Environmental Management Plan

Mesa A Hub Revised Proposal

RTIO-HSE-0325456

Robe River Mining Co. Pty. Ltd.

152-158 St Georges Terrace, Perth

GPO Box A42, Perth WA 6837

November 2018

Rio Tinto

Disclaimer and Limitation

This Environmental Management Plan has been prepared by Eco Logical Australia (Eco Logical) and Rio Tinto's Iron Ore group (Rio Tinto), on behalf of Robe River Mining Co. Pty. Limited (the Proponent), specifically for the Mesa A Hub. Neither the report nor its contents may be referred to without the express approval of Rio Tinto, unless the report has been released for referral and assessment of proposals.

Document Status					
Rev	**Author**	**Reviewer/s**	**Date**	**Approved for Issue**	
				To Whom	**Date**
A	Rio Tinto	Approvals, Ops Environment	July 2018		
1	Rio Tinto	GM West Angelas and Robe Valley	July 2018		
2	Rio Tinto		July 2018	EPA Services	July 2018
2.1	Rio Tinto		August 2018	EPA Services	August 2018
2.2	Rio Tinto		August 2018	EPA Services	August 2018
2.3	Rio Tinto		November 2018	EPA Services	November 2018

SUMMARY

This Mesa A Hub Environmental Management Plan (EMP) is submitted by Rio Tinto on behalf of Robe River Mining Co. Pty. Ltd. (the Proponent) in accordance with Ministerial Statement xxxx (MS xxxx).

Table S1 below presents the environmental criteria to measure achievement of the environmental outcomes and objectives to be met through implementation of this EMP.

Table S1: Environmental criteria to measure achievement of environmental outcomes and objectives

Proposal title		Mesa A Hub Revised Proposal
Proponent		Robe River Mining Co. Pty. Ltd.
Ministerial Statement		MS xxxx
Purpose of this EMP		This EMP fulfils the requirements of the Mesa A Hub Revised Proposal (the Revised Proposal) Environmental Scoping Document (Items 6, 25, 26, 42) and Conditions x – x of MS xxxx.
Hydrological Processes – Groundwater abstraction and riparian vegetation of the Robe River and Warramboo Creek **EPA Objective:** *To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.*		
Outcome based provisions	**Condition environmental outcome**	The Proponent shall ensure there is no irreversible impact to the health of riparian vegetation of the Robe River and Warramboo Creek as a result of groundwater abstraction for the Revised Proposal.
	Trigger criteria	1. The mean vegetation index for riparian overstorey taxa (*E. victrix, E. camaldulensis and M. argentea*) of the Robe River and Warramboo Creek changes by ≥ 2 standard deviations.
	Threshold criteria	1. The mean vegetation index for riparian overstorey taxa (*E. victrix, E. camaldulensis and M. argentea*) for the Robe River and Warramboo Creek changes by ≥ 2 standard deviations from baseline values over three consecutive years.
Hydrological Processes – Surplus water discharge and riparian vegetation of Warramboo Creek **EPA Objective:** *To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.*		
Outcome based provisions	**Condition environmental outcome**	The Proponent shall ensure there is no irreversible impact to the health of riparian vegetation of Warramboo Creek as a result of surplus water discharge from the Revised Proposal.
	Trigger criteria	1. The mean vegetation index for riparian overstorey taxa (*E. victrix and E. camaldulensis*) of Warramboo Creek changes by ≥ 2 standard deviation from baseline values. 2. Surface water expression present ≥ 6 km downstream of the discharge point in Warramboo Creek under natural no-flow conditions. 3. Detection of new introduced species not previously detected within the riparian zone of Warramboo Creek.

	Threshold criteria	1. The mean vegetation index for riparian overstorey taxa (*E. victrix and E. camaldulensis*) of Warramboo Creek changes by ≥ 2 standard deviations from baseline value over three consecutive years. 2. Surface water expression present > 8 km downstream of the discharge point in Warramboo Creek under natural no-flow conditions. 3. New introduced species becomes established and dominant within the riparian zone of Warramboo Creek.
Flora and Vegetation – Sand Sheet Vegetation (Robe Valley) Priority Ecological Community (PEC) **EPA Objective:** *To maintain representation, diversity, viability and ecological function at the species, population and community level.*		
Outcome based provisions	**Condition environmental outcome**	The Proponent shall ensure there is no direct disturbance to the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal that results in an irreversible impact, other than existing and authorised disturbance.
	Trigger criteria	1. Inadvertent ground disturbance or clearing of the Sand Sheet Vegetation (Robe Valley) PEC. 2. Detection of new introduced species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC.
	Threshold criteria	1. Inadvertent ground disturbance or clearing resulting in long-term loss of vegetation within the Sand Sheet Vegetation (Robe Valley) PEC. 2. New introduced species becomes established and dominant within the Sand Sheet Vegetation (Robe Valley) PEC.
Management based provisions	**Condition environmental objective**	The Proponent shall minimize impacts from the Revised Proposal to the Sand Sheet Vegetation (Robe Valley) PEC as far as practicable so that the biological diversity and ecological integrity of the PEC are maintained.
	Management targets	1. Persistence of the four key species (*Corymbia zygophylla*, *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* and *Triodia schinzii*) of the Sand Sheet Vegetation (Robe Valley) PEC. 2. No loss of catchment for the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal, other than existing and authorised disturbance. 3. 24-hour average dust levels (PM10), attributable to the Revised Proposal, no greater than 70ug/m^3 as measured at the Sand Sheet Vegetation (Robe Valley) PEC.
Terrestrial fauna – Ghost Bat (*Macroderma gigas*) **EPA Objective:** *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.*		
Outcome based provisions	**Condition environmental outcome**	The Proponent shall ensure there is no irreversible impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C Mining Exclusion Zones (MEZs), other than existing and authorised disturbance.
	Trigger criteria	1. Vibration levels exceed 50mm/s peak particle velocity at the potential diurnal/maternal Ghost Bat roost caves. 2. Disturbance, other than approved clearing, within 50m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves.
	Threshold criteria	1. Significant damage to diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7. 2. Disturbance, other than approved clearing, within 40m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves.

Management based provisions	**Condition environmental objective**	The Proponent shall improve knowledge of the Ghost Bat population and utilisation of high value habitat in the Robe Valley in order to assist in maintaining biological diversity and ecological integrity.
	Management targets	1. Estimate the local population of Ghost Bats in the western part of the Robe Valley. 2. Indicate how Ghost Bats use caves within the western part of the Robe Valley (e.g. diurnal versus maternal), including the degree of utilisation of caves by pregnant females.
Terrestrial fauna – Northern Quoll (*Dasyurus hallucatus*) **EPA Objective:** *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.*		
Outcome based provisions	**Condition environmental outcome**	The Proponent shall ensure there is no irreversible impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance.
	Trigger criteria	1. Disturbance of ≥ 5% of viable Northern Quoll denning habitat on the retained escarpments (MEZs) of Mesa A, B or C.
	Threshold criteria	1. Disturbance of >10% of viable denning Northern Quoll habitat on the retained escarpments (MEZs) of Mesa A, B or C.
Subterranean Fauna – Troglofauna **EPA Objective:** *To protect subterranean fauna so that biological diversity and ecological integrity are maintained.*		
Outcome based provisions	**Condition environmental outcome**	The Proponent shall ensure there is no irreversible impact, as a result of the Revised Proposal, to the troglofauna habitat retained within the Mesa A, B or C MEZs.
	Trigger criteria	1. Operational error **during mining** resulting in removal of greater than 0.01% by volume annually per mesa of the MEZ at Mesas A, B or C.
	Threshold criteria	1. Net loss of the MEZ at Mesas A, B or C at **completion of mining.**
Management based provisions	**Condition environmental objective**	The Proponent shall protect the biological diversity and ecological integrity of the troglofauna assemblages of Warramboo and Mesas A, B and C by minimising impacts as far as practicable.
	Management targets	1. Total clearing of native vegetation across the surface of the Mesa B and C MEZs is less than 30% of each MEZ surface area. 2. Troglofauna specimen capture rate is not below the baseline minimum for three consecutive sampling events for each individual location (Warramboo, Mesas A, B and C). 3. Estimate the degree of habitat connectivity and degree of troglofauna assemblage similarity between Highway/Tod Bore and Dinner Camp Bore areas. 4. No statistically significant change in down hole temperature and relative humidity in the Mesa A or B MEZs relative to reference sites.

Corporate endorsement

I hereby certify that to the best of my knowledge, the provisions within this Mesa A Hub Environmental Management Plan are true and correct and address the legal requirements of MS xxxx.

Name: **Signed:**

Designation: GM West Angelas and Robe Valley **Date:**

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Tables

Figures

1. CONTEXT, SCOPE AND RATIONALE

1.1 Mesa A Hub

The Mesa A Hub is located approximately 43 km west of Pannawonica in the Pilbara region of Western Australia (WA) (Figure 1-1):

The Proponent (Robe River Mining Co. Pty. Limited) manages and operates the Mesa A Hub Revised Proposal (the Revised Proposal) as approved by MS xxxx under Part IV of the *Environmental Protection Act 1986* (EP Act).

- Mine pits:
  - Above water table (AWT) mining at Mesa A, Mesa B and Highway/Tod Bore
  - AWT and below water table (BWT) mining at Warramboo and Mesa C
- Mineral waste management including but not limited to backfilling, out-of-pit waste dumps, low grade ore dumps, topsoil and subsoil stockpiles.
- Processing facilities including but not limited to a wet processing plant, waste fines storage facilities and reverse osmosis plant.
- Support facilities including but not limited to workshops, power supply infrastructure, hydrocarbon storage, laydown areas, laboratory, offices and waste water treatment plants.
- Installation of infrastructure such as tracks, utilities, telecommunications, monitoring stations and abandonment bunds in the Mining Exclusion Zones (MEZs) at Mesas A, B and C.
- Surface water management infrastructure including but not limited to diversion drains, levees and culverts.
- Linear infrastructure including but not limited to heavy vehicle and light vehicle access roads, pipelines and power (including sub-stations) and communications distribution networks.
- Water supply bore field at Warramboo.
- Dewatering and associated infrastructure at Warramboo and Mesa C.
- Management of surplus water including use in processing, use on-site, passive recharge via completed mine pits and controlled discharge to Warramboo Creek.
- Transport of mined and processed ore to Rio Tinto's port operations at Dampier and/or Cape Lambert via existing rail infrastructure.

The Development Envelope and the conceptual layout for the Revised Proposal are shown in Figure 1-2 and Figure 1-3 respectively.

This Environmental Management Plan (EMP) will be implemented subject to approval by the Environmental Protection Authority (EPA) and will replace the following existing management plans associated with the Mesa A/Warramboo Iron Ore Project:

- Mesa A Troglofauna Management Plan, November 2009 (RTIO-HSE-0048054);
- Mesa A/Warramboo Sand Sheet Vegetation Management Plan (RTIO-HSE-0048055).

This EMP has been developed in accordance with the EPA's *Instructions on how to prepare* Environmental Protection Act 1986 *Part IV Environmental Management Plans*.

LEGEND

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

Rio Tinto

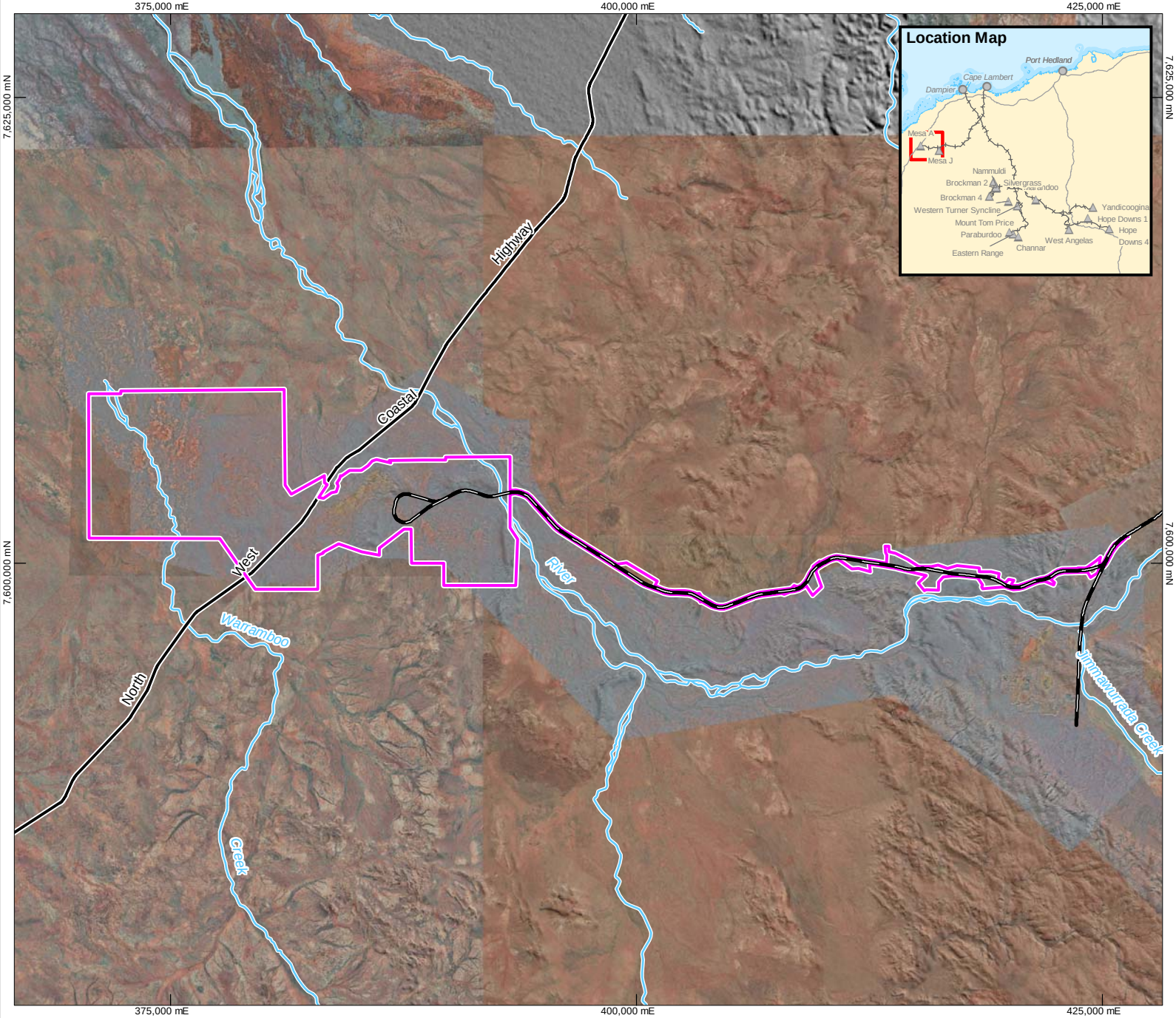
Iron Ore (WA)

Figure 1-1: Regional Location

Drawn: GIS Team
Date: February, 2018

Plan No: PDE0149312v1
Proj: MGA 94 (Zone 50)

Geospatial Information and Mapping



LEGEND

- Development Envelope
- Rio Tinto Railway
- Highway
- Major Watercourse

N

SCALE

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1:300 000 @ A4

Disclaimer

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Rio Tinto

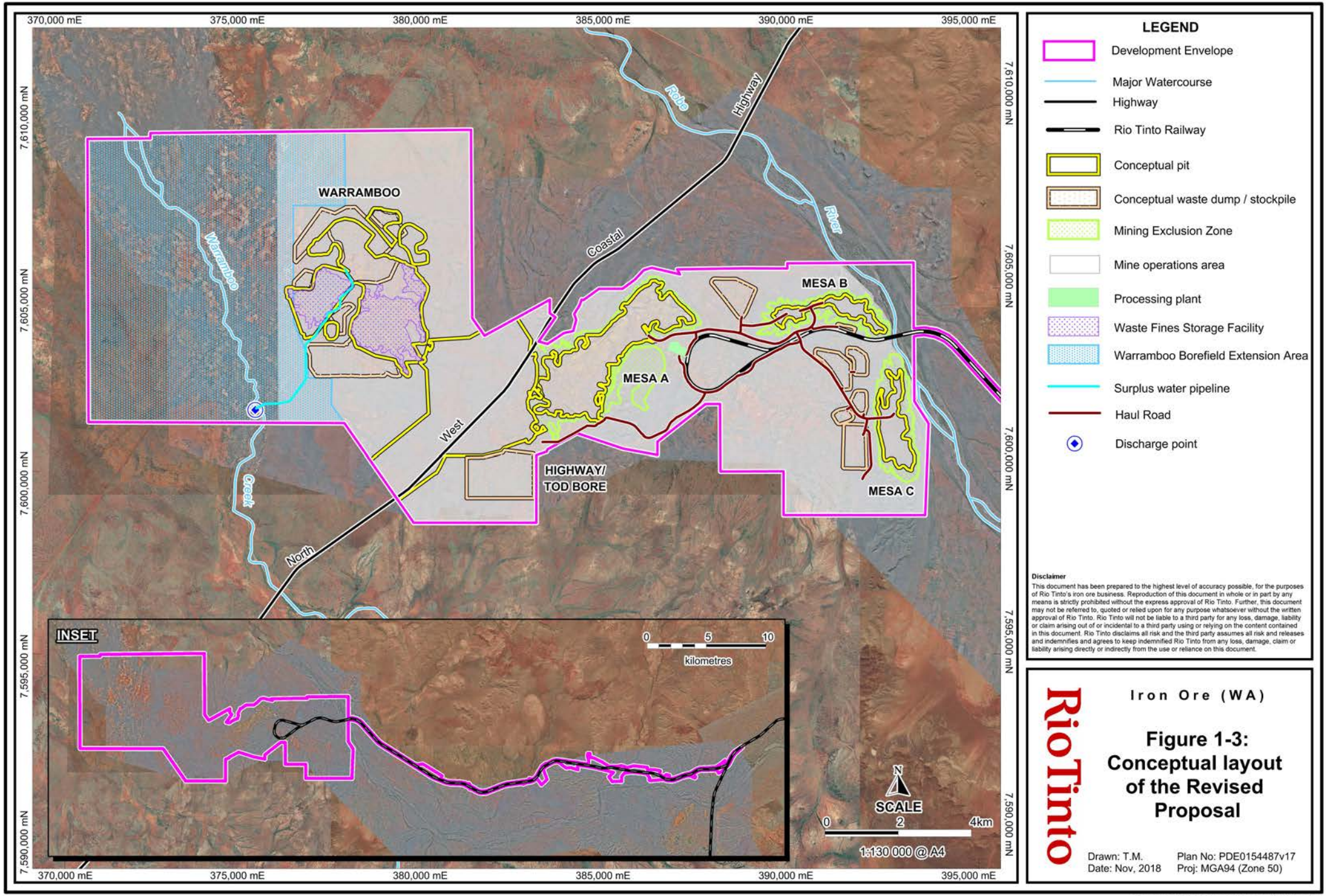
Iron Ore (WA)

Figure 1-2: Development Envelope

Drawn: T.Murphy
Date: Nov, 2018

Plan No: PDE0161695v3
Proj: MGA94 (Zone 50)

Geospatial Information and Mapping



Rio Tinto

Iron Ore (WA)

Figure 1-3: Conceptual layout of the Revised Proposal

Drawn: T.M.
Date: Nov, 2018

Plan No: PDE0154487v17
Proj: MGA94 (Zone 50)

Geospatial Information and Mapping

1.2 Key environmental factors

Management of the following key environmental factors is included in this Environmental Management Plan (EMP):

- Hydrological Processes
- Flora and Vegetation
- Terrestrial Fauna
- Subterranean Fauna

Hydrological Processes and Flora and Vegetation

Riparian ecosystems occur along the Robe River and along Warramboo Creek in and adjacent to the Development Envelope. The riparian vegetation of Warramboo Creek includes facultative phreatophytic species (i.e. species that utilise groundwater for a portion of their water requirements, but can also satisfy their water requirements through stored soil water reserves). Riparian vegetation of the Robe River differs from Warramboo Creek due to the dominance of obligate phreatophytic species, which are considered groundwater dependent.

Hydrogeological modelling indicates there is limited hydraulic connectivity between the Mesa C Channel Iron Deposit (CID) Aquifer and the Robe River alluvium. Consequently, drawdown of groundwater levels within the Mesa C CID Aquifer to enable BWT mining is not expected to result in observable changes to groundwater levels within the adjacent Robe River alluvial aquifer.

Groundwater drawdown in the Yarraloola aquifer beneath the ephemeral Warramboo Creek has the potential to result in loss or degradation of riparian vegetation as declines in groundwater levels and the associated capillary fringe may cause a decline in health or even tree death due to the groundwater levels being beyond the riparian root systems, thereby reducing their drought tolerance.

Dewatering of the Warramboo deposit will generate surplus water. Surplus water management will include use on site, passive recharge via completed mine pits and surface discharge to Warramboo Creek. Discharge of surplus water to the ephemeral Warramboo Creek has the potential to impact riparian vegetation via water logging, increased recruitment and community structural changes along Warramboo Creek up to 8 km downstream of the discharge point.

Flora and Vegetation

The Priority 3 Sand Sheet Vegetation (Robe Valley) Priority Ecological Community (Sand Sheet PEC) is located immediately adjacent to the south-eastern boundary of Mesa A. This PEC is of regional conservation significance as both a habitat and vegetation type that is atypical for the locality. It is the most northern expression of this vegetation type in the Carnarvon Basin and is poorly represented in the Pilbara Region and unrepresented in the reserve system. Two representations of the Sand Sheet PEC occur within the Development Envelope; one of approximately 147 ha and one of 7 ha.

Potential impacts of the Revised Proposal on the Sand Sheet PEC include degradation of vegetation due to changes in surface hydrology, ingress of weeds and dust deposition.

Terrestrial fauna

The Breakaways and Gullies habitat in the Development Envelope provides roost and denning habitat for the Ghost Bat and Northern Quoll respectively and the Major River/Creek habitat provides foraging and dispersal habitat for these species. Potential impacts of the Revised Proposal on the Ghost Bat and the Northern Quoll are loss or fragmentation of habitat, including breeding, foraging and dispersal habitat, due to clearing; indirect disturbance to high value habitat

(potential diurnal/maternal Ghost Bat roosts) via blast vibrations; and indirect impacts to foraging habitat in the Major River/Creek habitat due to groundwater drawdown and surplus water discharge.

Subterranean fauna

The target ore bodies in the Development Envelope comprise Robe Pisolite which is considered to be high prospectivity habitat for troglofauna within the Development Envelope. Most species of obligate troglofauna are considered to be Short Range Endemic (SRE) with many species believed to be endemic to individual mesas in the Robe Valley. Mine pit excavation to be conducted as part of the Revised Proposal will result in direct loss of troglofauna habitat and a loss of individuals, which in turn has the potential to result in changes to troglofauna assemblages. Clearing of vegetation may lead to a reduction in organic inputs into the subterranean environment which may reduce the quality of troglofauna habitat.

1.3 Condition requirements

The proposed conditions and the associated proposed environmental outcomes and objectives for the Mesa A Hub Revised Proposal are detailed below in Table 1-1.

Table 1-1: Proponent proposed condition for the Mesa A Hub Revised Proposal

Condition		Section in EMP
5	**Condition Environmental Management Plans**	
5-1	The Proponent shall prepare and submit a Condition Environmental Management Plan to the satisfaction of the CEO. This plan shall demonstrate that the environmental outcomes specified in conditions 6-1, 7-1, 8-1 and 9-1 and the environmental objectives specified in conditions 7-2, 8-2 and 9-2 will be met.	Draft EMP submitted in July 2018 with draft ERD for the Mesa A Hub Revised Proposal.
5-2	For outcome based provisions, the Condition Environmental Management Plan shall: (1) specify the environmental outcomes to be achieved, as specified in condition 5-1; (2) specify trigger criteria that must provide an early warning that the threshold criteria may not be met; (3) specify threshold criteria to demonstrate compliance with the environmental outcomes specified in condition 5-1. Exceedance of the threshold criteria represents non-compliance with these conditions; (4) specify monitoring to determine if trigger criteria and threshold criteria are exceeded; (5) specify trigger level actions to be implemented in the event that trigger criteria have been exceeded; (6) specify threshold contingency actions to be implemented in the event that threshold criteria are exceeded; and (7) provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that condition 5-1 has been met over the reporting period in the Compliance Assessment Report required by condition 3-6. For management based provisions, the Condition Environmental Management Plan shall: (1) specify the environmental objectives to be achieved, as specified in condition 5-1;	Table 2-1 to Table 2-6

	Condition	Section in EMP
	(2) specify management actions to meet the environmental objective; (3) specify management targets; (4) specify monitoring to determine if management targets are being met (8) provide the format and timing for the reporting of monitoring results against management targets to demonstrate that condition 5-1 has been met over the reporting period in the Compliance Assessment Report required by condition 3-6.	
5-3	After receiving notice in writing from the CEO that the Condition Environmental Management Plan satisfies the requirements of condition 5-2 the Proponent shall: (1) implement the Condition Environmental Management Plan, or any subsequent approved versions; and (2) continue to implement the Condition Environmental Management Plan until the CEO has confirmed by notice in writing that the Proponent has demonstrated the objectives specified in condition 5-1 have been met.	N/A
5-4	In the event that the monitoring indicates an exceedance of the threshold criteria specified in the Condition Environmental Management Plans, the Proponent shall: (1) report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified; (2) implement the threshold level contingency actions specified in the Condition Environmental Management Plans within 24 hours and continue implementation of those actions until the CEO has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met and the implementation of the threshold contingency actions is no longer required; (3) investigate to determine the cause of the threshold criteria being exceeded; (4) investigate to provide information for the CEO to determine potential environmental harm that occurred due to the threshold criteria being exceeded; and (5) provide a report to the CEO within twenty one (21) days of the exceedance being reported. The report shall include; a. details of threshold contingency actions implemented; b. the effectiveness of the threshold contingency actions implemented, against the threshold criteria; c. the findings of investigations; d. measures to prevent the threshold criteria being exceeded in the future; e. measures to prevent, control or abate the environmental harm which may have occurred; and f. justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes would continue to be met.	Table 2-1 to Table 2-6
5-5	The Proponent: (1) may review and revise the Condition Environmental Management Plan, or (2) shall review and revise the Condition Environmental Management Plan as and when directed by the CEO.	N/A
5-6	The Proponent shall implement the latest revision of the Condition Environmental Management Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 5-1 and condition 5-2.	

	Condition	Section in EMP
6	**Hydrological Processes - Groundwater abstraction, surplus water discharge and riparian vegetation of the Robe River and Warramboo Creek**	
6-1	The Proponent shall manage implementation of the Revised Proposal to meet the following environmental outcomes: (1) The Proponent shall ensure there is no irreversible impact to the health of riparian vegetation of the Robe River and Warramboo Creek as a result of groundwater abstraction for the Revised Proposal. (2) The Proponent shall ensure there is no irreversible impact to the health of riparian vegetation of Warramboo Creek as a result of surplus water discharge from the Revised Proposal.	Table 2-1 and Table 2-2
7	**Flora and Vegetation – Sand Sheet Vegetation (Robe Valley) PEC**	
7-1	The Proponent shall manage implementation of the Revised Proposal to meet the following environmental outcome: (1) The Proponent shall ensure there is no direct disturbance to the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal, that results in an irreversible impact, other than existing and authorised disturbance.	Table 2-3
7-2	The Proponent shall manage implementation of the Revised Proposal to meet the following environmental objective: (1) The Proponent shall minimize impacts from the Revised Proposal to the Sand Sheet Vegetation (Robe Valley) PEC as far as practicable so that the biological diversity and ecological integrity of the PEC are maintained.	Table 2-3
8	**Terrestrial Fauna – Conservation significant fauna species; Ghost Bat (*Macroderma gigas*) and Northern Quoll (*Dasyurus hallucatus*)**	
8-1	The proponent shall manage the implementation of the Revised Proposal to meet the following environmental outcome: (1) The Proponent shall ensure there is no irreversible impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpment of Mesa A, B and C MEZs, other than existing and authorised disturbance.	Table 2-4 and Table 2-5
8-2	The Proponent shall manage the implementation of the Revised Proposal to meet the following environmental objective: (1) The Proponent shall improve knowledge of the Ghost Bat population and utilisation of high value habitat in the Robe Valley in order to assist in maintaining biological diversity and ecological integrity.	Table 2-4
9	**Subterranean fauna - Troglofauna**	
9-1	The Proponent shall manage the implementation of the Revised Proposal to meet the following environmental outcome: (1) The Proponent shall ensure there is no irreversible impact, as a result of the Revised Proposal, to the troglofauna habitat retained within the Mesa A, B or C MEZs.	Table 2-6
9-2	The Proponent shall manage the implementation of the Revised Proposal to meet the following environmental objective: (1) The Proponent shall protect the biological diversity and ecological integrity of the troglofauna assemblages of Warramboo and Mesas A, B and C by minimising impacts as far as practicable.	Table 2-6

1.4 Rationale and approach

This EMP addresses environmental factors (and relevant environmental outcomes and objectives) which were determined by the EPA as being relevant to the management of groundwater abstraction, surface water discharge, conservation significant vegetation communities and fauna species associated with the Revised Proposal.

Results of baseline surveys, monitoring and a number of assumptions and uncertainties inform the management approach for meeting the environmental outcomes and objectives stated in conditions 6, 7, 8 and 9 of MS xxxx.

The identified performance indicators, management targets and response actions are aligned with the overall management approach.

Monitoring data are used to evaluate compliance with the trigger and threshold criteria to achieve the environmental outcomes and management targets are used to assess whether the management actions are effective in meeting the environmental objectives

1.4.1 Survey and study findings

a) Hydrological Processes and riparian vegetation

Riparian ecosystems occur along the Robe River and along Warramboo Creek in and adjacent to the Development Envelope. The most recent flora and vegetation surveys were conducted across the western portion of the Development Envelope (MWH 2016, Stantec 2018). The survey included quadrats, releves, mapping of vegetation units and targeted searches for conservation significant flora, vegetation condition assessment and identification of introduced species. Riparian vegetation monitoring transects were established during the baseline survey (MWH 2016). A targeted riparian vegetation survey of the Robe River from Pannawonica to the North West Coastal Highway was also conducted (Rio Tinto 2017). This survey mapped the nature and distribution of groundwater dependent vegetation along the Robe River to assess likely sensitivity to hydrological changes.

Warramboo Creek

Baseline surveys of Warramboo Creek recorded 81 native taxa and four introduced taxa, with no declared rare flora, threatened or PECs recorded. Warramboo Creek is an ephemeral, low to moderate sized Pilbara Creek system which supports the facultative phreatophytic species, *Eucalyptus camaldulensis* subsp. *refulgens*, and the facultative (and potentially vadophytic) species, *Eucalyptus victrix*. Three vegetation units as mapped by MWH (2016) (EcAanAtrAbAtuTe, EcCcAanTe and EcrEvAtpAlTtTe) associated with Warramboo Creek in the Development Envelope are considered to be of moderate local significance as they support the facultative phreatophytic species, *Eucalyptus camaldulensis* subsp. *refulgens*, and the facultative (and potentially vadophytic) species, *Eucalyptus victrix.* Subsequent additional mapping by Rio Tinto of the riparian vegetation along Warramboo Creek has been undertaken using high resolution aerial photography. The additional mapping of Warramboo Creek delineated five vegetation units (considered to be of moderate local significance) listed in Table 1-2 and shown in Figure 1-4 and provides further definition of, and confidence in, the distribution and extent of phreatophytic communities, particularly the extent of communities in which *Eucalyptus camaldulensis* subsp. *refulgens* is dominant or co-dominant. The vegetation units of this more detailed mapping generally align with those of the most recent flora and vegetation assessment of the Warramboo area (Stantec 2018).

Table 1-2: Description of riparian vegetation units along Warramboo Creek (Rio Tinto detailed mapping)

Vegetation Unit	Vegetation Description
EvCcAtpAccA	*Eucalyptus victrix* and *Corymbia candida* mid to low open woodland with scattered *Eucalyptus camaldulensis* subsp. *refulgens, Acacia tumida* var. *pilbarensis*, *Acacia colei* var. *colei* and *Acacia ancistrocarpa* tall sparse shrubland, over *Eriachne benthamii*, **Cenchrus ciliaris*, *Eulalia aurea* and *Dichanthium fecundum* mid tussock grassland
EcrEvCcAtAs	*Eucalyptus camaldulensis* subsp. *refulgens*, *Eucalyptus victrix* and *Corymbia candida* mid to low woodland, over *Acacia trachycarpa* and *Acacia sclerosperma* subsp. *sclerosperma* tall to mid sparse shrubland, over *Triodia epactia* open hummock grassland over **Cenchrus ciliaris*, *Eulalia aurea* and *Eriachne benthamii* sparse tussock grassland
EcrAtAanTe	*Eucalyptus camaldulensis* subsp. *refulgens* mid woodland over *Acacia trachycarpa* and *Acacia ancistrocarpa* tall open shrubland over *Triodia epactia* mid open hummock grassland
EcAanAtrAbAtuTe	*Corymbia candida* and *Eucalyptus victrix* low open woodland (with scattered *Eucalyptus camaldulensis* subsp. *refulgens*), over *Acacia ancistrocarpa*, *Acacia trachycarpa*, *Acacia bivenosa* and *Acacia tumida* var. *pilbarensis* tall to mid open shrubland, over *Triodia epactia* open to sparse hummock grassland
EcrAtAanAtTe	*Eucalyptus camaldulensis* subsp. *refulgens* mid woodland over *Acacia trachycarpa, Acacia ancistrocarpa* and *Acacia tumida* var. *pilbarensis* tall open shrubland over *Triodia epactia* mid open hummock grassland

The utilisation of groundwater by vegetation depends on the species present and the historical depth to groundwater. In the floodplain downstream of the defined channel of Warramboo Creek there is low to moderate potential for phreatophytic species to access groundwater. In the defined channel of Warramboo Creek adjacent to the bore field extension, there is low potential for phreatophytes to access groundwater; phreatophytes in this area may access groundwater but any access is likely to be minimal due to the existing water table being 14-20 m below ground level. Upstream of the bore field there is negligible potential for phreatophytes to access groundwater.

Robe River

Riparian vegetation communities associated with the Robe River in the western portion of the Development Envelope are represented by the vegetation units ChAbAtrTw and EcEvMgAtrCv as mapped by MWH (2016) and are considered to be of high local significance. Subsequent detailed mapping of the riparian vegetation of the Robe River from the North West Coastal Highway to near Pannawonica recorded *Melaleuca argentea*, *Eucalyptus camaldulensis* subsp*. refulgens* and *Eucalyptus victrix* adjacent to Mesas B and C (Rio Tinto 2017).

Drawdown of groundwater levels within the Mesa C CID Aquifer is not expected to result in observable changes to groundwater levels within the adjacent Robe River alluvial aquifer and hence impacts to vegetation are unlikely.

Two semi-permanent pools are present in the Robe River adjacent to Mesa B. Permanent pools associated with the Robe River and Mungarathoona Creek (a tributary of the Robe River) are present outside the Development Envelope with the closest pools located approximately 4 km to the north and 8 km to the south-east of the Development Envelope. Numerous permanent pools are present further upstream in the Robe River. Vegetation surrounding these pools in the vicinity of the Mesa A Hub is typically dominated by obligate phreatophytic vegetation which requires constant access to groundwater. Vegetation is dominated by dense *Melaleuca argentea* open

forests, accompanied by scattered and at times co-dominant *Eucalyptus camaldulensis* over mixed sedge, grass and herbaceous species. These associations occur on the edges of the Robe River, often close to breakaways and rock walls, where either adjacent (often porous) lithologies help maintain shallow water tables, or shallow water tables coincides with the main low-flow channel of the Robe River.

b) Flora and vegetation (Sand Sheet PEC)

One vegetation unit in the Development Envelope, the Priority 3 Sand Sheet Vegetation (Robe Valley) Priority Ecological Community (Sand Sheet PEC) is considered to be of regional significance:

- The Sand Sheet Vegetation (Robe Valley) PEC consists of *Corymbia zygophylla* scattered low trees over *Acacia tumida* var*. pilbarensis, Grevillea eriostachya* high shrubland over *Triodia schinzii* hummock grassland.
- The Sand Sheet PEC is located immediately adjacent to the south-eastern boundary of the existing Mesa A/Warramboo Iron Ore Project (Figure 1-5). This PEC is considered to be of regional conservation significance as both a habitat and vegetation type that is atypical for the locality. It is the most northern expression of this vegetation type in the Carnarvon Basin and is poorly represented in the Pilbara Region and unrepresented in the reserve system. It supports many species at their northern limits or which exist as disjunct populations including species restricted to the deep red sands of this habitat type (Parks and Wildlife 2014).

Two representations of the Sand Sheet PEC occur within the Mesa A Hub Development Envelope; one of approximately 147 ha and one of 7 ha. These representations each have a mapped buffer of 411 ha and 136 ha respectively.

Monitoring of the Sand Sheet PEC has been conducted since 2008 and is designed to assess the effects of mining operations from the Mesa A/Warramboo Iron Ore Project on the Sand Sheet Vegetation Community. The monitoring involves assessing permanent flora quadrats, documenting flora species occurring in the PEC, locating flora of conservation significance, recording introduced species and mapping vegetation condition and other disturbance. The most recent results available are from Astron (2017).

The condition of the Sand Sheet PEC vegetation in 2017 ranged from Excellent to Poor. Senescence was observed in several species in 2017, and previous years and it was particularly prevalent in *Acacia tumida* var. *pilbarensis* and *Triodia schinzii*. The presence of 'medium' or 'medium' – 'low' dust cover, introduced species (principally Buffel Grass, **Cenchrus ciliaris*), signs of cattle and historical clearing were responsible for the lower condition rating in some areas of the Sand Sheet PEC.

Astron (2017) noted that on-ground monitoring results showed a decline in the vegetation cover in the Sand Sheet PEC since the initial 2008 monitoring and specifically, widespread senescence of *Acacia tumida* var. *pilbarensis* (and other species) has been noted during monitoring within the Sand Sheet PEC since 2015 (Biota 2016, Astron 2017). Analysis of the data showed that the decline in cover amongst the monitored quadrats does not appear to be associated with proximity to the mine footprint. The decline in vegetation cover corresponded with a transition within the Robe Valley from above average rainfall conditions to more average rainfall between 2012 and 2016. However, analysis of the data does not show a direct correlation between vegetation cover and rainfall in the 12 months prior to each survey. This may be due to the presence of local groundwater retaining clay layers beneath parts of the Sand Sheet which undergo periodic cycles of replenishment and decline, allowing some species intermittent access to retained water. If groundwater anomalies are at least partly driving the observed changes in the Sand Sheet PEC, then the observed inter-annual to decadal scale changes in rainfall patterns are likely to be responsible for a substantial proportion of the changes observed. In addition, altered surface water flow patterns and altered fire regime (i.e. excluding fire driven reductions in biomass) as a

result of the Mesa A/Warramboo Iron Ore Project may have contributed to the observed decline in vegetation cover. Monitoring conducted in 2016 following above average rainfall in the four months prior to the survey noted recruitment of *Acacia tumida* var. *pilbarensis* (Biota 2016). Seedlings and saplings of *Acacia tumida* var. *pilbarensis* were also noted in the majority of monitoring quadrats in 2017 (Astron 2017).

Buffel Grass was the only introduced species recorded during the 2017 monitoring survey. Five introduced species were recorded in the Sand Sheet PEC during the 2016 monitoring, including two species not previously recorded in the Sand Sheet PEC; Speedy Weed (**Flaveria trinervia*) and Spiked Malvastrum (**Malvastrum americanum*) which were both recorded along the northern boundary of the PEC close to the existing Mesa A operation. Buffel Grass is the most common introduced species, and is most prevalent in the south-east section of the PEC (Biota 2016). As Buffel Grass is known to be an aggressive competitor, the more favourable climatic conditions in 2009, 2011, 2013, 2015 and 2016 would likely have contributed to the spread of this weed within the Sand Sheet PEC (Biota 2016).

c) Terrestrial fauna (Ghost Bat and Northern Quoll)

Ghost Bats

Roost sites used permanently by Ghost Bats are generally deep natural caves with a relatively stable temperature of 23-28^{o}C and humidity above 50%. Individuals require a range of cave sites and move between roosts seasonally or according to weather conditions. The most significant habitats in the Development Envelope for the species are the Breakaways and Gullies (including the mesa escarpments) and the Major River/Creek habitat (Figure 1-6); these areas represent potential roosting and foraging habitat. Habitat loss through impact or disturbance to, roost sites, specifically caves that play a role in breeding activities (maternal roosts) and nearby areas is seen as a key risk to this species conservation status.

The targeted Ghost bat cave assessment conducted by Bat Call WA (2016) confirmed the presence and foraging of Ghost Bats around the perimeters of both Mesa B and Mesa C. A Ghost Bat population of 15 to 20 individuals was estimated to be present in the Mesa A Hub area. Thirteen caves on Mesa B were assessed as currently in use by Ghost bats including one potential diurnal/maternal roost (MBC-05) and twelve nocturnal roost caves. MBC-05 is considered a potential maternal roost due to the depth of the cave (approximately 21 m) and presence of a high domed chamber at the rear (Bat Call WA 2016). Nine caves on Mesa C were assessed as being currently in use by Ghost bats, including one potential diurnal roost (MCC-02) and eight nocturnal roosts. Cave MCC-02 has two levels of cavities indicating this cave may be suitable as a diurnal roost and contained evidence of middens including food scraps (Bat Call WA 2016). Locations of MBC-05 and MCC-02 are shown in Figure 1-7. Further work is underway to confirm the roost status of MBC-05 and MCC-02.

Northern Quoll

In the Pilbara, the Northern Quoll favours rocky gorges, breakaways and hills, usually of high relief and often along drainage lines for denning purposes. Adjacent plains and vegetated areas provide habitat suitable for foraging and dispersal of young (Van Dyck and Strahan 2008), but are considered to be of less importance for the species' conservation (DSEWPaC 2011). The rocky facades of the mesa landforms are important sources of shelter, food and moisture for species of conservation significance.

The most important habitats in the Mesa A Hub area for the Northern Quoll are considered to be the Breakaways and Gullies and Major River/Creek habitats (Figure 1-6), which provide high value denning/shelter habitats associated with caves and rocky overhangs and/or enhanced foraging opportunities due to the availability of water (MWH 2015a).

MWH (2015a) recorded evidence of the Northern Quoll at 23 sites in the Mesa A Hub area, across Mesa Plateau, Rocky Slopes, Stony Hills and Rises, and Major River/Creek habitats. Previous surveys for the existing approved project recorded Northern Quoll on the Mesa B escarpment and in a cave and gorge at Mesa A (Biota 2005, 2006) and an additional 92 records are known within 50 km of the Mesa A Hub area, with the nearest approximately 2 km to the south of the Mesa A Hub area (Biota 2011).

d) Subterranean fauna (troglofauna)

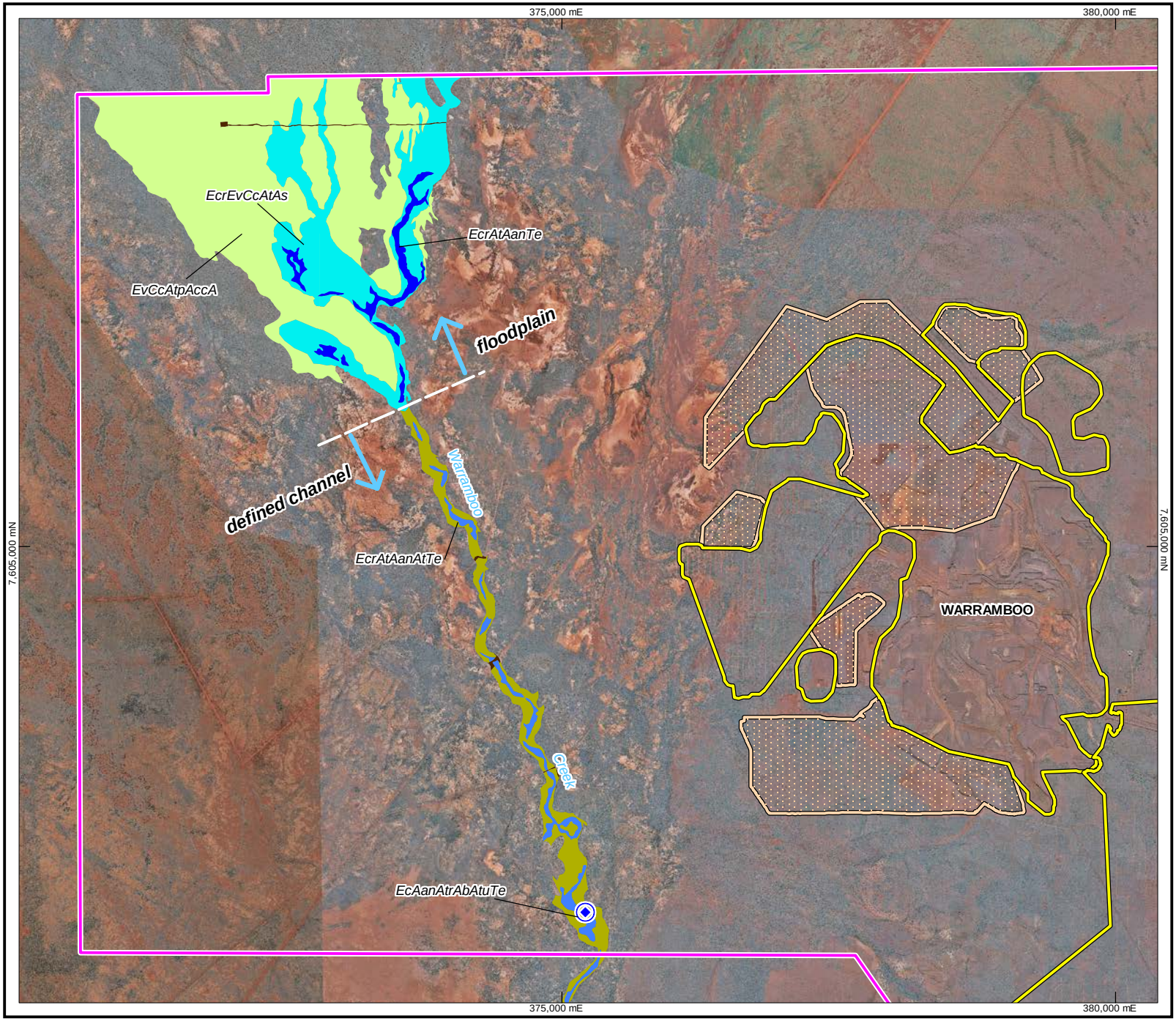
Troglofauna were first recorded at Mesa A in 2003 as by-catch of stygofauna sampling. Since 2003 numerous troglofauna surveys and assessments have been undertaken across the Robe Valley. The combined coverage of these surveys provides a considerable knowledge base of the troglofauna present in the Development Envelope.

Mesas A, B and C are part of a series of mesas that are remnants of a palaeochannel formed by sedimentary deposition of iron rich material (Robe Pisolite, more generically known as a Channel Iron Deposit (CID)) within the Robe River palaeo-channel. Subsequent uplift, erosion and surface water flows have removed much of the adjacent erodible basement material, leaving preserved parts of the paleo-river channels as outcropping mesas. The Warramboo and Highway/Tod Bore deposits are the buried downstream continuation of the CID present at Mesas A, B and C.

One of the key characteristics of geological units known to provide habitat for troglofauna relates to the physical features, particularly the presence of fractures and cavities sufficient in size to accommodate troglofauna. Throughout the Pilbara, a range of geological formations contain the necessary physical characteristics that have been shown to provide habitat for troglofauna. In the Development Envelope, the Robe Pisolite is considered to be the geological unit that provides primary habitat for troglofauna as it contains the necessary cavities to accommodate troglofauna. The clay pockets and lenses within the Robe Pisolite may also contribute to the suitability of the habitat for troglofauna as the retention of water in, or on top of, certain clay types may assist in maintaining high humidity levels in the subterranean environment.

Compilation of all troglofauna sampling to date shows:

- Fourteen potential SRE troglofauna species have been recorded in the Warramboo and Highway/Tod Bore area.
- Forty-nine troglofauna species have been recorded from Mesas B and C, comprising:
    - One conservation significant species: *Paradraculoides bythius* (Schedule 3 – Vulnerable).
    - One confirmed SRE species: *Ideoblothrus pisolitus.*
    - Forty-seven potential SRE species.
- Twenty-seven troglofauna species have been recorded from Mesa A comprising:
    - Four conservation significant species: *Paradraculoides anachoretus* (Schedule 3 – Vulnerable), *Ideoblothrus linnaei (Priority 1)*, *Ideoblothrus* sp. 'Mesa A' (Priority 1), *Lagynochthonius asema* (Priority 1).
    - Two confirmed SRE species: *Ideoblothrus* sp. 'Mesa A1', *Ideoblothrus* sp. 'Mesa A2'.
    - Twenty-one potential SRE species.



LEGEND

- Development Envelope
- Rio Tinto Railway
- Highway

Conceptual Mine Layout

- Pit
- Waste Dump / Stockpile
- Discharge point

N

SCALE

0.5 0 0.5 1 1.5km

1:50 000 @ A4

Rio Tinto

Iron Ore (WA)

Figure 1-4: Riparian vegetation of Warramboo Creek

Drawn: T.M.
Date: Nov, 2018

Plan No: PDE0161697v3
Proj: MGA 94 (Zone 50)

Geospatial Information and Mapping

Vegetation Unit Legend

EcAanAtrAbAtuTe

Corymbia candida and Eucalyptus victrix low open woodland (with scattered Eucalyptus camaldulensis subsp. refulgens), over Acacia ancistrocarpa, Acacia trachycarpa, Acacia bivenosa and Acacia tumida var. pilbarensis tall to mid open shrubland, over Triodia epactia open to sparse hummock grassland

EcrAtAanAtTe

Eucalyptus camaldulensis subsp. refulgens mid woodland over Acacia trachycarpa, Acacia ancistrocarpa and Acacia tumida var. pilbarensis tall open shrubland over Triodia epactia mid open hummock grassland

EcrAtAanTe

Eucalyptus camaldulensis subsp. refulgens mid woodland over Acacia trachycarpa and Acacia ancistrocarpa tall open shrubland over Triodia epactia mid open hummock grassland

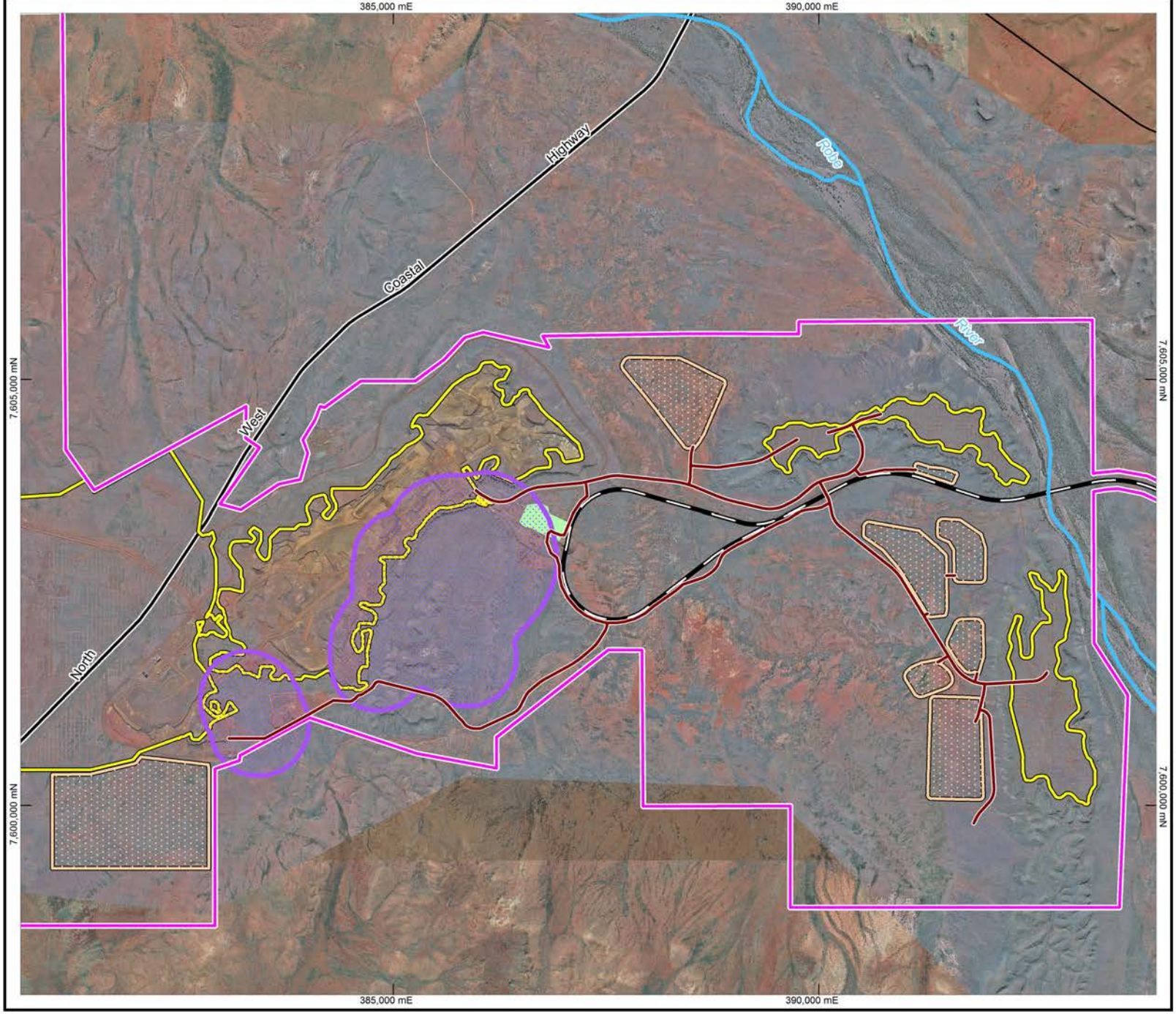
EcrEvCcAtAs

Eucalyptus camaldulensis subsp. refulgens, Eucalyptus victrix and Corymbia candida mid to low woodland, over Acacia trachycarpa and Acacia sclerosperma subsp. sclerosperma tall to mid sparse shrubland, over Triodia epactia open hummock grassland over *Cenchrus ciliaris, Eulalia aurea and Eriachne benthamii sparse tussock grassland

EvCcAtpAccA

Eucalyptus camaldulensis subsp. refulgens, Eucalyptus victrix and Corymbia candida mid to low woodland, over Acacia trachycarpa and Acacia sclerosperma subsp. sclerosperma tall to mid sparse shrubland, over Triodia epactia open hummock grassland over *Cenchrus ciliaris, Eulalia aurea and Eriachne benthamii sparse tussock grassland

Highly disturbed



LEGEND

- Development Envelope
- Sand Sheet Vegetation PEC Buffer
- Rio Tinto Railway
- Highway
- Major Watercourse

Conceptual Mine Layout

- Pit
- Waste Dump / Stockpile
- Processing plant
- Haul road

N

SCALE

1 0 1 2km

1:65 000 @ A4

Rio Tinto

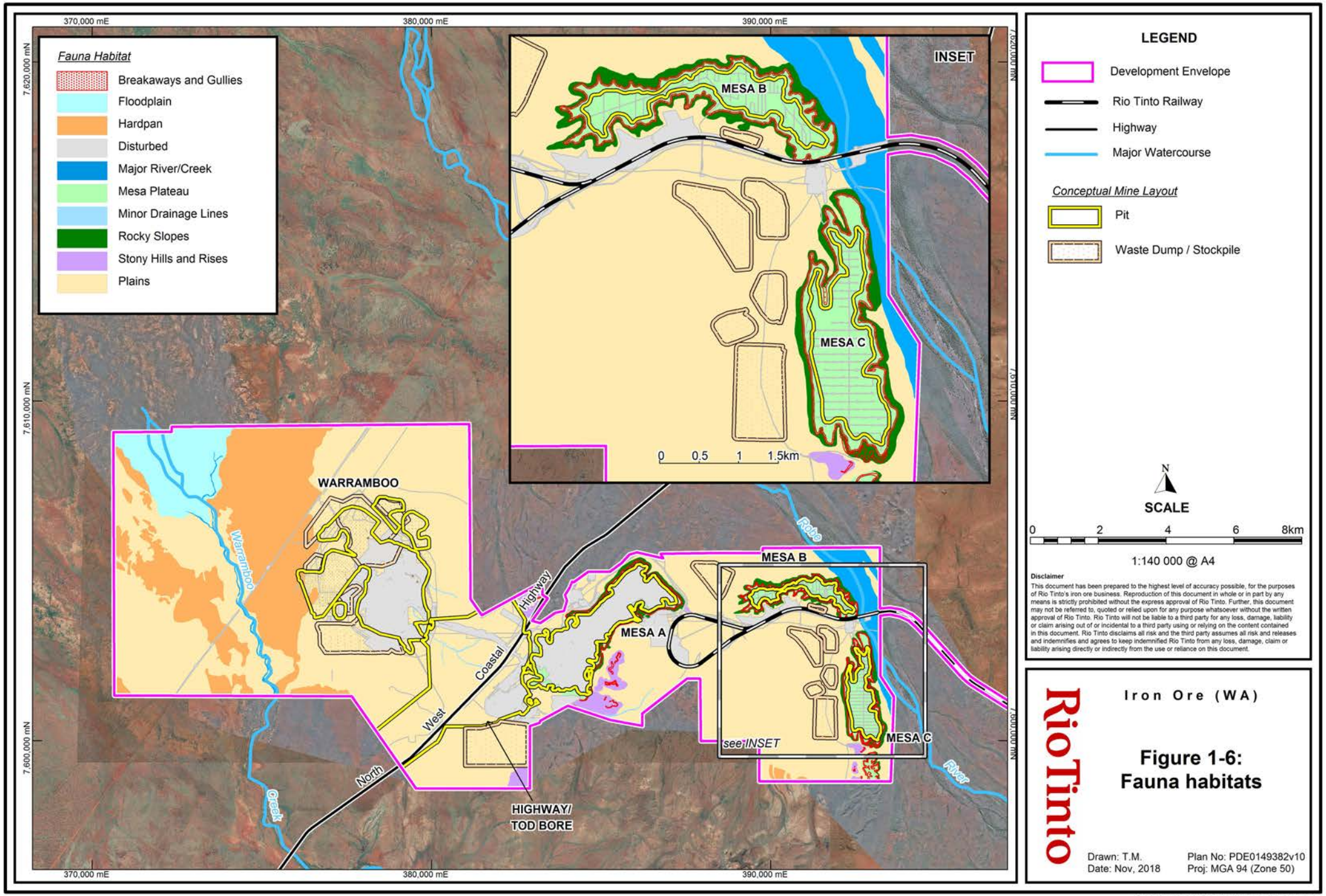
Iron Ore (WA)

Figure 1-5: Location of the Sand Sheet PEC buffer

Drawn: T.Murphy
Date: Nov, 2018

Plan No: PDE0161702v3
Proj: MGA 94 (Zone 50)

Geospatial Information and Mapping



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Rio Tinto

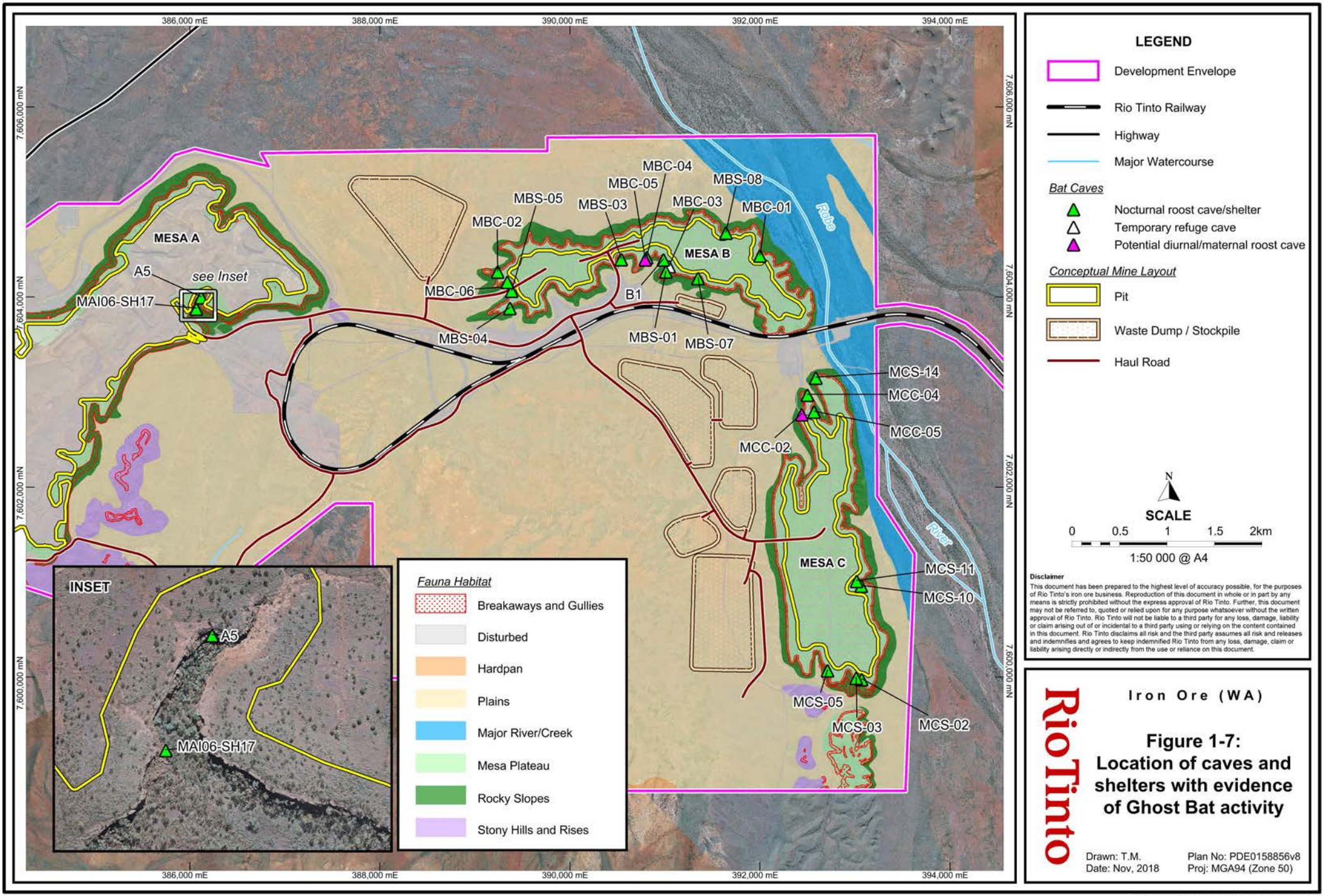
Iron Ore (WA)

Figure 1-6: Fauna habitats

Drawn: T.M.
Date: Nov, 2018

Plan No: PDE0149382v10
Proj: MGA 94 (Zone 50)

Geospatial Information and Mapping



LEGEND

- Development Envelope
- Rio Tinto Railway
- Highway
- Major Watercourse

Bat Caves

- Nocturnal roost cave/shelter
- Temporary refuge cave
- Potential diurnal/maternal roost cave

Conceptual Mine Layout

- Pit
- Waste Dump / Stockpile
- Haul Road

N

SCALE

0 0.5 1 1.5 2km

1:50 000 @ A4

Rio Tinto

Iron Ore (WA)

Figure 1-7: Location of caves and shelters with evidence of Ghost Bat activity

Drawn: T.M.
Date: Nov, 2018

Plan No: PDE0158856v8
Proj: MGA94 (Zone 50)

Geospatial Information and Mapping

1.4.2 Key assumptions and uncertainties

The key limitations relating to the information used for this EMP include:

- Limited hydrogeological data in the area between Mesa C and the Robe River to assess the hydraulic connectivity between aquifers and hence possible impacts to vegetation.
- Limited understanding of the response of riparian vegetation to cumulative stressors such as groundwater abstraction, surplus water discharge and climate variability.
- Inherent difficulty in interpolating local groundwater table elevation from limited groundwater data to predict the groundwater dependence of riparian vegetation.
- Limited baseline data for the Sand Sheet vegetation (Robe Valley) PEC to assess the long-term natural variation of species presence/absence (including weeds), ecosystem function and vegetation condition.
- Limited regional population studies for Ghost Bat and Northern Quoll to assist in understanding the long-term natural population variability and movements of these species.
- Limited data on the sensitivity of the Ghost Bat and Northern Quoll to noise and vibration.
- Lack of taxonomic framework and specialist expertise to identify and determine conservation significance of many groups of subterranean fauna.
- Inherent limitations in troglofauna sampling methodology that limit predictive ability of habitat modelling. Limitations include limited access to the subterranean environment (via drill holes only); modification of potential habitat through establishment of drill holes; trapping and scraping methodology may not be appropriate for some species depending on species preferences and mobility; sampling bias towards orebodies; difficulty in determining the specific geological strata that specimens originate from therefore limiting predictive ability of habitat modelling.
- Limited knowledge of troglofauna distribution patterns, ecological requirements and resilience.

The key assumptions relating to this EMP are:

- The hydrogeological modelling of groundwater abstraction from the Yarraloola aquifer and the Mesa C CID aquifer provides accurate estimates of the quality of the abstracted water and of the extent and depth of groundwater drawdown, based on the hydrogeological conceptualisation. The hydrogeological models will be updated as additional data become available hence revisions to the management of phreatophytic vegetation may be required.
- Hydrological modelling based on the hydrological conceptualisation has been used to provide an indicative extent of continuous flow under natural no-flow conditions for surplus water discharge to Warramboo Creek. The hydrological model and estimates will be reviewed as additional data become available, hence revisions to the management of phreatophytic vegetation may be required.
- Facultative phreatophytic vegetation along Warramboo Creek may be utilising groundwater to varying degrees despite the current depth to water table being at the limit of accessibility for facultative phreatophytic species, thus there is some potential for impacts from abstraction of groundwater from the Yarraloola aquifer.
- Baseline surveys of riparian vegetation, the Sand Sheet PEC, the Ghost Bat, the Northern Quoll and troglofauna provide representative species inventories and reflect sampling over variable seasonal conditions, however may not necessarily capture the full range of climatic variables experienced in an arid environment (which may be on a decade-scale).
- Baseline surveys provide a complete representative weed species inventory and reflect sampling over variable seasonal conditions.

- Tolerance of conservation significant fauna species to some level of noise, vibration and light emissions without any significant impact to their normal behaviours or survival.
- The presence of Ghost Bats during the day at cave MBC-05 and the dimensions of cave MBC-05 on Mesa B indicate that this cave is a potential diurnal/maternal Ghost Bat roost and the presence of two levels of cavities and middens in cave MCC-02 at Mesa C indicate that this cave is a potential diurnal Ghost Bat roost. The EMP has been developed on the conservative assumption that these caves are potential diurnal/maternal roosts and therefore warrant management. Additional data from longer term monitoring of these caves may indicate that a different status, and potentially a different level of management, may be appropriate for these caves.
- Each mesa formation represents an isolated troglofauna habitat. The EMP has been developed on the conservative assumption that each mesa formation represents isolated troglofauna habitat. Additional data from longer term monitoring may indicate a degree of troglofauna habitat connectivity between the mesas, potentially requiring revision of the EMP.
- The effectiveness of blast management measures to prevent disturbance to the retained mesa escarpments. The Proponent has a strong record of managing and maintaining landform stability, as demonstrated at the existing Mesa A/Warramboo Iron Ore Project, with no record of mesa escarpment collapse or failure.

1.4.3 Management approach

A risk-based approach has been taken through the Environmental Impact Assessment process to identify the key environmental values that may be impacted by the Revised Proposal and warrant additional management. Regional data, baseline survey data and, where available, ongoing monitoring data have been used to assess the potential impacts of the Revised Proposal on environmental values.

The key environmental values that have been identified as warranting additional management are:

- riparian vegetation associated with the Robe River and Warramboo Creek;
- the Sand Sheet PEC;
- conservation significant fauna (Ghost Bat and Northern Quoll); and
- troglofauna.

This EMP adopts a combination of an outcome-based approach and a management-based approach. For parts of the environment that can be objectively measured and monitored an outcome-based approach is adopted with establishment of trigger and threshold criteria and associated contingency actions if the environmental criteria are not met. Trigger criteria are set at a conservative level to ensure management actions are implemented well in advance of the environmental outcome being compromised. Thus, trigger criteria are set at a level below the threshold criteria to signal the need to focus and investigate and where applicable, mitigate the impact. For parts of the environment that are not amenable to objective measurement, a management-based approach is adopted with a management objective that relates to the EPA's environmental objective for the relevant environmental factor, management actions to meet the environmental objective and management targets to assess the effectiveness of the management actions.

This EMP also describes the monitoring that will be undertaken to measure performance against the environmental outcomes and to assess the effectiveness of management actions in meeting management-based objectives. The monitoring to be undertaken as part of this EMP has been designed to build upon and improve on existing monitoring programs conducted as part of the Mesa A/Warramboo Iron Ore Project and build upon data from baseline surveys.

Key to the overall environmental management approach for the Revised Proposal is avoidance of direct disturbance to key environmental values such as riparian vegetation of the Robe River,

potential diurnal/maternal Ghost Bat roosts at Mesas B and C and the Sand Sheet PEC. Where avoidance is not practicable, the management approach is to minimise disturbance to key environmental values, particularly habitats, such as troglofauna habitat and the mesa escarpments as detailed in this EMP.

1.4.4 Rationale for choice of provisions

Environmental criteria have been developed based on consideration of:

- Threatening processes and risks associated with each environmental value;
- The current state of knowledge for each environmental value; and
- The availability of suitable monitoring methods.

The specific trigger and threshold criteria, management targets and actions defined in Table 2-1 to Table 2-6 have been chosen as they provide a basis for detecting and avoiding or otherwise managing potential impacts, such that the condition environmental outcomes and objectives stated in conditions 6, 7, 8 and 9 of MS xxxx can be achieved.

Trigger criteria are set at a conservative level to ensure management actions are implemented well in advance of the environmental objective being compromised. Exceedance of a trigger criterion will, therefore, not be treated as a non-compliance. There is potential for the threshold criteria for vegetation to be exceeded due to natural variability; this must be accounted for in the management response. Exceedance of a threshold criterion will be treated as a potential non-compliance against the environmental objective if the exceedance is attributable to the Revised Proposal.

The tables of EMP provisions (Table 2-1 to Table 2-6) contain environmental outcomes that include 'no irreversible impact'. For the purpose of this EMP, an irreversible impact is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

The tables of EMP provisions (Table 2-1 to Table 2-6) include monitoring to measure performance against the environmental outcome and to determine whether trigger or threshold levels have been exceeded. Table 2-1, Table 2-2, Table 2-4 and Table 2-5 also include supporting monitoring that will be undertaken. Supporting monitoring is not directly required as a measure of performance but will be used to provide context, to assess the impact on the environmental value and to investigate possible causes should the trigger or threshold criteria be exceeded

The rationale for selection of provisions for each environmental value is discussed below.

Hydrological Processes and riparian vegetation

Two environmental outcomes have been adopted for riparian vegetation for different aspects of the Revised Proposal:

- No irreversible impact to the health of riparian vegetation of the Robe River and Warramboo Creek as a result of groundwater abstraction for the Revised Proposal; and
- No irreversible impact to the health of riparian vegetation of Warramboo Creek as a result of surplus water discharge from the Revised Proposal.

The outcomes for riparian vegetation were selected as it is acknowledged that the Revised Proposal may have an impact on riparian vegetation, however, potential impacts are not expected to be permanent as they will be limited in spatial extent and/or will occur over a limited time period and changes are considered unlikely to be so great that they result in changes in the composition of riparian vegetation.

The selected trigger and threshold criteria are based on standard deviations in foliage cover of phreatophytic overstorey riparian tree species from the baseline period mean as measured by mean vegetation index. Mean vegetation index is a readily measurable indicator of the health of riparian vegetation for which reference sites can be established and regular monitoring undertaken. Measurement of mean vegetation index is also consistent with other riparian vegetation monitoring programs. The approach taken is analogous to the 'control chart' method (Morrison 2008) that has been applied to a wide range of environmental impact studies and monitoring programs. In line with this, a trigger criterion of ≥ 2 standard deviations from baseline mean vegetation index has been selected for the following reasons:

- Decline from a baseline mean in number of standard deviations aligns with commonly accepted convention for establishing trigger criteria to detect potential environmental impacts.
- Quantifying decline in number of standard deviations from the baseline mean takes into account the natural variability observed in the system. This is preferable to using a set value or percentage decline which does not take natural variability into account.
- In a normally distributed dataset, two standard deviations from the mean encompasses 95% of the observed values, that is, there is a 5% chance of measuring a value either higher or lower than two standard deviations from the mean prior to any disturbance being imposed. This is aligned with the convention of using a statistical significance level of p=0.05.

A threshold criterion of ≥ 2 standard deviations from baseline mean vegetation index over a period of three consecutive years has been selected. Mean vegetation index is a readily measurable indicator of the health of riparian vegetation and comparison with standard deviation from baseline values is consistent with other riparian vegetation monitoring programs conducted by the Proponent in the Pilbara region. Rainfall and streamflow can fluctuate, both seasonally and across multiple years, influencing the condition of phreatophytic vegetation. As such three years has been selected as a suitable timeframe to assess whether the condition of upper canopy vegetation is under threat of long term impacts from the Revised Proposal, and to differentiate natural variation of the canopy against the impacts of dewatering. Following the completion of collection and analysis of baseline data, the trigger and threshold criteria will be reviewed and adjusted if deemed appropriate.

The trigger and threshold criteria for the location of surface water expression from surplus water discharge were selected as limiting the distance of surface water expression under natural no-flow conditions will limit the extent of potential impacts. Use of the distance of surface water expression is a readily measurable indicator of the extent of potential impacts which can be monitored regularly and is consistent with other riparian vegetation monitoring programs.

Trigger and threshold criteria for detection of new introduced species in the riparian zone of Warramboo Creek were selected as an indicator of potential impacts from discharge of surplus water. Introduced species can be monitored regularly, have a baseline and measurement of these parameters is consistent with other flora and vegetation monitoring programs.

Flora and Vegetation – Sand Sheet PEC

Outcome-based and management-based provisions have been adopted for the Sand Sheet PEC on the basis that objective measurement and reporting is possible for some parts of the environment and some of the potential impacts but not for others.

The environmental outcome adopted for the Sand Sheet PEC is:

- No direct disturbance to the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal that results in an irreversible impact, other than existing and authorised disturbance.

Removal of vegetation within the Sand Sheet PEC not only directly impacts vegetation through net loss but also has the potential to decrease diversity, introduce weed species and alter the structure of the community and hydrological flows. The above outcome has been selected as limiting direct disturbance will reduce the risk of irreversible impacts to the Sand Sheet PEC and direct disturbance is a readily measurable parameter.

Trigger and threshold criteria for ground disturbance and detection of new introduced species in the Sand Sheet PEC were selected as these are indicators of impacts that could result in irreversible damage attributable to the Revised Proposal. Both ground disturbance and monitoring of weeds are readily measurable, can be monitored regularly, have a baseline and measurement of these parameters is consistent with other flora and vegetation monitoring programs.

The management objective adopted for the Sand Sheet PEC is:

- To minimize impacts from the Revised Proposal to the Sand Sheet Vegetation (Robe Valley) PEC as far as practicable so that the biological diversity and ecological integrity of the PEC are maintained.

This management objective has been selected as it relates to the EPA objective for Flora and Vegetation and is specific to the Revised Proposal. Together the four key species of the Sand Sheet PEC help to define the Sand Sheet PEC and loss of one or more of the key species would result in a significant change to the structure of the sand sheet vegetation. A management target relating to persistence of the four key species present in the Sand Sheet PEC has, therefore, been selected.

Surface water flows may be important to the health of the Sand Sheet PEC. A management target has therefore, been selected to ensure that infrastructure is located and designed such that there is no loss of the catchment for the Sand Sheet PEC, other than existing and authorised disturbance.

Terrestrial Fauna - Ghost Bat

Outcome-based and management-based provisions have been adopted for the Ghost Bat on the basis that objective measurement and reporting is possible for some parts of the environment and some of the potential impacts but not for others.

The environmental outcome adopted for the Ghost Bat is:

- No irreversible impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance

This outcome has been selected as the Breakaways and Gullies habitat contained within the escarpments of Mesas A, B and C represents potential roosting and foraging habitat. Habitat loss through disturbance to roost caves, specifically caves that play a role in breeding activities (maternal roosts) and nearby areas is seen as a key risk to this species conservation status. The Revised Proposal has been designed to retain the Breakaways and Gullies habitat within the mesa escarpments, except where cuts are required to access the top of the mesa, and to avoid direct disturbance to a potential diurnal/maternal roost on Mesa B and a potential diurnal roost on Mesa C.

Vibration levels and direct disturbance near the potential diurnal/maternal roosts have been selected as triggers as both can be directly targeted to the highest value habitat, are readily measurable, can be monitored regularly and are consistent with other Ghost Bat monitoring programs. Ensuring the vibration levels at the potential diurnal/maternal roosts remain below a peak particle velocity determined for each cave reduces the risk that vibrations compromise the structural integrity of the roosts.

The management objective adopted for the Ghost Bat is:

- Improve knowledge of the Ghost Bat population and utilisation of high value habitat in the Robe Valley in order to assist in maintaining biological diversity and ecological integrity

This management objective has been selected as it relates to the EPA objective for Terrestrial Fauna and is specific to the Revised Proposal. One of the limitations noted during the Environmental Impact Assessment for the Mesa A Hub is the lack of long-term data that would provide an estimate of natural Ghost Bat population variability and an indication of how the Ghost Bat utilises caves within the western part of the Robe Valley. The proposed management action to undertake a five-year study of Ghost Bat utilisation of high value habitat in the Robe Valley has been selected to start to address this limitation.

Terrestrial Fauna – Northern Quoll

Northern Quoll population numbers fluctuate on both annual and inter-annual cycles. This variability is driven by both the reproductive biology of individuals (males usually die-off after one year) and longer-term cycles in response to regional stochastic processes such as rainfall, fire and related changes of prey populations (How *et al.* 2009). This natural variability makes threshold criteria based on population dynamics inappropriate for compliance at this stage. Protection of high value habitat for the Northern Quoll is, therefore, the most appropriate strategy to protect this conservation significant fauna within the Development Envelope.

The environmental outcome adopted for the Northern Quoll is:

- No irreversible impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance

This outcome has been selected as the escarpments of Mesas A, B and C contain high value denning and foraging habit. The Revised Proposal has been designed to retain the mesa escarpments, except where cuts are required to access the top of the mesa, and to avoid the highest value sections of mesa escarpment (MWH 2015b).

A trigger and threshold have been developed for direct disturbance to the Breakaways and Gullies habitat of the retained escarpment. Direct disturbance to the Breakaways and Gullies habitat in the retained escarpment is readily measurable and can be monitored regularly. Ensuring direct disturbance to the Breakaways and Gullies habitat of the mesa escarpment is minimised reduces the risk that Northern Quoll denning habitat is disturbed or degraded.

Subterranean Fauna - Troglofauna

Outcome-based and management-based provisions have been adopted for troglofauna on the basis that objective measurement and reporting is possible for some parts of the environment but not for others.

Troglofauna surveys in general have low capture rates per survey effort meaning the abundance and diversity of troglofauna recorded during surveys are highly variable (Halse and Pearson 2014). These sampling artefacts mean that threshold criteria based on troglofauna abundance or diversity would be inappropriate at this stage. Protection of high value habitat for troglofauna is, therefore, considered the most appropriate strategy to protect trolgofauna so that biological diversity and ecological integrity are maintained. The following environmental outcome has been adopted:

- No irreversible impact, as a result of the Revised Proposal, to the troglofauna habitat retained within the Mesa A, B or C MEZs

Mesas A, B and C comprise iron-rich Robe Pisolite. Within the Development Envelope, Robe Pisolite is considered to be the geological unit that provides primary habitat for troglofauna. As the Robe Pisolite is also the target ore body, a key part of the design of the Revised Proposal is to ensure retention of a significant volume of Robe Pisolite habitat in the form of a MEZ. The environmental outcome has been selected to reflect this key part of the design of the Revised Proposal.

Trigger and threshold criteria have been developed to limit the direct removal, through operational error, of troglofauna habitat to be retained in the MEZ. Blasting and excavation carried out as part of the mining process have a degree of operational error associated with them. The trigger and threshold criteria, while recognising the practical limits to operational precision, have been structured to ensure that significant volumes of troglofauna habitat are not lost from the MEZ over the life of the mine. Volume excavated is readily measurable and is part of the causal relationship between mining and impacts on troglofauna. The use of volume as a trigger and threshold replaces the use of depth in the Mesa A Troglofauna Management Plan (Biota 2009) as depth measurement is subject to interpretation dependent on the angle of the measurement and does not represent the potential impact to troglofauna habitat as explicitly as a volume measurement.

The management objective adopted for troglofauna is:

- To minimise impacts as far as practicable to protect the biological diversity and ecological integrity of the troglofauna assemblage at Mesas A, B and C.

This management objective has been selected as it relates to the EPA objective for Subterranean Fauna and is specific to a key part of the Revised Proposal. Four management targets have been selected to assess whether the management actions are effective in meeting the environmental objective. Management targets relate to:

- **Clearing of native vegetation in the MEZs** to limit the potential for degradation of retained troglofauna habitat as a result of diminished organic nutrient inputs;
- **Troglofauna specimen capture rate** to assess whether the Revised Proposalhas an impact on troglofauna utilization of retained habitat in the MEZs;
- **Habitat connectivity and degree of troglofauna assemblage similarity at Dinner Camp and Highway/Tod Bore** to improve understanding of troglofauna ecology; and
- **Down hole temperature and humidity** to assess whether the Revised Proposalhas an impact on the subterranean climate.

Management actions and targets have been selected to address potential impacts of the Revised Proposal as well as to build upon existing data.

2. EMP PROVISIONS

This section of the EMP identifies the legal provisions that the Proponent will implement to ensure that the environmental outcomes and management objectives of conditions 6, 7, 8 and 9 are met during implementation of the Mesa A Hub Revised Proposal. Outcome-based and management-based provisions are provided in Section 2.1 and monitoring and reporting are further detailed in Sections 2.2 and 2.3.

2.1 Outcome-based and management-based provisions

The environmental outcomes, environmental criteria (trigger and threshold) and response actions (trigger level and threshold level) are provided in Table 2-1 to Table 2-6 for each environmental value that is to be managed using outcome-based provisions. Management objectives, management actions and management targets are also provided in Table 2-3, Table 2-4 and Table 2-6 for environmental values where management-based provisions are adopted.

Table 2-1: EMP Provisions – Hydrological Processes (groundwater abstraction and riparian vegetation)

Hydrological Processes – Groundwater abstraction and riparian vegetation of the Robe River and Warramboo Creek			
EPA objective: To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected **Key environmental values:** Riparian[1] vegetation of the Robe River and Warramboo Creek **Key impacts and risks:** Potential adverse impacts on riparian vegetation as a result of groundwater abstraction from the Mesa C CID aquifer and the Yarraloola aquifer			
Outcome-based provisions			
Outcome: No irreversible impact[2] to the health of riparian vegetation of the Robe River and Warramboo Creek as a result of groundwater abstraction for the Revised Proposal			
Environmental criteria	**Response actions**	**Monitoring**	**Reporting**
Trigger criterion: 1. The mean vegetation index for riparian overstorey[3] taxa (*E. victrix, E. camaldulensis and M. argentea*[4]) of the Robe River and Warramboo Creek changes by ≥ 2 standard deviations from baseline values.	• Review groundwater abstraction rate, extent of the cone of depression and the drawdown at potential impact sites in relation to predicted impacts on riparian vegetation • Review supporting groundwater level monitoring data (conducted under the Groundwater Operating Strategy) and field-based overstorey and understorey vegetation monitoring data at selected sites • From monitoring data determine whether the change in mean vegetation index is broadly represented by canopy cover changes or alternatively what proportion is manifesting as increased overstorey/understory mortality. • Review similar local/regional reference data with regard to climatic information (including rainfall, temperature, flooding and fires) to assess if changes are due to natural variation • Increase frequency and/or extent of on-ground assessments as appropriate • Review contingency actions/strategy • Implement remedial or management actions as appropriate • Consult with DWER if investigation indicates threshold criterion is likely to be exceeded	• Annual capture and analysis of remote sensing images within selected[5], established monitoring areas, as appropriate[6]	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions

[1] See Section 1.4.1 for more information regarding composition of riparian vegetation within the Robe River and Warramboo Creek systems.

[2] Where 'irreversible impact' is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

[3] Due to the difficulty in distinguishing (field) characteristics of *E. victrix* and *E. camaldulensis* (reliance on seed capsules that are not always present), the overstorey riparian vegetation will be represented as a functional group for the trigger and threshold criteria. Should any exceedance occur around these species specific on-ground investigations may be appropriate

[4] *M. argentea* present only in the Robe River system

[5] The Proponent will determine "selected" transects from established transects based on factors such as trigger and threshold outcome from annual survey, discharge and/ or dewatering extent and volume.

[6] Locations may not always be available due to accessibility, weather conditions, safety considerations etc

Environmental criteria	Response actions	Monitoring	Reporting
Threshold criterion: 1. The mean vegetation index for riparian overstorey taxa (*E. victrix, E. camaldulensis and M. argentea*[7]) for the Robe River and Warramboo Creek changes by ≥ 2 standard deviations from baseline values over three consecutive years.	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Increase frequency and/or extent of on-ground assessments as appropriate • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o analysis of trends of riparian tree health o schedule for ongoing reporting
Supporting[8] riparian monitoring parameters for the trigger and threshold criteria			
Riparian overstorey taxa (*E. victrix, E. camaldulensis, M. argentea*)	N/A	• Annual post-wet season field survey in selected[9], established transects, as appropriate[10]	N/A
Riparian understorey taxa (native and introduced)	N/A		

[7] *M. argentea* present only in the Robe River system

[8] Parameters collected during annual surveys will assist in the interpretation of trigger and threshold criteria should an exceedance or trend be noted.

[9] The Proponent will determine "selected" transects from established transects based on factors such as trigger and threshold outcome from annual survey, discharge and/ or dewatering extent and volume.

[10] Locations may not always be available due to accessibility, weather conditions, safety considerations etc.

Table 2-2: EMP Provisions – Hydrological Processes (surface water discharge and riparian vegetation)

Hydrological Processes – Surplus water discharge and riparian vegetation of Warramboo Creek			
EPA objectives: To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected. To maintain the quality of groundwater and surface water so that environmental values are protected **Key environmental values:** Riparian[11] vegetation of Warramboo Creek **Key impacts and risks:** Potential adverse impacts on riparian vegetation as a result of surplus water discharge to Warramboo Creek			
Outcome-based provisions			
Outcome: No irreversible[12] impact to the health of riparian vegetation of Warramboo Creek as a result of surplus water discharge from the Revised Proposal			
Environmental criteria	**Response actions**	**Monitoring**	**Reporting**
Trigger criterion: 1. The mean vegetation index for riparian overstorey[13] taxa (*E. victrix and E. camaldulensis*) of Warramboo Creek changes by ≥ 2 standard deviation from baseline values.	• Review discharge regime, frequency, extent and timing in relation to predicted impacts on riparian vegetation • Review supporting water quality data for surplus discharge (conducted under the Groundwater Operating Strategy) and supporting field-based overstorey and understorey vegetation monitoring data at selected sites • Review local/regional reference data • Increase frequency and/or extent of on-ground assessments as appropriate • Review contingency actions/strategy, including potential modification to surplus water management and discharge regime • Implement remedial or management actions as appropriate • Consult with DWER if investigation indicates threshold criterion is likely to be exceeded	• Annual survey within established monitoring area/s • Capture and analysis of remote sensing images within selected[14], established monitoring areas, as appropriate[15]	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions

[11] See Section 1.4.1 for more information regarding composition of riparian vegetation within the Warramboo Creek system.

[12] Where 'irreversible impact' is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

[13] Due to the difficulty in distinguishing (field) characteristics of *E. victrix* and *E. camaldulensis* (reliance on seed capsules that are not always present), the overstorey riparian vegetation will be represented as a functional group for the trigger and threshold criteria. Should any exceedance occur around these species specific on-ground investigations may be appropriate.

[14] The Proponent will determine "selected" transects from the established transects based on factors such as trigger and threshold outcome from H2 survey, discharge and/or dewatering extent and volume.

[15] Locations may not always be available due to accessibility, weather conditions, safety considerations etc.

Environmental criteria	Response actions	Monitoring	Reporting
Threshold criterion: 1. The mean vegetation index for riparian overstorey taxa (*E. victrix and E. camaldulensis*) of Warramboo Creek changes by ≥ 2 standard deviations from baseline value over three consecutive years	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o analysis of trends of riparian tree health o schedule for ongoing reporting
Trigger criterion: 2. Surface water expression present ≥ 6 km downstream of the discharge point in Warramboo Creek under natural no-flow conditions	• Review discharge regime, frequency, extent, timing and hydrological model • Review supporting field-based overstorey and understorey vegetation monitoring data at selected sites • Review contingency actions/strategy, including potential modification to surplus water management and discharge regime • Implement remedial or management actions as appropriate	• Monthly determination of surface water expression at established monitoring point under natural no-flow conditions[16]	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions

[16] Location may not always be available due to accessibility, weather conditions, safety considerations etc.

Environmental criteria	Response actions	Monitoring	Reporting
Threshold criterion: 2. Surface water expression present > 8 km downstream of the discharge point in Warramboo Creek under natural no-flow conditions	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Increase frequency and/or extent of on-ground assessments as appropriate • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o analysis of trends of riparian tree health o schedule for ongoing reporting
Trigger criterion: 3. Detection of new introduced species not previously detected within the riparian zone of Warramboo Creek	• Review introduced species' presence and abundance. Internally record, report, map and monitor. Investigate the risk of the introduced species becoming dominant • Implement weed management controls where required • Review weed hygiene practices	• Annual monitoring • Targeted monitoring as required	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions in controlling the introduced species in the riparian zone of Warramboo Creek

Threshold criterion: 3. New introduced species becomes established[17] and dominant within the riparian zone of Warramboo Creek	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o schedule of ongoing reporting
Supporting[18] riparian monitoring parameters for the trigger and threshold criteria			
Riparian overstorey taxa (*E. victrix, E. camaldulensis*)	N/A	• Annual post-wet season survey in selected[19], established transects, as appropriate[20]	N/A
Riparian understorey taxa (native and introduced)	N/A		

[17] Where 'established' means 'A weed species which has grown to maturity and reproduced. Weeds are producing a viable second generation of individual plants signifying persistence at a given location in spite of treatment.'

[18] Parameters collected during annual surveys will assist in the interpretation of trigger and threshold criteria should an exceedance or trend be noted.

[19] The Proponent will determine "selected" transects from the established transects based on factors such as trigger and threshold outcome from H2 survey, discharge and/ or dewatering extent and volume.

[20] Locations may not always be available due to accessibility, weather conditions, safety concerns etc.

Table 2-3: EMP Provisions – Flora and Vegetation (Sand Sheet Vegetation (Robe Valley) PEC)

Flora and Vegetation - Sand Sheet Vegetation (Robe Valley) PEC			
EPA objectives: To protect flora and vegetation so that biological diversity and ecological integrity are maintained **Key environmental values:** Priority Ecological Community – Sand Sheet PEC **Key impacts and risks:** Potential degradation of the Sand Sheet Vegetation (Robe Valley) PEC due to ground disturbance, increased dust deposition and introduction of weed species as a result of implementation of the Revised Proposal			
Outcome-based provisions			
Outcome: No direct disturbance to the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal that results in an irreversible[21] impact, other than existing and authorised disturbance			
Environmental criteria	**Response actions**	**Monitoring actions**	**Reporting**
Trigger criterion: 1. Inadvertent ground disturbance or clearing of the Sand Sheet Vegetation (Robe Valley) PEC	• Inform all personnel of clearing restrictions within PEC boundaries and restrict access to authorised personnel only • Re-assess work practices and training needs to prevent further disturbance	• Annual land clearing reconciliation against Sand Sheet Vegetation (Robe Valley) PEC boundaries utilising GIS layers	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions at preventing further inadvertent ground disturbance in the Sand Sheet Vegetation (Robe Valley) PEC
Threshold criterion: 1. Inadvertent ground disturbance or clearing resulting in long-term loss of vegetation[22] within the Sand Sheet Vegetation (Robe Valley) PEC.	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o schedule for ongoing reporting

[21] Where 'irreversible impact' is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

[22] As indicated by no re-generation of Sand Sheet Vegetation (Robe River) PEC species after five years of attempted rehabilitation

Environmental criteria	Response actions	Monitoring actions	Reporting
Trigger criterion: 2. Detection of new introduced species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC	• Review monitoring results for emerging spatial and temporal trends and correlations between rainfall and fire patterns • Implement targeted monitoring of vegetation condition, introduced species or key species where required • Review introduced species' presence and abundance. Internally record, report, map and monitor. Investigate the risk of the introduced species becoming dominant • Implement weed management controls where required • Review weed hygiene practices	• Annual quadrat monitoring • Targeted monitoring as required	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions in controlling the introduced species in the Sand Sheet Vegetation (Robe Valley) PEC
Threshold criterion: 2. New introduced species becomes established[23] and dominant within the Sand Sheet Vegetation (Robe Valley) PEC	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o schedule of ongoing reporting

[23] Where 'established' means 'A weed species which has grown to maturity and reproduced. Weeds are producing a viable second generation of individual plants signifying persistence at a given location in spite of treatment.'

Management-based provisions			
Management objective: To minimize impacts from the Revised Proposal to the Sand Sheet Vegetation (Robe Valley) PEC as far as practicable so that the biological diversity and ecological integrity of the PEC are maintained			
Management actions	**Management targets**	**Monitoring**	**Reporting**
Design infrastructure such that there is no loss of catchment, excluding existing and authorised disturbance, affecting surface water flow to the Sand Sheet Vegetation (Robe Valley) PEC. Continue to implement dust control measures at the Mesa A Hub.	• Persistence of the four key species (*Corymbia zygophylla*, *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* and *Triodia schinzii*) of the Sand Sheet Vegetation (Robe Valley) PEC • No loss of catchment for the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal, other than existing and authorised disturbance. • 24-hour average dust levels (PM10), attributable to the Revised Proposal, no greater than 70ug/m^3 as measured at the Sand Sheet Vegetation (Robe Valley) PEC	• Annual quadrat monitoring including visual assessment of condition and visual dust cover rankings • Dust monitoring around the Sand Sheet PEC and at reference sites	• The environmental outcome will be reported against the management target for each calendar year by 30 April in the ACAR for MS xxxx • If the management target was not met during the reporting period, the annual report will include discussion of the effectiveness of the management actions and whether revision of the management actions is required

Table 2-4: EMP Provisions – Terrestrial Fauna (Ghost Bat)

Terrestrial fauna – Ghost Bat			
EPA objectives: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained **Key environmental values:** Conservation significant fauna species – Ghost Bat **Key impacts and risks:** Potential loss or degradation of high value (roosting) habitat as a result of implementation of the Revised Proposal			
Outcome-based provisions			
Outcome: No irreversible[24] impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance			
Environmental criteria	**Response Actions**	**Monitoring**	**Reporting**
Trigger criterion: 1. Vibration levels exceed 50 mm/s peak particle velocity at the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7.	• Complete in-field inspection of the area • Review blast vibration predictions and blast vibration monitoring data • Update vibration model if appropriate • Review supporting Ghost Bat monitoring data	• Blast vibration monitoring for all blasts within 300 m of the potential diurnal/maternal Ghost Bat roosts	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions in controlling vibration levels at the potential diurnal/maternal Ghost Bat roost caves
Threshold criterion: 1. Significant damage[25] to diurnal/maternal Ghost Bat roost caves.	As for trigger level actions with the addition of: • Conduct geotechnical assessment of the site to assess structural stability of the roost • If structural stability of the roost is considered to be compromised as a result of the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions

[24] Where 'irreversible impact' is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

[25] Where 'significant damage' is defined as, 'damage that negatively impacts the integrity of the cave such that future Ghost Bat use of the site is prevented'.

			o schedule for ongoing reporting
Environmental criteria	**Response Actions**	**Monitoring**	**Reporting**
Trigger criterion: 2. Disturbance, other than approved clearing, within 50 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves	• Complete in-field inspection of the area. • Review site specific observations; clearing extent; blast vibration predictions / blast vibration monitoring levels; and other natural factors (i.e. seasonal rainfall data etc.) to determine if disturbance is attributable to implementation of the Revised Proposal. • Review supporting Ghost Bat monitoring data • Investigate potential remediation strategies (such as review of land clearing procedure or modified blast management strategy).	• Annual land clearing reconciliation against potential diurnal/maternal Ghost Bat roost caves	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions in managing disturbance near the potential diurnal/maternal Ghost Bat roost caves
Threshold criterion: 2. Disturbance, other than approved clearing, within 40 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves	As for trigger level actions with the addition of: • Conduct geotechnical assessment of the site to assess structural stability of the roost • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o schedule for ongoing reporting
Supporting[26] Ghost Bat monitoring parameters for the trigger and threshold criteria			
Ghost Bat monitoring	N/A	• Annual assessment of evidence of Ghost Bat use in potential diurnal/ maternal roost caves in the broader Robe Valley	N/A

[26] Parameters collected during annual surveys will assist in the interpretation of trigger and threshold criteria should an exceedance or trend be noted.

Management-based provisions			
Management objective: Improve knowledge of the Ghost Bat population and utilisation of high value habitat in the Robe Valley in order to assist in maintaining biological diversity and ecological integrity			
Management Actions	**Management Targets**	**Monitoring**	**Reporting**
Undertake a five year study of Ghost Bat utilisation of high value habitat	• Estimate[27] the local population of Ghost Bats in the western part of the Robe Valley • Indicate how Ghost Bats use caves within the western part of the Robe Valley (e.g. diurnal versus maternal), including the degree of utilisation of caves by pregnant females[28]	• Bi-annual collection and analysis (genetic and hormone) of scat samples from across the broader Robe Valley[29]	• The environmental outcome will be reported against the management target for each calendar year by 30 April in the ACAR for MS xxxx • If a management target was not met during the reporting period, the annual report will include discussion of the effectiveness of the management actions and whether revision of the management actions is required

[27] Preliminary estimate of the local population based on the data collected during the five year study period

[28] Preliminary indication of utilisation based on the data collected during the five year study period

[29] Access subject to safety and heritage assessments of caves

Table 2-5: EMP Provisions – Terrestrial Fauna (Northern Quoll)

Terrestrial fauna – Northern Quoll			
EPA objectives: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained **Key environmental values:** Conservation significant fauna species – Northern Quoll **Key impacts and risks:** Potential loss or degradation of high value (denning) habitat as a result of implementation of the Revised Proposal			
Outcome-based provisions			
Outcome: No irreversible[30] impact, as a result of the Revised Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance			
Environmental criteria	**Response Actions**	**Monitoring**	**Reporting**
Trigger criterion: 1. Disturbance of ≥ 5% of viable Northern Quoll denning habitat on the retained escarpments (MEZs) of Mesa A, B or C	• Complete in-field inspection of the area. • Review site specific observations such as clearing extent and natural factors (e.g. seasonal rainfall data) to determine if disturbance is attributable to implementation of the Revised Proposal. • Review supporting Northern Quoll monitoring data • Review local/regional reference data • Increase frequency and/or extent of on-ground assessments as appropriate • Investigate potential remediation strategies	• Annual land clearing reconciliation against escarpments of Mesas A, B and C	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx If the trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions in managing disturbance of the mesa escarpments

[30] Where 'irreversible impact' is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

Environmental criteria	Response Actions	Monitoring	Reporting
Threshold criterion: 1. Disturbance of >10% of viable denning Northern Quoll habitat on the retained escarpments (MEZs) of Mesa A, B or C	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o effectiveness of contingency actions o schedule for ongoing reporting
Supporting[31] Northern Quoll monitoring parameters for the trigger and threshold criteria			
Northern Quoll monitoring	N/A	Annual field survey of Northern Quoll	N/A

[31] Parameters collected during annual surveys will assist in the interpretation of trigger and threshold criteria should an exceedance or trend be noted.

Table 2-6: EMP Provisions – Subterranean Fauna (troglofauna)

Subterranean fauna – troglofauna			
EPA objectives: To protect subterranean fauna so that biological diversity and ecological integrity are maintained **Key environmental values:** Subterranean fauna - troglofauna **Key impacts and risks:** Loss of habitat from mining as a result of implementation of the Revised Proposal			
Outcome-based provisions			
Outcome: No irreversible impact, as a result of the Revised Proposal, to the troglofauna habitat retained within the Mesa A, B or C MEZs			
Environmental criteria	**Response Actions**	**Monitoring actions**	**Reporting**
Trigger criterion: 1. Operational error **during mining** resulting in removal of greater than 0.01% by volume annually per mesa of the MEZ at Mesas A, B or C	• Review 3-dimensional pit shell and adjust to ensure no predicted net loss of the MEZ per individual mesa (i.e. amend mine plan to ensure retention of the same volume of habitat as approved under MS xxxx; or backfill; or attempt habitat recreation) • Assess the adequacy of work practices and propose changes if necessary to prevent future deviations from the planned 3-dimensional pit shell.	• Annual pit shell reconciliation for mine pits at Mesas A, B and C	• The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx • If the trigger criterion was exceeded during the reporting period, • The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS xxxx. • If trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions to prevent removal of the MEZ
Threshold criterion: 1. Net loss of the MEZ at Mesas A, B or C at **completion of mining**	As for trigger level actions with the addition of: • If exceedance of threshold criterion is considered likely to be attributable to the Revised Proposal, submit a report including proposed contingency actions (e.g. backfill; attempt habitat recreation) to the DWER • Implement contingency action/s as agreed with the DWER • Monitor to ensure contingency actions are successful and review procedures, if appropriate	• Monitor the effectiveness of contingency actions	• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being known • The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR • If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the adequacy of threshold contingency action/s that have been implemented to manage the potential impact • Submit a report within 12 months after notification to the DWER of the non-compliance detailing the: o adequacy of contingency actions to re-instate the appropriate amount of lost habitat o schedule for ongoing monitoring and reporting

Management-based provisions			
Management objective: To minimize impacts as far as practicable to protect the biological diversity and ecological integrity of the troglofauna assemblages of Warramboo and Mesas A, B and C			
Management actions	**Management targets**	**Monitoring**	**Reporting**
• Maintain MEZ (significant troglofauna habitat). • Minimise ground disturbance and potential for degradation in the retained MEZ habitat. • Backfill waste rock to support any projecting 'fingers' of rock in the MEZ. • Continue to improve understanding of troglofauna ecology, particularly in the Highway/Tod Bore and Dinner Camp Bore areas.	• Total clearing of native vegetation across the surface of the Mesa B and C MEZs is less than 30% of each MEZ surface area. • Troglofauna specimen capture rate is not below the baseline minimum for three consecutive sampling events for each individual location (Warramboo, Mesas A, B and C). • Estimate the degree of habitat connectivity and degree of troglofauna assemblage similarity between Highway/Tod Bore and Dinner Camp Bore areas. • No statistically significant change in down hole temperature and relative humidity in the Mesa A or B MEZs relative to reference sites.	• Annual land clearing reconciliation against escarpments of Mesas A, B and C. • Biennial troglofauna field survey. • Continuous down hole temperature and humidity monitoring. • Rainfall with daily total reporting.	• The environmental outcome will be reported against the management target for each calendar year by 30 April in the ACAR for MS xxxx. • If a management target was not met during the reporting period, the annual report will include discussion of the effectiveness of the management actions and whether revision of the management actions is required.

2.2 Monitoring

Monitoring will be undertaken to measure performance against the environmental outcomes and to assess the effectiveness of management actions in meeting management-based objectives. Monitoring will inform, through the environmental criteria, when trigger or threshold contingency actions will be implemented. A missed monitoring event will not be treated as a non-compliance provided the Proponent can validate that the required environmental outcome or management objective has still been achieved, for example through the use of alternative data.

a) Hydrological Processes and riparian vegetation

The Proponent will monitor the health of riparian vegetation of the Robe River and Warramboo Creek both within the potential groundwater drawdown and surplus water discharge impact zones and at reference sites.

The effects of groundwater drawdown on facultative and obligate phreatophytes are dependent upon both the baseline groundwater level and the rate of groundwater drawdown. For example, trees accessing shallow groundwater may be more sensitive to groundwater drawdown than trees growing above a groundwater table at greater depth. While it is inherently difficult to interpolate local groundwater table elevation from limited data and hence predict groundwater dependence of local phreatophytes, monitoring the cover of the upper canopy provides an indicator of stress either due to groundwater drawdown or due to surplus water discharge. The health of phreatophytic species along the Robe River and Warramboo Creek will, therefore, be monitored utilizing remote sensing with supporting field-based surveys. Due to the difficulty of distinguishing phreatophytic riparian trees using remote sensing, the phreatophytic assemblages of the Robe River and Warramboo Creek will be treated as a functional group 'riparian overstorey' for trigger and threshold criteria.

The Proponent will monitor the health of obligate and facultative vegetation of the Robe River and Warramboo Creek using modified soil-adjusted vegetation index (mSAVI) to ensure there are no significant changes to health beyond natural variation. Annual remote sensing will provide an indication of vegetation condition over the riparian zones. The foliage cover of the upper canopy will be assessed as a time series, to compare against both baseline conditions and also alongside correlative parameters including rainfall, water levels and fire. The large coverage of canopy captured in remote sensing will accommodate assessment of potential relationships between dewatering and vegetation condition across the entire riparian zone, overcoming some of the limitations of field-based assessment. Remote sensing (mSAVI) has been selected as an appropriate monitoring technique to examine the spectral vegetation index for of the upper canopy. Vegetation indices (mSAVI) provide a representation of the cover and photosynthetic vigour of vegetation, by assessing the ratio or red and near-infra red radiation wavelengths. Changes to spectral vegetation index can, therefore, be used to provide a meaningful indication of vegetation condition and stress. The monitoring to be undertaken is summarised in Table 2-7.

Table 2-7: Monitoring required to evaluate performance against the environmental outcomes for hydrological processes and riparian vegetation

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Capture and analysis of remote sensing images (criterion 1)	Selected potential impact sites and reference sites established during baseline monitoring	Annual during operational mine life[1] Post-wet season	Remote sensing images Calculation of mSAVI and analysis of changes to mSAVI	Operations Environment team
Monitoring of surface water expression (criterion 2)	Monitoring point established prior to commencement of groundwater abstraction and surplus water discharge for the Revised Proposal	Monthly during operational mine life when natural no-flow conditions are present and access is possible[1]	Visual inspection or camera	Hydrology team/ Operations Environment team
Monitoring of introduced species in the riparian zone of Warramboo Creek (criterion 3)	Selected transects established during baseline monitoring	Annual during operational mine life[1] Post wet season	Introduced species, number and locations	Operations Environment team
Annual field survey (supporting monitoring)	Selected transects established during baseline monitoring	Annual during operational mine life[1] Post wet season	Overstorey riparian taxa: species, number of individual species[2], DBH[3], habitat, height, health Understorey riparian taxa: species, projected foliage cover, habitat, vegetation description, vegetation condition (disturbance notes), photographs Introduced species: species, foliage cover, number of species (rooted in quadrat), condition, location	Operations Environment team

[1] Locations may not always be available due to accessibility, weather conditions, safety considerations etc.
[2] Number (count) of individuals (shrubs and trees) that would usually grow >1 m in height
[3] DBH (Diameter at Breast Height) for overstorey riparian species

Baseline data from potential impact and reference sites will be collected prior to operations commencing to quantify natural variation in foliage cover (and health). The mean of all measurements made during the baseline period will be calculated for each reach (or system). Changes over time at these reaches (or zones) will be compared back to the baseline and to reference sites to assess any potential impacts from the Revised Proposal.

A decline in mSAVI of ≥ 2 standard deviations from the baseline for upper canopy vegetation has been selected as the trigger (trigger criterion 1) to prompt causal investigation and if necessary, remedial actions. Applying criteria to the results of one image with no temporal replication does not adequately accommodate investigation into causation, and comparison with vegetation health

at reference sites, and hence is not appropriate as a pass/fail compliance measure. However, a shift of ≥ 2 standard deviations from a sample of adequate size (through spatial coverage) does warrant investigation, including time series assessment of vegetation condition in conjunction with correlative environmental parameters and monitoring results from reference sites. The outcomes of investigation will inform the Proponent whether dewatering operations pose a risk of irreversible impact to the riparian vegetation of the Robe River and Warramboo Creek.

A decline in mSAVI of ≥ 2 standard deviations from the baseline for upper canopy vegetation over a period of three years has been selected as the threshold criterion (threshold criterion 1). In the absence of data to support that obligate and facultative phreatophytic species can recover or re-establish following periods of stress, a decline of ≥ 2 standard deviations from baseline has been selected as a pass/fail criterion. In the event this criterion is exceeded, the Proponent will conduct additional assessments of the impacted riparian vegetation, and liaise with the EPA Services on both the appropriateness of a decline of ≥ 2 standard deviations as a compliance threshold, and also the remedial actions required to prevent the impacts becoming irreversible.

The species richness and cover of both native and introduced species will be recorded during field-based, post-wet season, supporting monitoring surveys in selected transects established during baseline surveys (Table 2-7). Supporting monitoring is not directly required as a measure of performance but will provide supporting data to assist in investigation of any trends noted from remote sensing and to identify whether vegetation condition is trending in a uniform manner across all taxa or if there are shifts in community assemblage and diversity.

b) Flora and vegetation (Sand Sheet PEC)

Annual quadrat monitoring of the Sand Sheet (PEC) has been conducted since 2008. Historically, visual assessment at quadrats, dust monitoring data, visual dust cover rankings, leaf chlorophyll fluorescence and remote sensing have been utilised to assess changes to vegetation condition (Biota 2016, Astron 2017). The Proponent considers that field-based monitoring continues to be the most suitable approach for monitoring community structure and species diversity (native and introduced) and, therefore, the overall condition of the Sand Sheet PEC. This EMP, therefore, includes a field-based monitoring program that builds upon previously collected monitoring data by incorporating parameters from the historical quadrat monitoring and field observations.

It is recognised that the condition of the Sand Sheet PEC is influenced by local environmental conditions, including rainfall and fire, that may result in natural variation in the monitoring results. There are limited baseline data available for the Sand Sheet PEC and identified reference sites are limited in that whilst they share some characteristics, they are not completely representative of the species and structure of the Sand Sheet PEC. These two factors constrain the consideration of local environmental conditions when analysing the Sand Sheet monitoring data.

Monitoring potential direct disturbance to the Sand Sheet PEC (criterion 1) will involve reconciliation of the Geographical Information System (GIS) disturbance layers against the Sand Sheet PEC boundaries on an annual basis.

The Proponent has well established strategies for monitoring and management of the risk of weed ingress at its Pilbara operations. The Proponent will continue to implement hygiene procedures to prevent introduction of new or additional populations of weed species at entry and exit points of the Development Envelope and to undertake an annual weed control program to minimise weed infestations in the Development Envelope. Monitoring the potential introduction of invasive species into the Sand Sheet PEC (criterion 2) will involve annual quadrat monitoring to determine the presence (and extent) of introduced flora species, along with targeted foot traverses within the Sand Sheet PEC as required. This monitoring will also supply information relevant to the management-based provisions listed in Table 2-3.

Annual quadrat monitoring of the Sand Sheet PEC will be conducted between July and September for consistency with historical monitoring. Monitoring of the 50 m x 50 m quadrats (Figure 2-1) will include as a minimum:

- Vegetation description,
- Habitat description,
- Soil description,
- Disturbance notes,
- Species recruitment notes,
- Species present,
- % foliage cover for each species (recorded as a number, not a category/class),
- Height (cm) for each species,
- Dust cover (visual rating) per quadrat,
- Photograph (from the NW corner).

Systematic searches for conservation significant flora and introduced flora species will be conducted as part of the annual quadrat monitoring. The searches will cover the entire Sand Sheet PEC as foot traverses approximately 50 m-70 m apart.

Targeted monitoring may also be required where a trigger criterion is met. This may include, foot traverses and observations to determine the extent of the change, mapping of weed infestations and assessment of vegetation condition.

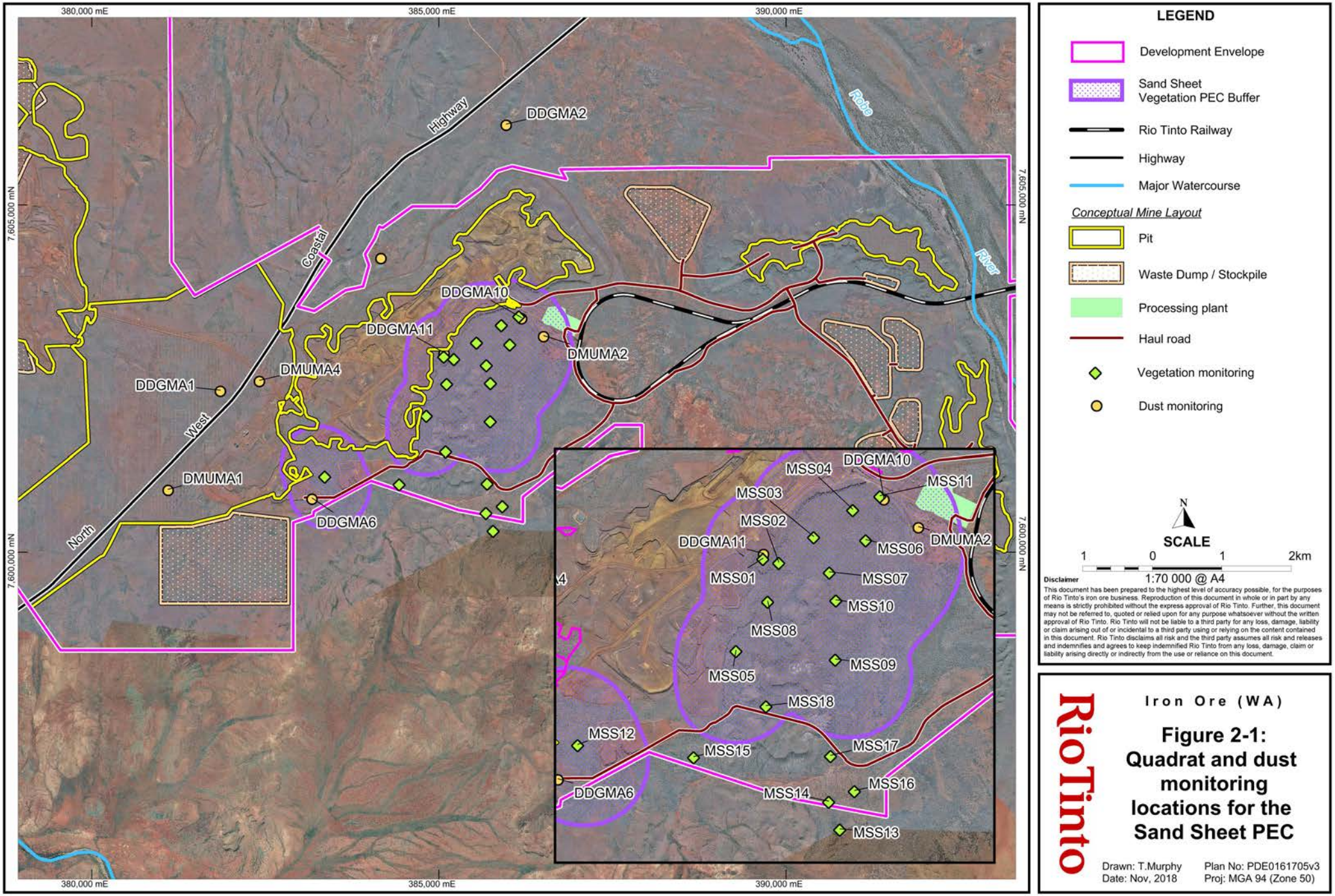
Annual dust monitoring will be carried out with the annual quadrat monitoring (visual ratings), along with analysis of data from E-sampler dust monitors and dust deposition gauges.

Table 2-8 summarises the monitoring required to measure performance against the environmental outcome and to assess the effectiveness of management actions in meeting the management-based objective.

Table 2-8: Monitoring required to evaluate performance against the environmental outcome and to assess the effectiveness of management actions for the Sand Sheet PEC

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Land clearing reconciliation (criterion 1)	Sand Sheet PEC	Annual during operational mine life	GIS avoidance and disturbance layers. Internal approvals request process	Operations Environment team
Quadrat monitoring of the Sand Sheet PEC (criterion 2 and management targets)	Monitoring sites MSS01-MSS12 Reference sites MSS13-MSS18 (Figure 2-1)*	Annual during operational mine life July-September	Quadrat monitoring. Vegetation disturbance, visual assessment of vegetation condition, key species foliage cover, introduced flora species and visual dust cover.	Operations Environment team
Targeted monitoring (criterion 2)	Sand Sheet PEC	Annual during operational mine life (completed with quadrat monitoring)	Foot traverses across the extent of the PEC at intervals of 50m-70m. Vegetation disturbance, visual assessment of vegetation condition, number and locations of introduced flora species, and conservation significant flora species.	Operations Environment team
Dust monitoring (management target)	Sand Sheet PEC and reference sites (Figure 2-1)	Continuous during operation mine life	Dust deposition gauges and E-sampler dust monitors. Dust deposition and airborne dust levels	Operations Environment team

*Changes or additions to monitoring sites may be required



LEGEND

- Development Envelope
- Sand Sheet Vegetation PEC Buffer
- Rio Tinto Railway
- Highway
- Major Watercourse

Conceptual Mine Layout

- Pit
- Waste Dump / Stockpile
- Processing plant
- Haul road
- Vegetation monitoring
- Dust monitoring

N

SCALE

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1:70 000 @ A4

Rio Tinto

Iron Ore (WA)

Figure 2-1: Quadrat and dust monitoring locations for the Sand Sheet PEC

Drawn: T.Murphy
Date: Nov, 2018

Plan No: PDE0161705v3
Proj: MGA 94 (Zone 50)

Geospatial Information and Mapping

c) Terrestrial fauna (Ghost Bat)

Protection of high value habitat for the Ghost Bat is the most appropriate strategy to protect this conservation significant fauna within the Development Envelope. High value habitat for the Ghost Bat includes the escarpment and cave structures associated with mesa formations in the Robe Valley. Trigger and threshold criteria have been applied to potential diurnal/maternal roosts, as diurnal/maternal roosts are recognised as geographically restricted and ecologically important. Baseline monitoring of the potential diurnal/maternal cave on Mesa B (MBC-05) and the potential diurnal cave on Mesa C (MCC-02) will continue to be undertaken prior to commencement of mining. Additional data from longer term monitoring of these caves may indicate that a different status, and potentially a different level of management, may be appropriate for these caves; this may require revision of the EMP.

Vibration levels will be measured at the potential diurnal/maternal Ghost Bat roost caves on Mesas B and C for all blasts within 300 m of the potential diurnal/maternal roosts. Ensuring the vibration levels at the potential diurnal/maternal roosts remain below a peak particle velocity determined for each cave reduces the risk that vibrations compromise the structural integrity of the roosts. Annual land clearing reconciliation using GIS disturbance layers will also be undertaken to monitor disturbance close to the potential diurnal/maternal roost caves. Annual visual assessment of Ghost Bat roost utilisation across the broader Robe Valley will also be completed as supporting monitoring to provide context to any potential impacts from blasting or ground disturbance in the vicinity of the potential diurnal/maternal roosts.

The Proponent has identified that there is a lack of regional population studies for the Ghost Bat to assist in understanding the long-term natural population variability and movements of this species. The EMP includes a management objective to improve knowledge of the Ghost Bat population and utilisation of high value habitat in the Robe Valley. The associated monitoring includes a five year program of bi-annual collection of scats from Ghost Bat roost caves (diurnal/maternal and nocturnal) across the broader Robe Valley where safety and heritage considerations allow. Scats will be collected twice per year, including over the pregnancy period, and analysis of scat samples will include genetic and hormone analysis to provide information on utilisation of caves by individuals, including pregnant females. The five year program will also meet the requirements of the supporting annual visual assessment of Ghost Bat utilisation of diurnal/maternal roosts across the broader Robe Valley. The Proponent proposes that upon completion of the five year scat collection program, annual visual assessment of Ghost Bat utilisation of diurnal/maternal roosts across the broader Robe Valley will continue.

Table 2-9 summarises the monitoring required to measure performance against the environmental outcome and to assess the effectiveness of management actions in meeting the management-based objective.

Table 2-9: Monitoring required to evaluate performance against the environmental outcome and to assess the effectiveness of management actions for the Ghost Bat

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Vibration levels (criterion 1)	Caves MBC-05 and MCC-02 (Figure 1-7)	For all blasts within 300m of caves MBC-05 and MCC-02	Modelling of peak particle velocity prior to blast. Vibration monitoring of actual peak particle velocity. Analysis of modelled versus actual peak particle velocity.	Drill and Blast team
Land clearing reconciliation (criterion 2)	Caves MBC-05 and MCC-02 (Figure 1-7)	Annual during operational mine life	GIS avoidance and disturbance layers. Internal approvals request process.	Operations Environment team
Scat collection and analysis (management target)	Diurnal/ maternal and nocturnal roost caves across the broader Robe Valley*	Bi-annual for 5 years	Scat collection from Ghost Bat roost caves using drop sheets. Scats to be collected over the pregnancy period. Genetic and hormone analysis. Measurement of temperature and humidity in Ghost Bat roost caves.	Operations Environment team
Assessment of evidence of Ghost Bat use in potential/diurnal caves (supporting monitoring)	Diurnal/ maternal roost caves across the broader Robe Valley*	Annual	Visual assessment	Operations Environment team

* Access subject to safety and heritage assessments of caves

d) Terrestrial fauna (Northern Quoll)

Protection of high value habitat for the Northern Quoll is the most appropriate strategy to protect this conservation significant fauna within the Development Envelope. High value habitat for the Northern Quoll in the Robe Valley includes the Breakaways and Gullies habitat contained within the mesa escarpments which provides denning habitat. Trigger and threshold criteria for disturbance to Northern Quoll denning habitat on the retained escarpments of Mesas A, B and C will be applied.

Offset actions are being undertaken as part of the approved Yandicoogina Threatened Species Offset Plan (**TSOP**) on parts of Yarraloola Pastoral Station. Yarraloola Pastoral Station underlies and surrounds the Mesa A Hub area.

An annual field survey of Northern Quoll will be undertaken as supporting monitoring. Offset actions, including Northern Quoll monitoring, are currently being undertaken on parts of Yarraloola Station as part of the approved Yandicoogina Threatened Species Offset Plan (TSOP). Yarraloola Pastoral Station underlies and surrounds part of the Development Envelope. Camera monitoring and trap monitoring protocols for the annual field survey will be based on the protocols established as part of the TSOP so that data from the two programs are comparable. Forty cameras will be utilised at eight mesas across the Robe Valley (nominally Mesa A, Mesa B, Mesa C, Mesa F, Mesa G, Mesa H, Mesa 2402D and Mesa 2403E).

Four trap sites will be established within the Robe Valley and designed in two categories ‘impact’ or ‘reference’ sites. Impact sites will be located at Mesa B (TSOP Site Q) and Mesa H (TSOP Site L) and reference sites will be located at Mesa G (TSOP Site K) and Mesa F (TSOP Site B).

Each site will consist of 20 cage traps spaced at 50 m intervals and will be set up, where possible, in preferred habitat for this species in the Robe Valley. The preferred habitat is seen as the rocky escarpments abutting a major drainage system (i.e. Robe River).

Table 2-10 summarises the monitoring required to measure performance against the environmental outcome and the supporting field monitoring that will be undertaken.

Table 2-10: Monitoring required to evaluate performance against the environmental outcome for the Northern Quoll

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Land clearing reconciliation (criterion 1)	Escarpments of Mesas A, B and C	Annual during the operational mine life	GIS avoidance and disturbance layers. Internal approvals request process.	Operations Environment team
Annual field survey (supporting monitoring)*	Escarpments of mesas across the broader Robe Valley 40 camera monitoring sites spread over Mesa A, Mesa B, Mesa C, Mesa F, Mesa G, Mesa H, Mesa 2402D and Mesa 2403E 4 trap monitoring sites located at Mesa B, Mesa H, Mesa G and Mesa F	Annual (May–September) during operational mine life	Camera monitoring Trapping	Operations Environment team

* Monitoring frequency, type of monitoring and monitoring sites for the annual field survey will be reviewed after 3 years of monitoring.

e) Subterranean fauna (troglofauna)

Protection of high value habitat for troglofauna is the most appropriate strategy to protect troglofauna so that biological diversity and ecological integrity are maintained. High value habitat in the Development Envelope includes the Robe Pisolite comprising Mesas A, B and C. The Proponent will ensure that at least 50% by volume of pre-mining troglofauna habitat will be retained at each mesa through delineation of a MEZ at each mesa. The Proponent has conservatively assumed that each mesa formation represents an isolated habitat thus trigger and threshold criteria will be applied to each mesa individually.

Monitoring of the retained volume of troglofauna habitat in the MEZs will require regular on-ground surveying of the actual pit shell for comparison with the planned pit shell.

An annual field survey for troglofauna specimens will also be conducted (Table 2-11). This will be the primary source of monitoring data with which to evaluate progress against management targets. As a minimum, the survey will include trapping and scraping from 25 drill holes at each of Mesas A, B and C, ten drill holes at Warramboo, 22 drill holes at Warramboo/Tod Bore and seven drill holes at Dinner Camp Bore. Previously sampled sites will be used wherever possible to ensure results from each survey are readily comparable. All specimens will be identified to species level and aligned with existing taxa/specimens where possible. Molecular identification will be used where morphological identification is not possible or is less efficient. All specimens with troglomorphic characteristics will be included in the analysis and reporting as 'potentially troglobitic' until shown otherwise.

Following biennial sampling, troglofauna capture rate will be calculated as the number of troglobitic specimens collected per 100 trapping sites, per survey. Appendix 1 shows baseline values for capture rates at Mesa A, Mesa B, Mesa C and Warramboo/Highway/Tod Bore. Capture rate has naturally high variability with survey timing, location and rainfall potentially

influencing the capture rate. Specimens collected via scraping will be excluded from capture rate calculations to ensure pre-mining data are comparable with data collected during mining.

Monitoring of rainfall and downhole temperature and humidity is currently undertaken at Mesas A and B. Review of the measurement of subterranean temperature and humidity conducted under the Mesa A Troglofauna Management Plan indicated that the monitoring is providing valuable data about the subterranean environment. Monitoring of subterranean temperature and humidity will, therefore, be continued (Table 2-11). The Revised Proposal will result in one of the monitoring stations at Mesa A being decommissioned; eleven monitoring stations will remain accessible. Monitoring will also continue at Mesa B, with two of the three monitoring stations to be moved to the MEZ at Mesa B. An additional three monitoring stations will also be established at Mesa F as reference sites. Temporary downhole temperature and humidity monitoring stations will also continue to be used where practicable in the Mesa A pit floor. The design of the subterranean temperature and humidity monitoring program thus includes monitoring before mining (Mesa B), during mining (Mesa A and subject to approval, Mesa B) and in reference habitat (Mesa F). The information collected from the monitoring program can be applied more broadly across the Robe Valley for design purposes and to assist in understanding the effect of mining on the downhole temperature and humidity in mesa formations.

Table 2-11: Monitoring required to evaluate performance against the environmental outcome and to assess the effectiveness of management actions for troglofauna

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Pit shell reconciliation (criterion 1)	Mine pits at Mesas A, B and C	Annual during operational mine life	High accuracy differential GPS. 3-dimensional coordinates of the mine pit shell in the area of active mining. Reconcile actual and planned 3-dimensional pit shell.	Mine Planning team
Land clearing reconciliation (management target)	MEZs at Mesas A, B and C	Annual during operation mine life	GIS avoidance and disturbance layers. Internal approvals request process.	Operations Environment team
Troglofauna field survey (management target)	- 25 drill holes in the Mesa A MEZ - 25 drill holes in the Mesa B MEZ - 25 drill holes in the Mesa C MEZ - 10 drill holes at Warramboo - 22 drill holes at Highway/Tod Bore - 7 drill holes at Dinner Camp Bore	Biennial during operational mine life Post- wet season	Trapping and scraping. Morphological and molecular species level identifications. Analysis to evaluate capture rate and degree of troglofauna assemblage similarity between Highway/Tod Bore and Dinner Camp Bore areas.	Operations Environment team
Downhole temperature and humidity monitoring (management target)	Permanent sites at Mesas A, B and F: - 10 sites at Mesa A - 3 sites at Mesa B - 3 sites at Mesa F Temporary sites in the pit floor at Mesa A	Continuous data collection with annual analysis during operational mine life	Downhole temperature and humidity monitoring using permanently installed specialised probes	Operations Environment team
Rainfall monitoring (management target)	Mesa A	Rainfall with daily total reporting	Weather station equipment. Standard method	Operations Environment team

2.3 Reporting

The environmental outcomes will be reported against trigger and threshold criteria and the effectiveness of management actions will be reported against management targets (Table 2-12) for each calendar year in the Annual Compliance Assessment Report (ACAR) for the Mesa A Hub against MS xxxx.

The annual report will also include a summary of the analysis of monitoring data to facilitate adaptive management.

In the event that trigger and threshold criteria are exceeded during the reporting period or management targets are not met, the annual report will include a description of the effectiveness of any management contingency actions that have been implemented to manage the impact. A

stand-alone report will also be produced for the Environmental Protection Authority Services (EPAS) within 21 days of any exceedance of the threshold criteria. A follow up report detailing the adequacy of the response actions will also be submitted to the EPAS within 12 months of the initial notification.

Table 2-12: Mesa A Hub Environmental Management Plan reporting table

Key environmental factors: Hydrological Processes, Flora and Vegetation (riparian vegetation and Sand Sheet PEC), Terrestrial Fauna (Ghost Bat and Northern Quoll), Subterranean Fauna (troglofauna)	
Environmental outcomes, trigger and threshold criteria and management targets as per MS xxxx	**Reporting periods 1 January-31 December**
Trigger criteria:	**Status report:** Trigger criteria not exceeded Trigger criteria exceeded
1. The mean vegetation index for riparian overstorey taxa (*E. victrix, E. camaldulensis and M. argentea*) of the Robe River and Warramboo Creek changes by ≥ 2 standard deviations from baseline values. [groundwater abstraction]	
2. The mean vegetation index for riparian overstorey[32] taxa (*E. victrix and E. camaldulensis*) of Warramboo Creek changes by ≥ 2 standard deviation from baseline values. [surplus water discharge]	
3. Surface water expression present ≥ 6 km downstream of the discharge point in Warramboo Creek under natural no-flow conditions.	
4. Detection of new introduced species not previously detected within the riparian zone of Warramboo Creek.	
5. Inadvertent ground disturbance or clearing of the Sand Sheet Vegetation (Robe Valley) PEC.	
6. Detection of new introduced species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC.	
7. Vibration levels exceed 50 mm/s peak particle velocity at the potential diurnal/maternal Ghost Bat roost caves.	
8. Disturbance, other than approved clearing, within 50 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves.	
9. Disturbance of ≥ 5% of viable Northern Quoll denning habitat on the retained escarpments (MEZs) of Mesa A, B or C.	
10. Operational error **during mining** resulting in removal of greater than 0.01% by volume annually per mesa of the MEZ at Mesas A, B or C.	

[32] Due to the difficulty in distinguishing (field) characteristics of *E. victrix* and *E. camaldulensis* (reliance on seed capsules that are not always present), the overstorey riparian vegetation will be represented as a functional group for the trigger and threshold criteria. Should any exceedance occur around these species specific on-ground investigations may be appropriate.

Threshold criteria:	**Status report:** Threshold criteria not exceeded Threshold criteria exceeded
1. The mean vegetation index for riparian overstorey taxa (*E. victrix, E. camaldulensis and M. argentea*) for the Robe River and Warramboo Creek changes by ≥ 2 standard deviations from baseline values over three consecutive years. [groundwater abstraction]	
2. The mean vegetation index for riparian overstorey taxa (*E. victrix and E. camaldulensis*) of Warramboo Creek changes by ≥ 2 standard deviations from baseline value over three consecutive years. [surplus water discharge]	
3. Surface water expression present >8 km downstream of the discharge point in Warramboo Creek under natural no-flow conditions.	
4. New introduced species becomes established and dominant within the riparian zone of Warramboo Creek.	
5. Inadvertent ground disturbance or clearing resulting in long-term loss of vegetation within the Sand Sheet Vegetation (Robe Valley) PEC.	
6. New introduced species becomes established and dominant within the Sand Sheet Vegetation (Robe Valley) PEC.	
7. Significant damage to diurnal/maternal Ghost Bat roost caves.	
8. Disturbance, other than approved clearing, within 40 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves	
9. Disturbance of > 10% of viable Northern Quoll denning habitat on the retained escarpments (MEZs) of Mesa A, B or C	
10. Net loss of the MEZ at Mesas A, B or C at **completion of mining.**	
Management targets:	**Status report:** Management target achieved Management target not achieved
1. Persistence of the four key species (*Corymbia zygophylla*, *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* and *Triodia schinzii*) of the Sand Sheet Vegetation (Robe Valley) PEC.	
2. No loss of catchment for the Sand Sheet Vegetation (Robe Valley) PEC due to the Revised Proposal, other than existing and	

	authorised disturbance.	
3.	24-hour average dust levels (PM10), attributable to the Revised Proposal, no greater than 70ug/m^3 as measured at the Sand Sheet Vegetation (Robe Valley) PEC.	
4.	Estimate the local population of Ghost Bats in the western part of the Robe Valley.	
5.	Indicate how Ghost Bats use caves within the western part of the Robe Valley (e.g. diurnal versus maternal), including the degree of utilization of caves by pregnant females.	
6.	Total clearing of native vegetation across the surface of the Mesa B and C MEZs is less than 30% of each MEZ surface area.	
7.	Troglofauna specimen capture rate is not below the baseline minimum for three consecutive sampling events for each individual location (Warramboo, Mesas A, B and C).	
8.	Estimate the degree of habitat connectivity and degree of troglofauna assemblage similarity between Highway/Tod Bore and Dinner Camp Bore areas.	
9.	No statistically significant change in down hole temperature and relative humidity in the Mesa A or B MEZs relative to reference sites.	

3. ADAPTIVE MANAGEMENT AND REVIEW OF THIS EMP

The Proponent will implement adaptive management to learn from monitoring and evaluation against trigger and threshold criteria, monitoring and evaluation of progress against management targets and monitoring of the effectiveness of response action, to more effectively meet the environmental outcomes and management objectives.

The following approach will apply:

- Monitoring data will be systematically evaluated and compared to baseline and reference site data on a regular basis in a process of adaptive management to verify whether responses to the impact are the same or similar to predictions.
- The effectiveness and relevance of trigger level and threshold contingency actions will be evaluated on an annual basis to determine if any changes are required.
- The effectiveness and relevance of management actions will be evaluated on an annual basis to determine is any changes are required.

4. STAKEHOLDER CONSULTATION

Stakeholder consultation for the Revised Proposal was undertaken prior to submission of the draft Environmental Review Document. Additional consultation specific to the EMP will be undertaken during the Environmental Impact Assessment process for the Revised Proposal. Consultation will be documented and any concerns will be addressed prior to finalisation of the EMP. Stakeholder consultation will include the Department of Biodiversity, Conservation and Attraction - Park and Wildlife Service and the Department of Water and Environmental Regulation – EPA Services and Compliance and Reporting (Water).

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APPENDIX 1

Baseline troglofauna capture rates for Mesa A, Mesa B, Mesa C and Warramboo/Highway Tod Bore

Table A-1 shows the troglofauna capture rate per 100 trapped holes at Mesa A. Eleven sampling events over a 15 year period are shown including sampling events before and during mining. All troglobitic specimens (including indeterminate specimens) have been included for completeness in the calculations. Specimens collected via scraping have been excluded as this collection method has only been used in recent sampling events; inclusion of specimens from scraping would result in pre-mining and during mining capture rates that aren't comparable. Capture rates pre-mining and during mining are similar (between 51.6 and 164.3 specimens per 100 trapped holes pre-mining and between 61.5 and 163.9 specimens per 100 trapped holes during mining) and the natural range is large. Higher capture rates are likely to be a result of rainfall prior to sampling. However, the required timing and size of the rainfall event required to produce a high capture rate has not yet been determined. Weather data up to 2007 were taken from the Yarraloola Homestead Bureau of Meteorology (BOM) station, data post-2007 were taken from the Pannawonica BOM station.

Table A-1: Troglofauna capture rates recorded at Mesa A

Mesa A	**Pre-mining**							**During mining**			
Sample collection date	**17/12/2003** (stygofauna bycatch)	**20/01/05**	**25/05/05**	**8/9/2005**	**3/08/2006**	**6/02/2007**	**23/05/2007**	**8/10/2010**	**20/07/2012**	**5/09/2014**	**18/09/2016**
Rainfall during survey	n/a	12.2	120.8	2.8	0.0	0.0	35.0	23.8	28.4	0.0	2.0
Rainfall 3 months prior to collection date	n/a	16.0	132.6	120.6	15.0	13.2	118.6	26.8	28.4	9.0	110.6
Rainfall 12 months prior to collection date	n/a	272.6	164.2	275.8	614.4	440.8	146.8	221.8	238.3	383.0	363.2
Number of trapped holes at A	n/a	11	14	49	31	31	36	41	36	41	39
Number of specimens collected at A	3	6	23	40	25	16	27	26	59	38	24
Number of specimens per 100 trapped holes	n/a	54.5	164.3	81.6	80.6	51.6	75.0	63.4	163.9	92.7	61.5

Table A-2 shows the troglofauna capture rate per 100 trapped holes at Mesa B. Nine sampling events over a 12 year period are shown all of which are pre-mining. All troglobitic specimens (including indeterminate specimens) have been included for completeness in the calculations. Specimens collected via scraping have been excluded as this collection method has only been used in recent sampling events. The natural capture rate range is large (between 75 and 427.3 specimens per 100 trapped holes). Note the last sampling event (2016 A and B compliance monitoring highlighted in grey) is omitted from analysis due to the low number of trapped holes. Higher capture rates are likely to be a result of rainfall prior to sampling. However, the required timing and size of the rainfall event required to produce a high capture rate has not yet been determined. Weather data were taken from the Pannawonica BOM station.

Table A-2: Troglofauna capture rates recorded at Mesa B

Mesa B	**Pre-mining**								
Sample collection date	**2005 (8th Apr - 26th May)**	**2010 (21st Sep - 10th Nov)**	**2012 A and B compliance (24th May - 20th July)**	**2014 A and B compliance (30th June - 5th Sep)**	**2015 EIA P1 (7th Jun- 6th Aug)**	**2015 EIA P2 (8th Aug- 2nd Oct)**	**2016 EIA P3 (17th Jan- 17th Mar)**	**2016 EIA P4 (28th Jul- 15th Sep)**	**2016 A and B compliance (9th July to 18th Sep)**
Rainfall during survey	120.8	0.0	28.4	0.0	14.2	0	82.4	3.6	2.0
Rainfall 3 months prior to collection date	132.6	23.8	28.4	9.0	56.8	14.2	86.2	110.6	110.6
Rainfall 12 months prior to collection date	164.2	219.2	238.3	383.0	394.8	394.8	339.6	363.2	363.2
Number of trapped holes at B	11	20	10	10	14	15	26	15	6
Number of holes scraped at B	0	0	0	10	6	3	26	14	5
Number of specimens collected	47	15	26	20	11	29	30	18	1
Number of specimens per 100 trapped holes	427.3	75.0	260.0	200.0	78.6	193.3	115.4	120.0	n/a

Table A-3 shows the troglofauna capture rate per 100 trapped holes at Mesa C. Five sampling events over a 12 year period are shown all of which are pre-mining. All troglobitic specimens (including indeterminate specimens) have been included for completeness in the calculations. Specimens collected via scraping have been excluded as this collection method has only been used in recent sampling events. The natural capture rate range is large (between 22.2 and 133.3 specimens per 100 trapped holes). Higher capture rates are likely to be a result of rainfall prior to sampling. However, the required timing and size of the rainfall event required to produce a high capture rate has not yet been determined. Weather data were taken from the Pannawonica BOM station.

Table A-3: Troglofauna capture rates recorded at Mesa C

Mesa C	**Pre-mining**				
Sample collection date	**2005 (8th Apr- 26th May)**	**2015 EIA P1 (7th Jun- 6th Aug)**	**2015 EIA P2 (8th Aug- 2nd Oct)**	**2016 EIA P3 (17th Jan- 17th Mar)**	**2016 EIA P4 (28th Jul- 15th Sep)**
Rainfall during survey	120.8	14.2	0	82.4	3.6
Rainfall 3 months prior to collection date	132.6	56.8	14.2	86.2	110.6
Rainfall 12 months prior to collection date	164.2	394.8	394.8	339.6	363.2
Number of trapped holes at C	4	9	9	27	34
Number of holes scraped at C	0	2	0	27	32
Number of specimens collected	8	7	2	36	12
Number of specimens per 100 trapped holes	n/a	77.8	22.2	133.3	35.3

Table A-4 shows the troglofauna capture rate per 100 trapped holes at Warramboo/Highway/Tod Bore C. Five sampling events over a ten year period are shown for pre-mining and for areas in close proximity to mining activities and areas further from mining activities. All troglobitic specimens (including indeterminate specimens) have been included for completeness in the calculations. Specimens collected via scraping have been excluded as this collection method has only been used in recent sampling events. The natural capture rate range is large (between 18.4 and 86.2 specimens per 100 trapped holes). Higher capture rates are likely to be a result of rainfall prior to sampling. However, the required timing and size of the rainfall event required to produce a high capture rate has not yet been determined. Weather data were taken from the Pannawonica BOM station.

Table A-4: Troglofauna capture rates recorded at Warramboo/Highway/Tod Bore

Warramboo/ Highway/Tod Bore					
Sample collection date	**2005 (21st Jan - 20th Mar)**	**2005 (26th Jul - 8th Sep)**	**2013* (22nd Oct - 8th Dec)**	**2015 EIA P1* (7th Jun- 6th Aug)**	**2015 EIA P2* (8th Aug- 2nd Oct)**
Rainfall during survey	74.2	2.8	7.6	14.2	0
Rainfall 3 months prior to collection date	77.2	120.6	7.6	56.8	14.2
Rainfall 12 months prior to collection date	129.2	275.8	425.8	394.8	394.8
Number of trapped holes at Warramboo/Hwy/Tod Bore	8	27	38	29	29
Number of holes scraped at Warramboo/Hwy/Tod Bore	0	0	27	8	0
Number of specimens collected	2	5	7	25	10
Number of specimens per 100 trapped holes	25.0	18.5	18.4	86.2	34.5

* This survey covered other tenements but only sampling conducted within the Warramboo/Hwy/Tod bore area was included