in the B4 area only the priority species *Notoscincus butleri* (skink) was recorded within the Proposal's riparian impact zone. • The predicted extent of groundwater drawdown will be reduced from that assessed for the approved B4 Project. Therefore no new or additional impacts to subterranean fauna are expected to result from implementation of this

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
		is unlikely. Consequently, it is considered highly unlikely that the development of the Proposal would have an impact on the conservation status of such species. **Terrestrial fauna – riparian impact zone** 53 vegetation types were identified within the B4 Project area, most of which have been previously recorded outside the B4 Project area or are likely to occur in the vicinity, as the landforms are widespread and the dominant species are relatively common. Fourteen vegetation types were considered unlikely to be widespread in the region (Biota 2005a), and it follows that aspects of these fauna habitats may therefore also have limited distribution: • Creekline vegetation types C2, C6, C13, C17 and C20 (variously dominated by *Mulga, Eucalyptus xerothermica*, *Acacia pyrifolia, A. citroniviridis* or *Gastrolobium grandflorum*) (Biota 2005a) Of the four conservation significant vertebrate fauna recorded, the priority species *Notoscincus butleri* was recorded in the Biota 2005 survey in creekline habitat at Boolgeeda Creek. However the conservation status of this species was deemed unlikely to be impacted by the proposed mining activities at the bioregion and subregion level. There are no apparent areas of sheet flow dependent habitat in the B4 Project area; however Boolgeeda Creek exists as a broad drainage channel where appropriate culverts will be required to eliminate erosion and avoid weed introduction and spread. A potential impact of surplus water discharge to Boolgeeda Creek, which was highlighted during consultation with the Cheela Plains pastoral station, is the attraction of feral herbivores to surface water. Whilst this has not been a significant issue at the Proponent's other mine operations, it may be for the Revised Proposal given the reported presence of donkeys and feral cattle in the area. Reconnaissance of Boolgeeda Creek in November 2009 and April 2010 revealed no surface water present in the area currently modelled for this Proposal (WRM 2011a). Pools in Boolgeeda Creek are likely to be transient and ephemeral and water quality will vary with the season. They are likely to be dependent on rainfall, surface water and shallow alluvial interflow rather than regional groundwater. The pools noted by Biota during the August 2013 survey have not been identified in previous studies. However, they are likely to be a result of the unseasonably high rainfall recorded at B4 in May and June 2013 (32.8 mm and 52.8 mm respectively, compared with 8.8mm and 16.4 mm in 2011 and 0 mm and 12.4 mm in 2012).	Therefore no new or additional impacts to subterranean fauna are expected to result from implementation of this Proposal. • None of the recorded taxa that may represent SRE species are considered likely to be restricted to the B4 area, and the majority of records of each of these taxa were collected from outside of the Project Boundary. Appropriate management measures to avoid, minimise and mitigate potential impacts of the Proposal on fauna will be implemented (and where applicable, have been implemented during Proposal design and operation of the B4 Operation to date).

10 OTHER CHANGES TO SCHEDULE 1 OF MINISTERIAL STATEMENT 717

This Section provides details of requested changes to Schedule 1 of MS 717 for inclusion in the proposed new Statement that are not considered to warrant impact assessment.

10.1 WASTE DUMP OPTIMISATION

In line with B4 Operation and Closure commitments, the Life of Mine Schedule has incorporated in-pit dumping to ensure that below water table pits are backfilled to at least 2 m above the pre-mining water table at closure. However, timely access to pit voids to allow the commencement of backfilling activities will not be possible before 2018. In addition, areas with potential future low grade cutbacks cannot be backfilled as it would result in a loss of this low grade ore resource to backfill material and compromise the potential value from future processing.

It is against this background that the Proponent seeks the following waste dump optimisation:

- removal of the waste dump height and waste rock limits to allow flexibility in handling of waste rock and low grade ore whilst maintaining the backfill schedule; and
- an increase in waste dump capacity and clearing of native vegetation.

10.1.1 Waste Dump Height Limit

The height of a waste dump is constrained by a combination of its approved footprint limit, maximum waste rock capacity and the batter slopes required for long term stability. The latter is determined by the material properties of the waste rock. The final height is determined by the final landform design requirements, although changes in operational height may be required during the life of the mine in order to maximise flexibility in handling of waste rock and low grade material.

Any increases in waste dump height will be managed in accordance with the Proponent's Landform Design Guidelines (RTIO-HSE-0015708) and the Proponent's D3 Standard– Management of pit slopes, stockpiles, spoil and waste dumps. Additional lift heights will be 20 m, with operational angles of approximately 37 degrees (angle of repose). Final rehabilitation angles of 18 degrees will be required, based on the material types and quantities expected in the dumps. The Brockman 4 Closure Plan is currently being updated (scheduled to be submitted to Government in Quarter 1 2015 in accordance with MS 717 Condition 10.2) and will provide further detail on each of the waste dumps (including material type and volume) and their associated rehabilitation criteria.

10.1.2 Waste Dump Capacity

The Proponent considers that the above mentioned flexibility regarding the height of waste dumps will provide a temporal buffer to the availability of relevant pit voids for backfilling and reduce the post-closure footprint that would otherwise be required for the B4 Operation. However, additional waste dumps are required to cater for waste rock handling from the eastern pits (Pit 18, 11, 12 and 17).

New waste dumps will be built with the same configuration as the existing waste dumps and will require capacity to manage an expected increase in waste rock generated from 420 Mt to approximately 620 Mt. The Proponent considers that the volume of waste rock generated is not

environmentally significant beyond the clearing footprint and ability to backfill voids to avoid pit lakes. As constraints are proposed for both of these aspects, the Proponent proposes that the waste volume be removed from Schedule 1.

10.1.3 Mineral Waste Characteristics

The majority of waste material at B4 is competent rocky material (over 80 percent of waste comprises Joffre, Dales Gorge and Hydrated Zone material).

Pits 1, 2, 3 and 5 have been identified as containing potentially acid forming material (**PAF**); however it is a relatively small amount of material (2.1 Mt) which, based on the current B4 mine plan, is scheduled to be intercepted by mining in 2015. This material will be placed in an out of pit dump on Rocklea Station as no pit void will be available for use at the predicted time of interception.

The PAF material will be managed (encapsulated) during operations in accordance with the Mineral Waste Management Plan (**WMP**) and the Spontaneous Combustion and Acid Rock Drainage (**SCARD**) Management Plan for the B4 Operation (SCARD and WMP are provided in Appendix 10 and Appendix 11). PAF material will remain encapsulated at closure.

10.2 CHANGES TO KEY CHARACTERISTICS OF MS 717

The Proponent requires the following changes to the Key Proposal Characteristics as currently specified in MS 717:

- *Removal of GHG emissions limit* - the Proponent considers that Greenhouse Gas Emissions (**GHG**) is not environmentally significant for the B4 Project. In Bulletin 1214 the EPA considered that GHG was not considered a relevant environmental factor that required evaluation. In addition, this factor is adequately managed under Commonwealth legislation. Therefore, this Proposal seeks the removal of this limit from the Key Proposal Characteristics.
- *Removal of stripping ratio* - the Proponent requires the flexibility to mine its resources within an approved area and to meet changes in technology and economic situations. As such, the specification of a stripping ratio should be removed from the Key Proposal Characteristics as this aspect can be managed under more relevant environmental restrictions (i.e. the overall clearing limit).
- *Removal of waste dump height restriction* – the Proponent considers that the operational height of a waste dump is constrained by a combination of the available clearing limit, the maximum waste rock capacity, and batter slopes required for long term stability of the waste dump. Similarly, the Proponent considers that the final height of a waste dump will be determined by the final landform design as part of the mine closure planning. The absence of no sensitive receptors in the surrounding area removes the need to consider visual amenity as a factor. The Proponent therefore proposes the removal of the specific height limits to waste dumps at B4.
- *Removal of water supply limit* - the Proponent considers that the water supply limits stated in the Key Proposal Characteristics can be removed as this aspect can be managed under the *Rights in Water and Irrigation Act 1914* (**RIWI Act**).
- *Removal of specific locations of plant, administration, workshops and stockpiles location* – the Proponent considers that the flexibility in defining the layout of a project afforded by EAG1,

through the provision of a Development Envelope and a limit on disturbance of vegetation, removes the need to specify infrastructure locations in Schedule 1 beyond the standard project layout figure.

- *Removal of restriction to accommodation and workforce numbers* - the Proponent requires the flexibility to staff the mine site to meet requirements associated with changes in technology, safety, environment and other activities associated with mining and as such, requests that the specification of workforce numbers and accommodation be removed from the Key Proposal Characteristics as there is no environment impact associated with this aspect.

This Proposal includes removal of the production rate from Schedule 1 of MS 717 on the basis that production rate in itself does not result in environmental impacts and is instead limited by clearing, water abstraction and water discharge for which limits are expected to be prescribed in Schedule 1.

These proposed changes to the Key Proposal Characteristics of MS 717 are summarised in Table 10-1. The proposed Schedule 1 has been prepared in accordance with the requirements of EAG1 and is presented in Section 3.1.

Table 10-1: Proposed Changes to the Key Characteristics (MS 717)

Element	Approved Description	Proposed Change
Area of disturbance	Approximately 2,610 ha.	*Increase limit:* Clearing of no more than 3,560 ha within the 20,046 ha Development Envelope, comprising: No more than 2,160 ha in Area 1 No more than 1,400 ha in Area 2
Waste rock	420 Mt (approx. 150 Mt will be used to backfill pits).	*Remove limit on quantity of waste:* Mine pits are to be backfilled at closure so that the final surface levels are at a higher elevation than the pre-mining groundwater level to prevent the formation of pit lakes.
Greenhouse Gas Emissions	5.59 kg CO_{2e} per tonne of production per annum.	*Remove*
Stripping ratio	Ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average 1.2:1).	*Remove*
Waste dumps, high and low grade stockpiles – location and height	Original site as shown in Figure 2 of Attachment 1 of MS 717 and a stockpile area adjacent to rail loop as shown in Figure 5 of attachment 2 in MS 717. Height of waste dumps to be total height of 50m.	*Remove specified location; location to be within Proposed B4 Development Envelope (Area 1).* *Remove limit on waste dump height.*

Element	Approved Description	Proposed Change
Dewatering	Supplied from the Orebody and Wittenoom Dolomite aquifers. Alternative borefield as an additional source via pipeline along infrastructure corridor. 4.38 GL/annum (dust management) plus additional 0.15 GL/annum for the mine camp.	Groundwater abstraction of not more than 6.4 GL/annum. *Remove source and specific limits required for each of operations and mine camp.*
Plant, administration, workshops and stockpiles location	Original site as shown in Figure 2 of Attachment 1 of MS 717 and a stockpile area adjacent to rail loop as shown in Figure 5 of Attachment 2 in MS 717.	*Remove*
Construction operation workforce	Peak of 700 300 (plus approximately 40 during periodic shutdown maintenance periods)	*Remove*
Accommodation	- Construction village capacity 1570 rooms - Operational village capacity 570 rooms	*Remove*

11 OTHER ENVIRONMENTAL IMPACTS AND MANAGEMENT

11.1 ENVIRONMENTAL IMPACTS AND MANAGEMENT

In accordance with the EPA Prepared Scoping Guideline for this proposal (Appendix 3), the preliminary key environmental factors relating to this Proposal are:

- Hydrological Processes;
- Flora and Vegetation; and
- Terrestrial Fauna.

Environmental impacts and management of these environmental factors are addressed in a series of Tables (Table 7-1 and Table 9-4).

The Proponent considers that the following factors will not result in any significant change in addition to or different from that originally assessed and approved under MS 717:

- rehabilitation and closure;
- heritage;
- air quality;
- visual amenity; and
- cumulative impacts.

The assessment of impacts and management of these factors is presented below within this Section.

Residual risk and management is addressed in Section 11.

11.2 ENVIRONMENTAL MANAGEMENT SYSTEM OVERVIEW

The Proponent has developed and refined environmental management objectives, systems and procedures over decades of operational mining experience in the Pilbara region that are successfully applied at multiple iron ore mine sites.

The key components to be implemented for this Proposal include:

1. The Rio Tinto Iron Ore Group Health, Safety, Environment, Communities and Quality Policy (**HSECQ Policy**). The HSECQ Policy is the guiding document for environmental management and provides context and direction for continuous improvement.
2. Rio Tinto Iron Ore (WA) operates under an Environmental Management System (**EMS**), contained within the HSEQ Management System. The HSEQ Management System is a continuous improvement model covering:
    - systematic assessment of environmental risk and legal requirements; systems for training, operational control, communication, emergency response and corrective actions;
    - the development of objectives and targets for improvements; and

- audits and review.

3. Monitoring and management plans applicable to the Revised Proposal that will interface with the HSEQ Management System.

4. The Rio Tinto Closure Standard will continue to guide closure planning for the Revised Proposal including this Proposal. This standard governs:

    - commencement of planning for closure prior to project commencement;
    - the development and content of closure plans;
    - stakeholder consultation regarding closure;
    - financial provisioning for closure;
    - the review of closure plans; and
    - the development of Decommissioning Plans five years prior to scheduled closure.

As discussed previously the key environmental factors of the Revised Proposal are Hydrological Processes: Surface Water (refer to Section 7); Flora and Vegetation (Section 8) and Terrestrial Fauna (Section 9); Rehabilitation and Closure; and Residual Risk and Management. The assessment of potential impacts associated with Rehabilitation and Closure Management are provided in Table 11-1.

Table 11-2 outlines environmental factors that were not considered in this Proposal as they will not result in any significant change in addition to or different from that originally assessed and approved under MS 717.

Table 11-1: Rehabilitation and Closure: Description of Factor, Impact Assessment and Management

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
To ensure that premises can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.	**Mineral waste physical characteristics** The majority of waste material at B4 is competent rocky material (over 80 percent of waste in Dumps DP2 and DP4 comprises Joffre, Dales Gorge and Hydrated Zone material). Appropriate rehabilitation design criteria of 20 m lifts, 18 degree slopes and 10 m berms will be implemented for waste dumps on site. This will be further detailed in the update to the Brockman 4 Closure Plan[8]. **Mineral waste geochemical characteristics** Several pits at B4 (Pit 1, 2, 3 and 5) have been identified as containing PAF; however it is predicted to be a relatively small amount of material (2.1 Mt). This material is scheduled to be intercepted by mining in 2015 based on the current mine plan. Dump DP2 has been designated as the storage location of this material as no pit void is available for use at the time the material is intercepted. PAF material will be managed (encapsulated) during operations in accordance with the Mineral Waste	**Waste dumps** The additional waste dumps and changes to existing waste dumps is considered unlikely to have significant additional environment impact to that assessed in the original B4 Project PER. This is based on the following consideration: • Waste dump designs will consider the physical and chemical properties of waste material. • A substantial volume of competent waste is available, enabling design/construction of waste dumps that are stable and not susceptible to excessive erosion. • A substantial volume of inert waste material is available, enabling design/construction of waste dumps that encapsulate the lower volumes of waste rock that poses a potential Acid Mine Drainage (**AMD**) risk.	• The Rio Tinto Iron Ore (WA) Landform Design Guidelines will continue to be implemented to ensure waste dumps at B4 are safe and stable during operations and at closure. • The Rio Tinto Iron Ore (WA) Mineral Waste Management Plan and the SCARD Management Plan will continue to be implemented, to ensure waste material is adequately geochemically characterised (via static testing, and kinetic testing where warranted) during B4 Operation, and PAF material that poses an AMD risk is appropriately managed. • The Rio Tinto Iron Ore (WA) Soil Resource Management Work Practice will continue to be implemented to manage recovery and storage of topsoil and subsoil resources. • Planning for closure will continue to be undertaken throughout the operation of B4. The first Closure Plan for B4 was developed in 2007 (RTIO-HSE-0063820). The site is subject to MS 717 Condition 10.2 which requires submission of a revised Closure Plan within 5 years of mine commissioning. As mining commenced in 2010, the Brockman 4 Closure Plan is due for submission in 2015.

[8] Condition 10.2 of MS717 requires submission of a revised closure plan in 2015. The revised Brockman 4 Closure Plan (ref. RTIO-HSE-0205402) is scheduled for submission to OEPA during 2014.

EPA Objective	Existing Environment	Potential Impact (without mitigation)	Management and Outcome
	Management Plan (**WMP**) and the Spontaneous Combustion and Acid Rock Drainage (**SCARD**) Management Plan for the B4 Operation. PAF will remain encapsulated at closure. The SCARD and WMP are provided in Appendix 10 and Appendix 11 respectively.		Work commenced in 2013 on review and update of this plan and the plan is scheduled for submission to OEPA in 2014. In terms of this Proposal, this revised Closure Plan will address waste dump rehabilitation design, progressive rehabilitation and the management of PAF material. **Outcome** The Revised Proposal can be managed to meet the EPA objectives for this factor, in summary: • Mineral waste dumps are unlikely to have significant environmental impacts, based on analysis of mineral waste volumes, and physical and chemical properties, which indicates the majority of mineral waste is relatively benign and only a very small amount of PAF material (2.1Mt) is expected. • A Closure Plan for the B4 Operation was prepared in 2007 and submitted with the original proposal. This Plan provides appropriate management measures regarding closure and rehabilitation and is currently being reviewed in accordance with MS 717 Condition 10.2.

Table 11-2: Factors Considered Not Relevant to this Proposal

Factor	EPA Objective	Description of Factor	Impacts – no management	Existing Management and Mitigation Measures
Heritage	To ensure that historical and cultural associations are not adversely affected.	B4 is located within the traditional lands of the Eastern Guruma people and the PKKP people. Discharge into Boolgeeda Creek is not expected to impact heritage sites or the heritage values of the place, as water will be restricted within the current creek banks, which have already been disturbed by natural flows. The additional clearing for waste dump optimisation will only be undertaken following heritage surveys and any s18's if required.	Surveys undertaken to date indicate the Proposal is unlikely to have significant impact on Aboriginal heritage, in addition to or different from the B4 Operation: • No ethnographic sites have been identified to date within the Development Envelope. • Some archaeological sites identified to date may be impacted by the Revised Proposal; however, these sites are of low to moderate significance. • Additional clearing required for waste dump optimisation is likely to result in the loss of several heritage sites. If sites cannot otherwise be avoided, the impacts will be managed in accordance with the *Aboriginal Heritage Act 1972* (**AHA**) Section 18, and in consultation with Traditional Owners.	Heritage values will be addressed during planning and implementation of the Proposal, in accordance with existing B4 Operation management plans, by: • Avoiding disturbance to heritage sites where practical. • Obtaining approval for any required disturbance to identified sites in accordance with s18 of the AHA and in consultation with the Eastern Guruma or PKKP people as applicable. • Protecting all identified sites located near construction or operational areas that are not approved to be disturbed under s18 of the AHA (e.g. through the installation of physical barriers and buffer zones). • Documenting the location of all protected sites in the Proponent's Geographic Information System (**GIS**) database and on site plans, and designating buffer zones around these sites.
Air Quality (Dust, Noise and Vibration and Greenhouse Gas Emissions)	To maintain air quality for the protection of the environment and human health and amenity.	The Revised Proposal will generate dust, noise, vibration and GHG emissions.	The potential impacts to air quality are not considered to be different from, or in addition to, the approved activities and impacts for the B4 Operation.	The generation of noise, dust, GHG and vibration from the Revised Proposal will continue to be managed in accordance with existing B4 Operation EMP.

Factor	EPA Objective	Description of Factor	Impacts – no management	Existing Management and Mitigation Measures
Amenity (Visual)	To ensure that impacts to amenity are reduced as low as reasonably practicable.	The visual landscape of the Pilbara is generally characterised by rugged ridges and ranges supporting spinifex grasslands, with land uses generally comprising pastoralism and mining infrastructure. The visual character of the landscape in the broader area around the Revised Proposal is predominantly natural in appearance, with localised areas of highly modified landscapes due to multiple mining developments (e.g. Brockman 4, Brockman 2 and Nammuldi-Silvergrass).	In general, visual impact of the Proposal from public roads and publicly accessible viewpoints is not expected to be different or additional to that of the existing B4 Project, in consideration of the following : • The Revised Proposal is a small extension to the existing B4 operation. • The Revised Proposal is not overlooked by or adjacent to populated or sensitive areas such as scenic outlooks, settlements or National Parks. • Access to the Revised Proposal area is via a sealed road and can only be approached from the south via the White Quartz Road. • There are no known plans for future tourism ventures in the immediate vicinity.	Visual amenity will continue to be managed in accordance with existing B4 Operation management plans by: • Undertaking waste dump design in accordance with the Rio Tinto Iron Ore (WA) Landform Design Guidelines and with consideration of closure objectives for the Proposal, to achieve final landforms that are considered aesthetically compatible with the surrounding landscape. • Rehabilitating waste dumps with native vegetation. • Rehabilitating any long-term low grade stockpiles that remain in-situ at mine closure with native vegetation (as per waste dumps). • Removing infrastructure (other than pits and dumps not used for backfilling) at closure and rehabilitate remaining disturbed areas with native vegetation.

12 CUMULATIVE IMPACTS

Cumulative impacts can arise where operation level impacts act synergistically, cause indirect impacts or combine to exacerbate impacts spatially and/or through time. In the case of Pilbara mining projects, a principal concern is the potential for multiple mining projects to incrementally diminish and degrade environmental values that would otherwise not be significantly affected by each project in isolation.

The Proponent's knowledge of current and potential mining projects in the region, in addition to the Revised Proposal, is limited to its own projects as follows:

- **Duck Creek/Boolgeeda Creek catchment**
  - Brockman 2 Detrital Iron Ore Mine (MS 131 and MS 867);
  - Nammuldi operation (MS 925); and
  - Brockman Syncline 4 Marra Mambas (potential).
- **Beasley River catchment**
  - Western Turner Syncline Stage 2 Project (MS 946); and
  - Beasley River Limonites CID Project (potential).

Given its distance from the nearest existing operations, absence of unique or unusual ecological features, and the relatively small scale of clearing and surplus water discharge proposed, the Proponent does not consider that the Revised Proposal will contribute to significant cumulative impacts. An assessment of the potential for cumulative impacts in relation to this proposal is summarised in Table 12-1.

Table 12-1 Assessment of potential for cumulative impacts

Possible cumulative impact	Description and assessment of significance
Disturbance to landforms	The Development Envelope does not include landforms with elevated conservation significance or other special interest. Whilst existing and potential future operations may affect the same land systems, all of the land systems mapped as occurring in the Development Envelope are widely distributed across the Pilbara. No significant cumulative impacts are predicted.
Disturbance to Hydrological Processes	The Revised Proposal involves the discharge of surplus water to the nearby Boolgeeda Creek. Nearby WTS Stage 2 discharges water to the Beasley River, with a potential wetting front of up to 20 km in length and the Nammuldi-Silvergrass Expansion is authorised to discharge surplus water into Duck Creek periodically. The modelled wetting front for this discharge (under steady state conditions at discharge of up to 200 ML/d) is 157 km. Boolgeeda Creek has been selected as the receiving water body for surplus water from the Revised Proposal, in part to avoid the potential for cumulative impacts to occur within Duck Creek and Beasley River as a result of discharge from multiple operations. The predicted maximum wetting front for a peak discharge rate of 17.5 ML/day is 37 km representing approximately 35% of the Boolgeeda Creek.

Possible cumulative impact	Description and assessment of significance
	The potential for future operations locally (Beasley River Limonites CID and BS4 Marra Mambas) to include dewatering and surplus water management has not been quantified, however any additional surplus water volume generated as a result of these developments would need to be disposed of or used. Any discharge would have the capacity to contribute to cumulative impacts in the local catchment.
Disturbance to vegetation and significant flora	The proposed additional clearing is centred around the existing B4 Operation, which is at least 22 km from the nearest operation at Brockman 2/Nammuldi. All vegetation units and Priority Flora species that will be disturbed by this proposal are represented elsewhere within and/or outside of the Development Envelope. The proposed clearing is not considered to contribute to cumulative impacts on flora and vegetation.
Disturbance to habitat for significant fauna species	The habitat types within the project area are well represented in the Pilbara bioregion. These habitats do not have regional significance for rare and endangered fauna species; The proposed additional clearing is not considered to contribute to cumulative impacts on flora and vegetation. No significant cumulative impacts to habitat for significant fauna species are predicted.

13 RESIDUAL IMPACTS

13.1 DETERMINATION OF CRITICAL AND HIGH VALUE ASSETS

EPA Position Statement No. 9: Environmental Offsets (EPA 2006a) and EPA Guidance Statement No. 19: Environmental Offsets (EPA 2008a) provide guidance to proponents on the approach needed to determine offset requirements for proposals. The environmental aspects of the Revised Proposal have been assessed for their potential value as critical or high value assets as per the definitions and additional criteria presented in these policy documents. Environmental aspects meeting the requirements for either category have been included in the determination of appropriate offsets Table 13-1.

The definitions of critical and high value assets in EPA Position Statement No. 9: Environmental Offsets are as follows:

> *Critical Assets: represent the State's most important environmental assets that must be fully protected and conserved. Significant adverse impacts to these assets should be avoided at all costs. Therefore, the EPA in providing its advice will adopt a presumption against approval of project proposals where significant adverse impacts affect 'critical assets'. However, where projects have been approved by the State Government approval should be conditional on the:*
>
> - *consideration or demonstration (to the maximum extent possible) of onsite impact mitigation; and*
> - *development and implementation of an acceptable offsets package for significant, residual adverse impacts.*
>
> *High Value Assets: represents those environmental assets that are in good to excellent condition, and are considered valuable by the community and / or government but are not identified as 'critical assets'. Project proposals and offset activities for these assets may be referred to and assessed by the EPA on a case-by-case basis, but are otherwise considered by relevant environmental government agencies.*

In order to determine which vegetation communities or fauna habitats within the Development Envelope are 'high value' assets, their condition and value to community and / or government was considered.

As described in Section 8 the Development Envelope does not contain any assets considered of value to the government as it does not lie within a State or Commonwealth Government reserve or protected area. Vegetation mapping for the Development Envelope has been completed and does not indicate the presence of any vegetation types that qualify for specific legislative protection (i.e. TECs). Similarly, no PECs have been identified within the Development Envelope.

Vegetation communities mapped within the Development Envelope were generally found to be in Good to Excellent condition as per the Keighery Condition Scale despite the evidence of **Cenchrus ciliaris* invasion along creek beds and surrounding floodplains.

The majority of vegetation communities recorded in the Development Envelope is well represented across the Pilbara region. Whilst some occurrences of Priority Listed Species (flora and fauna) have been recorded within the Development Envelope, none of these were found to be restricted to the Development Envelope and therefore have not been individually classified as 'high value assets'.

13.2 OFFSET REQUIREMENTS FOR THE REVISED PROPOSAL

The EPA's objective for environmental offsets is to counterbalance any significant residual environmental impacts or uncertainty through the application of offsets. The requirement for offsets is considered in Table 13-1.

MS 717 covering the B4 Operation does not specify the need for an offset.

Table 13-1: Environmental Offsets Reporting Form

Section A: Administrative information
1. Proposal or scheme name: Brockman Syncline 4 – Revised Proposal
2. Summary of proposal or scheme: The Proponent, Hamersley Iron Pty Limited (a wholly owned subsidiary of Rio Tinto Iron Ore [Rio Tinto]), revise the existing Brockman Syncline 4 Operation with a resulting increase of 950 ha in clearing of native vegetation and the requirement to discharge surplus dewater to Boolgeeda Creek.
Section B: Type of environmental asset (s) – State whether Critical or High Value, describe the environmental values and attributes
No 'Critical' environmental assets are located within the Development Envelope. Environmental assets that are present within the Development Envelope that could be considered 'High Value' environmental assets defined in EPA Position Statement No. 9: Environmental Offsets (EPA 2006a) include two vegetation units that are considered to be of High Conservation Significance in the region: • **P11 - *Acacia synchronicia* scattered shrubs over *Triodia angusta* hummock grassland**. This vegetation type did not belong to a restricted floristic group, but was the main associated vegetation type for a significant sized population of the Priority 3 species *Ptilotus subspinescens*. This vegetation type occurs extensively outside the immediate mining area and on similar substrates along White Quartz Road (Michi Maier, Biota Environmental Sciences, pers. obs.), however is considered unlikely to be well represented in the Hamersley subregion. (Recorded Biota 2005a) • **EcAciMgCv - *Eucalyptus camaldulensis var. obtusa open forest over Acacia citrinoviridis, Melaleuca glomerata tall open scrub over Cyperus vaginatus very open sedgeland*** Recorded from two creeklines that are crossed by White Quartz Road and extend beyond the Development Envelope. This proposal does not involve clearing of this vegetation unit. (Recorded Biota 2007b) In addition a total of 39 vegetation types that are considered to be of Moderate Significance occur within the Development Envelope (Table 8-4).
Section C: Significant impacts (describe the significant adverse environmental impacts related to the proposal or scheme before mitigation measures are applied)
Potential significant impacts on high value environmental assets from the Revised Proposal are: • Discharging surplus water to Boolgeeda Creek Duck Creek may elevate the water table locally and provide a more constant flow regime in the short term. This may in turn change the composition of creek vegetation communities. • Clearing of up to 950 ha of vegetation including vegetation communities of local conservation significance (High and Moderate significance). • Clearing of vegetation may reduce a small proportion of locally available habitat for Priority Flora species and potentially disturb individual occurrences of Priority Flora species. • Clearing of vegetation may directly disturb fauna habitat and will result in the displacement of fauna and the loss of individuals of some terrestrial fauna species.

Section D: Mitigation measures (describe all measures to Avoid, Minimise, Rectify and Reduce)

Mitigation measures to reduce impacts on environmental assets as a result of the Revised Proposal include:

Minimise:

- Minimise clearing as far as practicable.
- Preferentially locate infrastructure in previously disturbed areas to minimise clearing of undisturbed native vegetation and to prevent loss of potential fauna and Priority Flora habitat.
- Design creek realignment to protect upstream and downstream channel and water quality.

Rectify and Reduce:

- Monitor creek ecosystems during discharge and compare against baseline data.
- Undertake progressive rehabilitation of riparian vegetation where monitoring indicates significant changes in riparian vegetation condition during project operation.
- If, at cessation of discharge, riparian vegetation differs significantly from baseline (pre-impact) riparian vegetation condition, rehabilitation actions will be undertaken to restore (as far as practicable) riparian vegetation to baseline (pre-impact) condition.
- Rehabilitate areas disturbed (excluding pit voids) following decommissioning, meeting final land use criteria specified in the Closure Plan.
- Clearing vegetation in a deliberately outward manner that allows for the progressive movement of fauna into areas beyond the disturbance footprint.
- Implement the Discharge Monitoring and Management Plan that includes monitoring and adaptive management measures as well as contingency measures to ensure that discharge does not have an adverse effect on the water quality of Boolgeeda Creek.

Section E: Significant residual impacts (describe all the significant adverse residual impacts that remain after all mitigation attempts have been exhausted)

The Revised Proposal will not result in any significant residual impacts to any 'Critical' environmental assets within the Development Envelope.

Following the implementation of all mitigation measures the Revised Proposal will not result in any significant residual impacts to 'High Value' assets within the Development Envelope.

Section F: Proposed offsets for each significant residual impact (identify direct and contributing offsets).

The Proponent considers that no offset is required as no significant residual impact will occur as a result of implementation of the Revised Proposal.

Section G: Spatial data relating to offset site/s (see *EPA Guidance Statement No. 19: environmental offsets- biodiversity*, Appendix 4)

Not Applicable

Section H: Relevant data sources and evidence of consultation

Not Applicable.

14 OTHER LEGISLATION AND APPROVALS

Other legislation applicable to regulation of the potential environmental impacts of the Revised Proposal, and approvals required, are outlined in Table 14-1. The Proponent will comply with all relevant legislation (including obtaining specific approvals where required) prior to, and during implementation of the Revised Proposal.

Table 14-1: Other Legislation and Approvals

Environmental factor	Secondary Approval	Responsible Agency	Statute
Flora and Vegetation	Licence to take rare flora.	DPaW	*Wildlife Conservation Act 1950*
Fauna	Licence to take protected fauna.	DPaW	
Water quality and quantity	Licence to operate	DER	*Environmental Protection Act 1986*
Interference with watercourses	26D Permit to obstruct or interfere with bed/banks.	DoW	*Rights in Water and Irrigation Act 1914*
Groundwater abstraction	5C Licence to construct or alter wells. Licence to take groundwater/amendment to existing groundwater licences.	DoW	
Rehabilitation and closure	Mining proposal and mine Closure Plan – for infrastructure on Mining Act tenure.	DMP	*Mining Act 1978*
Heritage	S18	DAA	*Aboriginal Heritage Act 1972*

15 PRINCIPLES OF ENVIRONMENTAL PROTECTION AND EIA

This section describes how the objectives of the EP Act and the principles of EIA have been addressed and how the Proposal meets the criteria for an API (Category A) assessment as described in the 2012 Administrative Procedures.

15.1 PRINCIPLES OF ENVIRONMENTAL PROTECTION

The objective of the EP Act is to protect the environment of the State, having regard to five principles. These principles have been considered in the EIA for the Proposal and are summarised in Table 15-1 below.

Table 15-1: Principles of Environmental Protection

Principle	Consideration Given in Proposal
1. Precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: • Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment. • An assessment of the risk-weighted consequences of various options.	During the Revised Proposal planning and design phase, the Proponent undertook comprehensive baseline studies, investigations and modelling of aspects of the Revised Proposal that may affect the surrounding environment. Where significant environmental impacts were identified, measures have been, and will continue to be, incorporated into Revised Proposal design and management to avoid or minimise predicted impacts.
2. Intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The Rio Tinto Iron Ore HSEQ Policy incorporates the principle of sustainable development and includes the following commitments: • Prioritising research and implementation programs through technology to reduce impacts to land, enhancing our contribution to biodiversity and improving our efficiency in water and energy use. • Identifying climate change improvement solutions through dedicated optimisation work programs. • Contributing to the health and well-being of local communities.

Principle	Consideration Given in Proposal
3. Conservation of biological diversity and ecological integrity. Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Biological investigations are undertaken by the Proponent during the Revised Proposal planning process to identify aspects of the environment that are of conservation significance. Where significant potential environmental impacts are identified, measures have been, and will continue to be, incorporated into Proposal design and management to avoid or minimise these impacts where practical. The Rio Tinto HSEQ Management System has well established rehabilitation procedures for restoring disturbed environments.
4. Improved valuation, pricing and incentive mechanisms • Environmental factors should be included in the valuation of assets and services. • The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. • The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. • Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	Environmental factors have been considered during the Revised Proposal planning phase, and will continue to be considered during the operational and closure phases of the Proposal. Proposal planning, design and operational management will continue to investigate and implement opportunities to reduce impact to land, and improve efficiency in water and energy use, in accordance with the Rio Tinto Iron Ore Group HSEQ Policy.
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	All reasonable and practicable measures are taken to minimise the generation of waste and its discharge into the environment through the existing B4 Operation EMP and procedures.

15.2 PRINCIPLES OF EIA FOR THE PROPONENT

Table 15-2 outlines the principles of EIA as described in clause 5 of the 2012 Administrative Procedures.

Table 15-2: Principles of EIA for the Proponent

The principles of EIA for the Proponent		Discussed in the Document
1.	Consult with all stakeholders, including the EPA, DMAs, other relevant government agencies and the local community as early as possible in the planning of their proposal, during the environmental review and assessment of their proposal, and where necessary during the life of the project.	Table 5-1 details the stakeholder consultation undertaken to date. This consultation includes the OEPA, relevant DMAs, Traditional Owners and Pastoral Station managers. the Proponent will continue to consult with relevant stakeholders during the environmental approval process, and during implementation of the Revised Proposal.

The principles of EIA for the Proponent		Discussed in the Document
2.	Ensure the public is provided with sufficient information relevant to the EIA of a proposal to be able to make informed comment, prior to the EPA completing the assessment report.	Table 7-1, Table 8-6, Table 9-4 and Table 11-1 provide an EIA of the Revised Proposal, for the preliminary key environmental factors identified by the EPA, based on: • a summary of the key findings of studies and investigations (full reports provided as appendices, where relevant); • assessment of potential impacts of the Proposal; • key environmental management measures. Table 11-2 provides a brief EIA of the Proposal for other environmental factors.
3.	Use best practicable measures and genuine evaluation of options or alternatives in locating, planning and designing their proposal to mitigate detrimental environmental impacts and to facilitate positive environmental outcomes and a continuous improvement approach to environmental management.	Avoiding and minimising impacts to the environment where practical is a key management commitment for the Proposal, and has been implemented during Proposal design. For example, modification of the B4 Development Envelope since referral has been undertaken, to exclude extensive areas of vegetation of elevated conservation significance, and several occurrences of a Priority 1 flora species. As detailed in Section 11.1, continuous improvement is a key aspect of the Rio Tinto Iron Ore (WA) HSEQ Management System.
4.	Identify the environmental factors likely to be impacted and the aspects likely to cause impacts in the early stages of planning for their proposal. The onus is on the proponent through the EIA process to demonstrate that the unavoidable impacts will meet the EPA objectives for environmental factors and therefore their proposal is environmentally acceptable.	Section 3.2, Section 6, Section 7, Section 8, and Section 9 identify the preliminary key environmental factors relevant to the Proposal, potential impacts, key management measures, and how the EPA objectives relevant to each environmental factor can be met by the Revised Proposal. Table 11-2 provides a brief EIA of the Revised Proposal for other environmental factors.
5.	Consider the following, during project planning and discussions with the EPA, regarding the form, content and timing of their environmental review: a. The activities, investigations (and consequent authorisations) required to undertake the environmental review. b. The efficacy of the investigations to produce sound scientific baseline data about the receiving environment. c. The documentation and reporting of investigations. d. The likely timeframes in which to complete the environmental review; e. Use best endeavours to meet assessment timelines.	The form and content of the environmental review has incorporated advice provided by the OEPA in several meetings, and addressed OEPA comment on drafts of the environmental review. Comprehensive studies and investigations, of high standard, have been undertaken to support the environmental review, and are provided as appendices. Proposal planning has considered the expected timeframes for completion of supporting studies, environmental review preparation and assessment, and timings for key milestones are regularly discussed with the OEPA.

The principles of EIA for the Proponent		Discussed in the Document
6.	Identify in their environmental review, subject to EPA guidance: a. Best practicable measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment. b. Responsible corporate environmental policies, strategies and management practices, which demonstrate how the proposal can be implemented to meet the EPA environmental objectives for environmental factors.	Table 8-6, Table 9-4 and Table 11-1 identify key management measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment. These tables also provide an assessment of how the Proposal meets EPA environmental objectives for relevant environmental factors, based on implementation of key management practices, and corporate environmental policies and strategies.

15.3 CRITERIA FOR API CATEGORY A

Clause 10.1.1 in the 2012 Administrative Procedures states that the OEPA applies an API A level of assessment where the proponent has provided sufficient information about the proposal, its environmental impacts, proposed management, and it appears that the proposal is consistent with Category A criteria. Consistency of the Proposal with these criteria is addressed in Table 15-3.

Table 15-3: Criteria for API Category A

Category A Criteria	Discussion
The proposal raises a limited number of key environmental factors that can be readily managed and for which there is an established condition-setting framework.	The Proposal raises preliminary key environmental factors which are assessed within this ER. These factors are typical of iron ore mining in the Pilbara and can be readily managed under the existing B4 Operation EMP and other regulatory approvals. Numerous operating iron ore mines in the region subject to Ministerial Conditions provide appropriate precedents for assessment and condition-setting.
The proposal is consistent with established environmental policies, guidelines and standards.	The Proposal is consistent with established environmental policies, guidelines and standards, as set out Table 8-6 and Table 9-4.
The proponent can demonstrate that it has conducted appropriate and effective stakeholder consultation, in particular with DMAs.	Section 5 details the stakeholder consultation that has been undertaken to date, issues raised, and Proponent response to issues raised. This consultation included the OEPA and other DMAs.
There is limited or local concern only about the likely effect of the proposal, if implemented, on the environment.	Stakeholder consultation has been undertaken to date; the majority of stakeholders have not raised any major concerns with the Proposal (refer to Section 4). The key issued raised, by downstream pastoral station managers, include concern over the assessment and selection of surplus water management options and the potential impacts that may result from discharge to Boolgeeda Creek. In particular the potential for feral herbivores to be attracted to discharge waters, the loss of biodiversity within the creekline and reduction in vegetation condition.

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APPENDICES

The following supporting documents are contained on CD_ROM inside the back cover of this API Environmental Review Document.

Appendix 1 S38 Referral Form

Appendix 2 Ministerial Statement 717

Appendix 3 EPA Prepared Scoping Guideline (27 May 2014)

Appendix 4 Proposed Environmental Conditions for Revised Proposal

Appendix 5 Modelled Scenario for Boolgeeda Creek Discharge

Appendix 6 Discharge Monitoring and Management Plan (3 July 2014)

Appendix 7 Key Flora and Vegetation Studies:

Biota Environmental Sciences (Biota) 2005a, A Vegetation and Flora Survey of the Brockman Syncline 4 Project Area, near Tom Price

Biota Environmental Sciences (Biota) 2007b, A Vegetation and Flora Survey of the White Quartz Road Corridor near Tom Price

Biota Environmental Sciences (Biota) 2009a, A Vegetation and Flora Survey of Beasley River

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Biota Environmental Sciences (Biota) 2013d, Marra Mamba West (AR-13-11158) Native Vegetation Clearing Permit Report

Appendix 8 Vegetation types and Fauna Habitats to be disturbed

Appendix 9 Key Fauna Studies:

Biota Environmental Sciences (Biota) 2005b, Fauna Habitats and Fauna Assemblage of the B4 Project, near Tom Price

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Biota Environmental Sciences (2013c), Brockman Syncline 4 Marra Mamba - Targeted Fauna Survey.

Appendix 10 Brockman Syncline 4 Spontaneous Combustion and ARD (SCARD) Management Plan

Appendix 11 Mineral Waste Management Plan

Appendix 12 Checklist on terrestrial biodiversity