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Mr Anthony Sutton
Director Assessment and Compliance Division
Office of the Environmental Protection Authority
The Atrium, 168 St Georges Terrace
Locked Bag 10,
East Perth WA 6892

Our Ref: RTIO-HSE-0311321

10 July 2017

Dear Mr Sutton,

WEST ANGELAS IRON ORE PROJECT, DEPOSIT C, D AND G PROPOSAL REFFERAL UNDER SECTION 38(1) OF THE *ENVIRONMENTAL PROTECTION ACT 1986*

The existing West Angelas Iron Ore Mine, located approximately 130 kilometres northwest of Newman in the Pilbara region of Western Australia, operates under existing Ministerial Statement 970 (MS 970) and Ministerial Statement 1015 (MS 1015).

Robe River Mining Co. Pty. Ltd. (the Proponent) operates the existing West Angelas Iron Ore Mine on behalf of the Robe River Iron Associates joint venture which is an unincorporated joint venture in which the Rio Tinto Group (53%), Mitsui (33%), Nippon Steel (10.5%) and Sumitomo Metal Industries (3.5%) retain interests.

From 2019, development of additional ore sources is required to sustain iron ore production from West Angelas. As a result, the Proponent is seeking environmental approval under section 38 of the *Environmental Protection Act 1986* (EP Act) to develop Deposits C, D and G (this Proposal) at West Angelas. Accordingly, please find enclosed the Proponent's completed Referral Form for the Deposit C, D and G Proposal.

An Environmental Review document has been prepared to support the formal referral of the West Angelas Deposits C, D and G Proposal. The Environmental Review document provides additional detail on the following:

- the scope of the Proposal;
- the studies undertaken;
- the stakeholder consultation undertaken to date;
- a detailed environmental impact assessment; and
- a description of proposed environmental management strategies for preliminary key environmental factors.

Subject to approval of this Proposal, it is proposed that a new Ministerial Statement be published to supersede MS 970 and MS 1015. A Proposed drafted Ministerial Statement is included for the OEPA's consideration.

If you require any further information in relation to the Proposal, please do not hesitate to contact Carly Nixon on 6213 1297 or carly.nixon@riotinto.com in the first instance.

Yours sincerely

Chris Richards

General Manager, State Agreements and Approvals

Rio Tinto

Attachments:

- *Proponent section 38 Referral Form.*
- *West Angelas Iron Ore Mine, Deposit C, D and G Proposal, Environmental Review document (dated June 2017).*
- *CD containing Proponent section 38 Referral Form, Environmental Review document, appendices, figures and spatial data for this Proposal.*

Rio Tinto

Environmental Review Document

West Angelas Iron Ore Project

Deposit C, D and G Proposal

RTIO-HSE-0311321

Robe River Mining Co. Pty. Ltd.

152-158 St Georges Terrace, Perth

GPO Box A42, Perth, WA 6837

June 2017

Rio Tinto

Disclaimer and Limitation

This report has been prepared by Rio Tinto's Iron Ore Group (Rio Tinto), on behalf of Robe River Mining Co. Pty. Ltd. (the Proponent), specifically for the West Angelas Iron Ore Project. Neither the report nor its contents may be referred to without the express approval of Rio Tinto, unless the report has been released for referral and assessment of proposals.

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1. INTRODUCTION

1.1 Purpose and Scope

The existing West Angelas Iron Ore Mine, located approximately 130 kilometres (km) northwest of Newman in the Pilbara region of Western Australia (Figure 1-1), operates under existing Ministerial Statement 970 (MS 970) and Ministerial Statement 1015 (MS 1015).

This Environmental Review (ER) document has been prepared by Robe River Mining Co. Pty. Limited (Robe, the Proponent), in accordance with the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* and the *Environmental Impact Assessment (Divisions 1 and 2) Procedures Manual 2016,* to support the formal referral of the West Angelas Deposits C, D and G Proposal (this Proposal) to the Environmental Protection Authority (EPA) under section 38 of the *Environmental Protection Act 1986* (EP Act) (WA). The referral form for this Proposal is provided as Appendix 1.

The purpose of the document is to present an environmental review of the principal components of this Proposal, including a detailed environmental impact assessment and description of proposed environmental management strategies for preliminary key environmental factors.

The following terminology is used throughout this document:

- **Original Proposal** – components of the original proposal approved via Ministerial Statement 514 (MS 514) which included Deposits A and B.
- **Existing West Angelas Project** – components of the original proposal, amended via MS 970 (which includes Deposit E) and MS 1015 (which includes Deposit A west and Deposit F).
- **This Proposal** – expansion of the West Angelas Project to include development of additional Deposits C, D and G.
- **Revised West Angelas Project** – upon approval, components of the West Angelas Project that are currently authorised under MS 970 (Deposits A, B and E) and MS 1015 (Deposits A west and F), and the expansion of the West Angelas Project described in this Proposal (Deposits C, D and G).
- **Existing West Angelas Development Envelope(s)** – the development envelope(s), approved via MS 970 and MS 1015, within which the approved West Angelas Project (which includes Deposits A, A west, B, E and F) is contained.
- **Proposal area** – the conceptual footprint within which this Proposal (which includes Deposits C, D and G) is contained.
- **Development Envelope extension area** – upon approval, expansion of the West Angelas Mine Development Envelope to include Deposits C and D.
- **West Angelas Development Envelopes** – upon approval, the development envelope within which the Revised West Angelas Project (which includes Deposits A, A west, B, C, D, E, F and G) is contained.

Subject to approval of this Proposal, it is proposed that a new Ministerial Statement be published to supersede the existing Ministerial Statements; MS 970 and MS 1015 (Appendix 2). A Proponent drafted Ministerial Statement is provided as Appendix 3 for the OEPA's consideration.

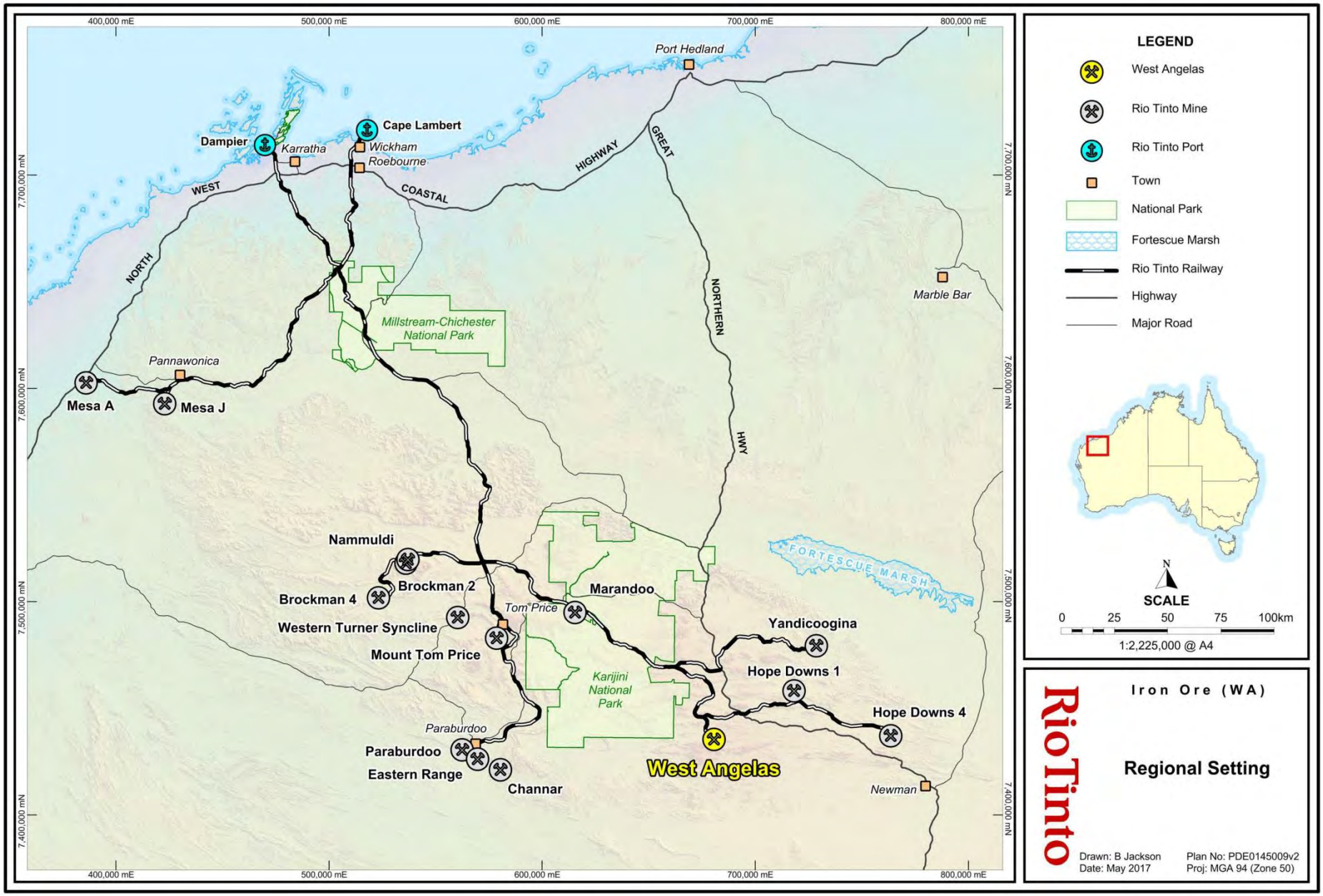

Figure 1-1: Regional Setting

1.2 Proponent

The Proponent for the Proposal is Robe River Mining Co. Pty. Ltd.

ABN: 71 008 694 246

GPO Box A42

Perth WA 6837

Robe River Mining Co. Pty. Ltd. (a wholly owned subsidiary of the Rio Tinto) is the authorised management company for the Robe River Iron Associates joint venture which is an unincorporated joint venture in which the Rio Tinto Group (53%), Mitsui (33%), Nippon Steel (10.5%) and Sumitomo Metal Industries (3.5%) retain interests.

The Rio Tinto Iron Ore Group (Rio Tinto) contact person in relation to the environmental approvals process for this Proposal is:

Carly Nixon

Environmental Approvals Specialist

T: +61 (08) 6213 1297

carly.nixon@riotinto.com

1.3 Environmental Impact Assessment Process

The key legislative requirements relating to this Proposal include assessment under Part IV of the EP Act (Section 1.3.1) and consideration of Commonwealth protected Matters of National Environmental Significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act, Section 1.3.2).

1.3.1 Environmental Protection Act 1986 (WA)

Part IV Division 1 of the EP Act provides for the referral and assessment of Proposal*s* which, if implemented, may have a significant impact on the environment. Part IV Division 2 of the EP Act provides for the implementation of Proposals after it is decided that a proposal may be implemented.

This Proposal has the potential to result in a significant impact on the environment and therefore warrants referral to the EPA under section 38 of the EP Act. Formal referral of this Proposal will enable the EPA to decide whether or not to assess the Proposal and the level of assessment if the Proposal is to be assessed. The Proponent considers that this Proposal warrants assessment at the level of Environmental Review - No public review as the level of public interest about the potential impacts of this Proposal on the environment are likely to be limited at a local, regional or broader scale.

The EPA uses environmental principles, factors and objectives as the basis for assessing whether a proposal's impact on the environment is acceptable. Guidance on the environmental principles, factors and objectives is provided in the *Statement of Environmental Principles, Factors and Objectives* (EPA 2016b) and in the associated Environmental Factor Guidelines and Environmental Factor Technical Guidance.

A review of environmental principles, factors and objectives relevant to this Proposal is provided in this ER document to enable the EPA to determine the environmental acceptability of this Proposal. The Proponent considers that the preliminary key environmental factors relevant to this Proposal are: *Flora and Vegetation*; *Terrestrial Fauna; Subterranean Fauna*; and *Hydrological Processes.* The preliminary key environmental factors are addressed in Sections 5 - 8. In addition, Closure and Offsets are considered relevant to this Proposal. These are addressed in Sections 9 and 10. Other environmental factors relevant to this Proposal are addressed in Section 11.

At the completion of the assessment of a Proposal, the EPA prepares its Report and Recommendations for the Minister for Environment (the Minister). The Report and Recommendations sets out what the EPA considers are the key environmental factors relevant to the Proposal, the EPA's recommendations as to whether or not the Proposal may be implemented and the conditions to which implementation of the Proposal should be subject. The EPAs Report and Recommendations is published to the EPA website with a statutory two-week public comment period.

Subsequent to the determination of appeals (if any), the Minister will then decide whether or not the Proposal may be implemented and if so, under what conditions. If the Minister determines that the Proposal may be implemented a Ministerial Statement is issued under section 45(5) of the EP Act.

If the Minister determines that this Proposal may be implemented, the Proponent requests that a new Ministerial Statement is published to supersede the existing Ministerial Statements (MS 970 and 1015, Appendix 2). A Proponent drafted Ministerial Statement is provided as Appendix 3 for the OEPA's consideration.

Further guidance on the procedures of Environmental Impact Assessment of Proposals is provided in the EPA's *Environmental Impact Assessment (Divisions 1 and 2) Administrative Procedures 2016* (EPA 2016a) and *Environmental Impact Assessment (Divisions 1 and 2) Procedures Manual 2016* (EPA 2016c).

1.3.2 Environment Protection and Biodiversity Conservation Act 1999 (Cwth)

The Commonwealth EPBC Act provides for the referral and assessment of Proposals which, if implemented, may have a significant impact on threatened species, ecological communities or heritage places listed as MNES.

Previous biological surveys conducted throughout the West Angelas region since 1979 have not recorded any Threatened species and / or communities and as such, the West Angelas Project has not warranted referral to the Department of the Environment and Energy (DoEE) under the requirements of the EPBC Act to date.

Recent biological surveys have however recorded Threatened species. Three threatened species: the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia,* EPBC Vulnerable); Ghost Bat (*Macroderma gigas*, EPBC Vulnerable); and Fork-tailed Swift (*Apus pacificus*, EPBC Migratory) were recorded in the West Angelas region and a further three Threatened species: the Northern Quoll (*Dasyurus hallucatus*, EPBC Endangered); Pilbara Olive Python (*Liasis olivaceus barroni*, EPBC Vulnerable) and Rainbow Bee-eater (*Merops ornatus*, EPBC Migratory) were assessed as having a moderate or high likelihood of occurrence in the region. Further information about the Threatened species recorded or assessed as having a moderate to high likelihood of occurrence in the West Angelas region and an assessment of potential impacts on these species is provided in Section 6.

This Proposal is unlikely to result in a significant impact on these threatened species and as such, the Proponent has determined that this Proposal does not warrant referral under the requirements of the EPBC Act. Further information regarding this determination provided in Section 12.

1.4 Other Approvals and Regulation

This Proposal is also subject to compliance with other relevant state legislation and regulations and is guided by relevant key over-arching state policies and strategies. In addition, there are EPA Factor Guidelines and Technical Guidance documents that have been used to determine the significance of the environmental impacts of the Proposal.

Other approvals and legislation relevant to this Proposal are outlined in Table 1-1.

1.4.1 Tenure and State Agreement

The West Angelas Project is located on Mineral Lease 248SA (ML248SA) which was granted in 1976 under the *Iron Ore (Robe River) Agreement Act 1964 (WA)* (Robe River State Agreement).

This Proposal is also located on Mineral Lease ML248SA and therefore subject to the same State Agreement legislation as the existing West Angelas Project. Approval under the Robe River State Agreement will be required for the development of Deposits C, D and G and associated infrastructure and activities.

ML248SA is considered appropriate tenure for all current and proposed mining and mining related infrastructure.

The infrastructure at West Angelas that is located outside of ML248SA is supported by other tenure (General Purpose Leases and Miscellaneous Licences) that have been granted under the *Mining Act 1978 (WA)* (Mining Act) in accordance with the Robe River State Agreement as follows:

- General purpose leases 47/1235 and 47/1236;
- Miscellaneous Licence L47/50 for the rail;
- Miscellaneous Licence L47/409 for the gas pipeline; and
- Miscellaneous Licence L47/53 for the pipeline and powerline to the Turee B Borefield and L47/41 for the Turee B Borefield.

These leases and licences are managed by the Proponent and are also considered appropriate for current mining related infrastructure.

The existing West Angelas Gas Pipeline (the Pipeline) interacts with Deposit C, and therefore will need to be realigned, likely to the north within the Robe River JV's Exploration Licence E47/797. A new Miscellaneous Licence under the Mining Act will be required to be granted in accordance with approved proposals under the Robe River State Agreement. As there are currently no third party tenure holders over the areas identified for the Pipeline realignment, the grant of tenure is not expected to be subject to objections. Approval under the Robe River State Agreement will be required for the grant of additional tenure and for the Pipeline realignment. The Pipeline realignment does not form part of this Proposal.

1.4.2 Native Title Agreements

The Yinhawangka People are the native title claimants and traditional custodians of the majority of the land within the West Angelas Mine Development Envelope (Figure 1-2). The Rio Tinto – Yinhawangka Claim Wide Participation Agreement was executed on 31 January 2013 and the subsequent Indigenous Land Use Agreement (ILUA) was registered with the National Native Title Tribunal on 5 July 2013.

The ILUA provides consent of the Yinhawangka People to Rio Tinto's Pilbara Iron Ore Business, including this Proposal, in the Yinhawangka People's country. This includes support for the grants of Interests and Approvals to Rio Tinto, or associated companies, generally anywhere within the extended boundaries of the claim areas of the Yinhawangka People.

It is noted that whilst this Proposal is situated within the Yinhawangka claim area, the Ngarlawangga People are the native title holders for a portion of the West Angelas Mine Development Envelope. The Rio Tinto – Ngarlawangga Northern Claim Area Participation Agreement was fully executed on 22 March 2011. The Ngarlawangga People Rio Tinto ILUA was registered on 6 March 2013.

The comprehensive agreements between Traditional Owners and Rio Tinto provide guidelines and requirement for communication and participation with traditional owners in respect to cultural heritage management, environmental management, life of mine planning, land access, employment and training, business development, and cultural awareness training.

1.4.3 Heritage

This Proposal is located within the traditional lands of the Yinhawangka People. The identification and management of cultural heritage within the traditional lands of the Yinhawangka People is in accordance with the principles and practices outlined within Rio Tinto's Communities and Social Performance Guidelines, the Rio Tinto Cultural Heritage Group Procedure, and the heritage protocol within the Yinhawangka People Claim Wide Participation Agreement.

In line with statutory requirements and these internal heritage management standards, Archaeological and ethnographic surveys have been completed for the majority of the Proposal area. These surveys have identified a rich and diverse region of material culture that includes an abundance of artefact scatters, rockshelters scarred trees and rock art, in part due to the proximity of the West Angelas Project to Turee Creek East and its tributaries and the presence of readily accessible naturally formed shelters. The large concentration and close proximity of artefact scatters and scarred trees to rockshelters seemingly demonstrates the adaptation to the local environment and the story of subsistence of people moving through this part of the country.

Two sites of ethnographic significance have been identified in the region: 'Guburingu' located approximately 7km to the north west of Deposit C (outside the Proposal area, within the Karijini National Park) and 'Garjiringu' located approximately 150m to the west of Deposit D infrastructure (within the Proposal area).

This Proposal is not expected to have a direct impact on either of these sites of ethnographic significance however, the proposed dewatering may have an indirect impact on the environmental values associated with 'Guburingu'. Further work is underway to determine the likelihood and required mitigation strategies (discussed further in Section 11).

A management plan is also currently being finalised with the Yinhawangka through their Heritage Body for the ongoing management of 'Garjiringu'.

Numerous sites of archaeological significance have also been recorded in the Proposal area: artefact scatters; rockshelters; scarred trees; and rock art sites. Some of these heritage places contain heritage features that are under-represented in the East Pilbara archaeological record and are considered to be of high archaeological significance to Traditional Owners. These include walled features within rockshelters, grinding patches and engraving / rock art sites.

Rio Tinto is committed to avoiding sites of high ethnographic and / or archaeological significance to Traditional Owners wherever possible at its Pilbara operations. For example, the Central Waste Dump which is common to Deposits C and D has been redesigned and a substantial volume of waste material relocated to avoid sites of high ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners.

The Proponent has, and will continue to, minimise potential disturbance to other sites within the West Angelas Mine Development Envelope wherever possible. However, some sites are likely to be disturbed by this Proposal. The Proponent will request approval under section 18 of the *Aboriginal Heritage Act 1972* where disturbance to sites cannot be avoided. Cultural material contained within those sites which cannot be avoided will be mitigated in accordance with the approval conditions set by the Minister of Aboriginal Affairs and in consultation with the Yinhawangka Traditional Owners.

Rio Tinto regularly consults with Traditional Owners on the protection and management of cultural heritage sites. Issues relevant to the Yinhawangka People are discussed at biannual Local Implementation Committee (LIC) meetings, as agreed to in the Yinhawangka Claim Wide Participation Agreement, and at Yinhawangka - Rio Tinto Heritage Sub-committee (HSC) meetings. A summary of formal consultation undertaken to date with the Yinhawangka Traditional Owners is included in Section 3.

Consultation with the Yinhawangka Traditional Owners to date has been on both a broader level and a detailed level with the main concerns raised being in relation to long term alteration to the cultural landscape and regional hydrological regime. The Yinhawangka Traditional Owners consider water systems to be of cultural significance because of the sustaining properties of the water to the landscape. A regular program of consultation regarding water management strategies has been, and will continue to be, undertaken with the Yinhawangka Traditional Owners to ensure the sustainable management of water in the broader cultural landscape and address the community's values and concerns.

Table 1-1: Other approvals and legislation relevant to this Proposal

Approval	Purpose	Legislation and Agency	Proposal Activities
Tenure		*Mining Act 1978* (Department of Mines and Petroleum)	West Angelas is located on ML248SA which was granted in 1976 under the *Iron Ore (Robe River) Agreement Act 1964 (WA)*. ML248SA is appropriate tenure for all current and proposed mining and mining related infrastructure. A new Miscellaneous Licence under the *Mining Act 1978* is required for the realignment of the existing West Angelas Gas Pipeline. The current proposed realignment is to the north, within an area that is currently subject to the Robe River JV's Exploration Licence E47/797.
State Agreement	Required to significantly modify, expand or otherwise vary activities approved under an existing State Agreement.	*Iron Ore (Robe River) Agreement Act 1964* (WA) (Department of State Development)	Robe River Mining Co Pty Ltd, as manager for and on behalf of the Robe River Iron Associates Joint Venture, currently has approval to mine from Deposits A, B, E and F at under the *Iron Ore (Robe River) Agreement Act 1964 (WA).* State Agreement approval is required under the *Iron Ore (Robe River) Agreement Act 1964 (WA)* for the proposed additional Deposits C, D and G and new associated infrastructure (including but not limited to transport routes, power and water supply, accommodation). Approval is also required for the relocation of the existing West Angelas Gas Pipeline and the grant of associated tenure.
Heritage	Where a heritage site is deemed unavoidable by the Project, consent is required to disturb a protected site.	Section 16 / section 18 of the *Aboriginal Heritage Act 1972* (Department of Aboriginal Affairs)	Consent to use the Land for a given Purpose is required under section 18 of the *Aboriginal Heritage Act 1972* should it have an impact on Aboriginal Heritage sites.
Native Vegetation Clearing Permit	Required to clear native vegetation (where there is no approval under Part IV of the *Environmental Protection Act 1986*).	Part V of the *Environmental Protection Act 1986* (Department of Mines and Petroleum)	A Regional NVCP exists for mineral exploration, hydrogeological and geotechnical investigative activities. Clearing for the development of Deposits C, D and G and associated infrastructure is subject to approval under Part IV of the EP Act. A new NVCP is required under Part V of the EP Act for the realignment of the existing West Angelas Gas Pipeline.

Approval	Purpose	Legislation and Agency	Proposal Activities
Operating Licence	Required to operate a prescribed premise. A licence amendment is potentially required when changing the volume or nature of an emission at existing prescribed premises.	Part V of the *Environmental Protection Act 1986* (Department of Environmental Regulation)	The existing Operating Licence, L7774/2000, issued under Part V of the EP Act, includes processing of ore, dewatering (discharge), screening, power generation, sewage facility, landfill and bulk storage of chemicals. An Operating Licence amendment may be required if a Works Approval has been issued in order to operate a new facility or for changes to existing facilities within the existing prescribed premise.
Works Approval	Required when causing an emission considered a prescribed activity that is not covered by an existing licence (e.g. process plant, landfill, dewatering discharge).	Part V of the *Environmental Protection Act 1986* (Department of Environmental Regulation)	A Works Approval may be required for new infrastructure considered a prescribed activity (i.e. processing facilities).
Permit to Obstruct or Interfere with Bed / Banks	Required when there is interference or obstruction of significant waterways.	Sections 11/17/21A of the *Rights in Water and Irrigation Act 1914* (Department of Water)	A Permit to Obstruct or Interfere with Bed / Banks may be required for creek diversions (i.e. the Turee Creek East Realignment at Deposit C).
Licence to Construct or Alter Wells	Required to construct groundwater bores.	Section 26D of the *Rights in Water and Irrigation Act 1914* (Department of Water)	A Licence to Construct Wells is required under section 26D of the *Rights in Water and Irrigation Act 1914* for new bores.
Licence to Take Groundwater	Required to abstract groundwater for water supply (e.g. construction, ore processing, dust suppression, camp).	Section 5C of the *Rights in Water and Irrigation Act 1914* (Department of Water)	The following existing Licences to Take Groundwater have been issued under the *Rights in Water and Irrigation Act 1914*: • GWL98740 for abstraction of 5,380,000 kL from the mine for dewatering and water supply purposes; and • GWL103136 for abstraction of 3,102,500 kL from the Turee B Borefield for water supply purposes. A Licence to Take Groundwater (new or amendment) is required under section 5C of the *Rights in Water and Irrigation Act 1914* for groundwater abstraction from new water supply / dewatering bores or an increase in abstraction from existing water supply / dewatering bores. The existing Groundwater Operating Strategy (GWOS) must also be updated prior to groundwater abstraction commencing.

Approval	Purpose	Legislation and Agency	Proposal Activities
Programme of Works	Required for low impact activities such as drilling programs or geotechnical investigation on Mining Act tenure.	*Mining Act 1978* (Department of Mines and Petroleum)	A Programme of Works may be required for geotechnical and sterilisation drilling on Exploration tenements.
Mining Proposal	Required for ground disturbance on Mining Act tenure.	*Mining Act 1978* (Department of Mines and Petroleum)	Mining Proposals will be required for work on General Purpose Leases (waste dumps, camp expansion etc.). A hybrid document (with an Environmental Plan) may be required for the realignment of the West Angelas Gas Pipeline. A new Miscellaneous Licence under the *Mining Act 1978* is required for the realignment of the existing West Angelas Gas Pipeline. The current proposed realignment is to the north, within an area that is currently subject to the Robe River JV's Exploration Licence E47/797.
Environmental Plan	Required for the construction and operation of a petroleum pipeline in Western Australia.	*Petroleum and Geothermal Energy Resources Act 1967* *Petroleum Pipelines Act 1969* Petroleum Pipelines (Environment) Regulations 2012 (Department of Mines and Petroleum)	A hybrid document (with a Mining Proposal) may be required for the realignment of the existing West Angelas Gas Pipeline.
Local Government	Required for installation of buildings, ablutions and any other infrastructure.	*Building Act 2011* *Planning and Development Act 2005* Part V of the *Environmental Protection Act 1986* (Shire of East Pilbara and Department of Health)	Planning and building approvals will be required for any new/expansion of existing accommodation. Construction and operation of any waste water treatment plant requires approval from the Shire of East Pilbara and Department of Health (in addition to the requirements to obtain approval under Part V of the EP Act). An application for this approval, if required, is submitted via the Shire.

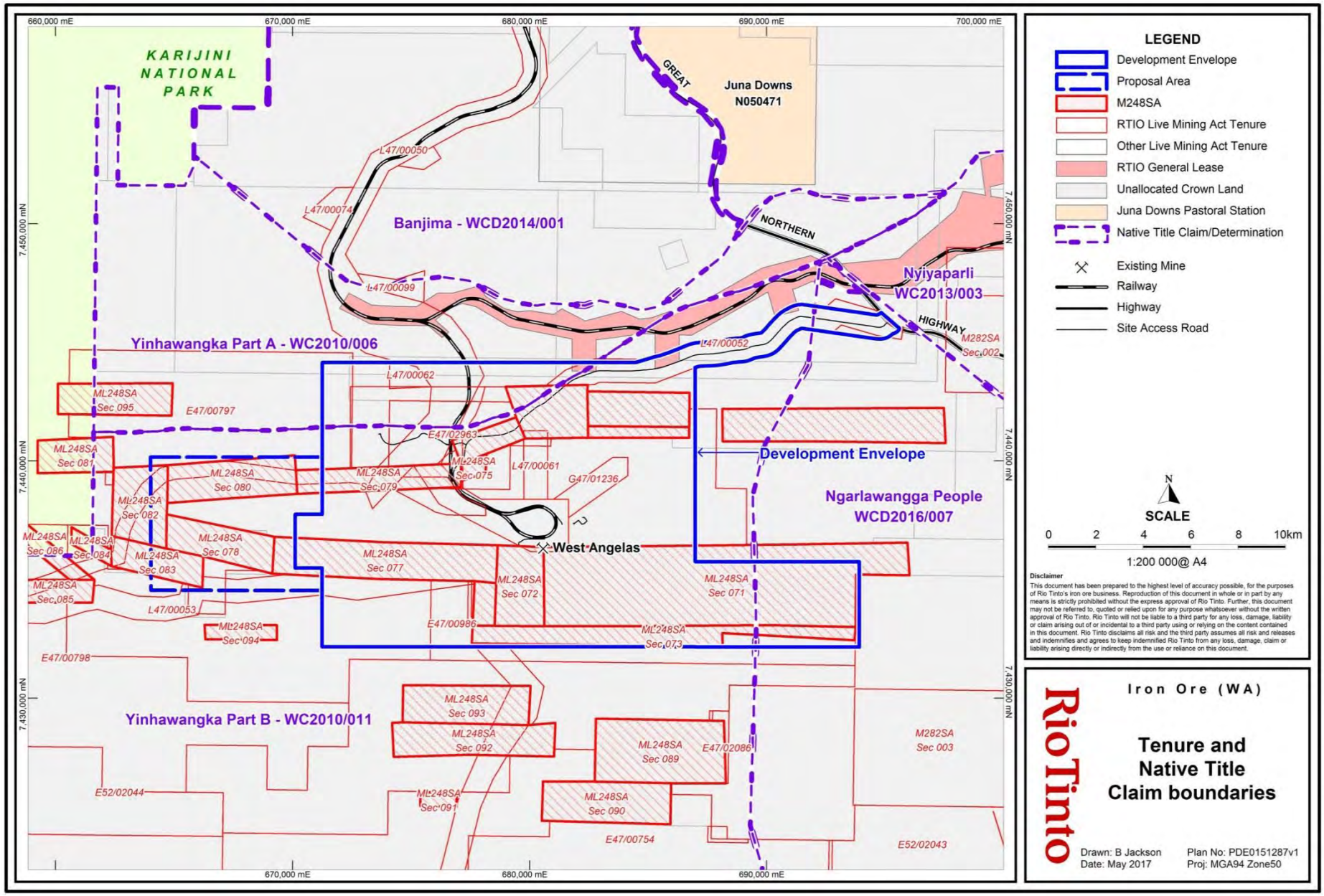

Figure 1-2: Tenure and Native Title Claim boundaries

2. THE PROPOSAL

2.1 Background

The Original West Angelas Proposal, which included the development of Deposits A and B, was referred to the EPA under Part IV of the EP Act in May 1997 and was assessed at the level of Environmental Review and Management Program (ERMP). The EPA published its Report and Recommendations (Bulletin 924) in January 1999.

The environmental aspects considered by the EPA, as described in the EPAs Report and Recommendations (Bulletin 924), January 1999 (EPA 1999), were:

- vegetation communities;
- Declared Rare and Priority flora;
- specially protected (Threatened) fauna;
- subterranean fauna;
- surface water (sheet flows);
- groundwater quantity; and
- Aboriginal culture and heritage.

The Minister approved implementation of the Original Proposal, subject to the conditions of MS 514, on 28 June 1999.

In 2010 the Proponent referred the mining of above watertable ore from Deposit E and the discharge of surplus dewatering water to the environment to the OEPA for formal assessment under Part IV of the EP Act. These proposals were granted *Not Assessed* on 21 June 2010 and 20 December 2010 respectively.

A subsequent proposal to include the development of Deposit E and contemporise conditions of MS 514 was submitted to the EPA under s46 of the EP Act was approved by the Minister, via MS 970, on 11 June 2014.

In 2014 the Proponent referred the West Angelas Deposit A west and F proposal to the OEPA for formal assessment under Part IV of the EP Act. The Proposal was assessed at the level of Assessment on Proponent Information (API) and the EPA published its Report and Recommendations (Bulletin 1551) in June 2015.

The environmental aspects considered by the EPA during the assessment of the Deposit A west and Deposit F Proposal (as a revision to MS 514), as described in the EPAs Report and Recommendations (Report 1551), June 2015 (EPA 2015), were:

- Flora and Vegetation - direct impacts from the clearing of flora and vegetation within the Development Envelopes.
- Offsets (Integrating factor) - to counterbalance the significant residual impacts to native vegetation in ‘good to excellent’ condition

The Minister approved implementation of the Proposal as an amendment to MS 970, subject to conditions of MS 1015, on 21 August 2015.

The West Angelas Project, as approved by MS 970 and MS 1015 and implemented, therefore currently consists of:

- Open cut above and below water table mining of iron ore from Deposits A, A west, B, E and F, by conventional drill, blast, and load and haul techniques.
- Ore processing in central processing facilities at approximately 35 Million tonnes per annum (Mt/a).

- Surface waste dumps which are used in backfilling of the pits as far as practicable.
- Infrastructure including but not limited to the following:
    - dewatering and surplus water management infrastructure (including the Turee Creek B borefield, located approximately 30 km west of the mine site, which abstracts up to 3.1 gigalitres per annum (GL/a) to provide potable water to the mine and accommodation village (and, when required, water for operational purposes) and the mine dewatering borefield which abstracts up to 5.4 GL/a to support below water table mining. Dewatering water is used onsite in the first instance to supply water for operational purposes. Surplus dewatering water that exceeds operational water requirement (up to 6 GL/a) is discharged to a local ephemeral tributary of Turee Creek East (Turee Creek East tributary);
    - surface water management infrastructure, including diversions to direct surface water flows around deposits;
    - linear infrastructure, including the mine access road of approximately 35 km long which links the mine site with the Great Northern Highway and the rail network which transports processed ore approximately 413 km to port facilities located at Cape Lambert;
    - processing facilities; and
    - support facilities, including the West Angelas accommodation village which is located approximately 9 km west of the mine site.

The key characteristics and authorised extent of the West Angelas Project are described in Schedule 1 of MS 970 and MS 1015 (Appendix 2) and the existing conceptual layout is shown in Figure 2-1 below.

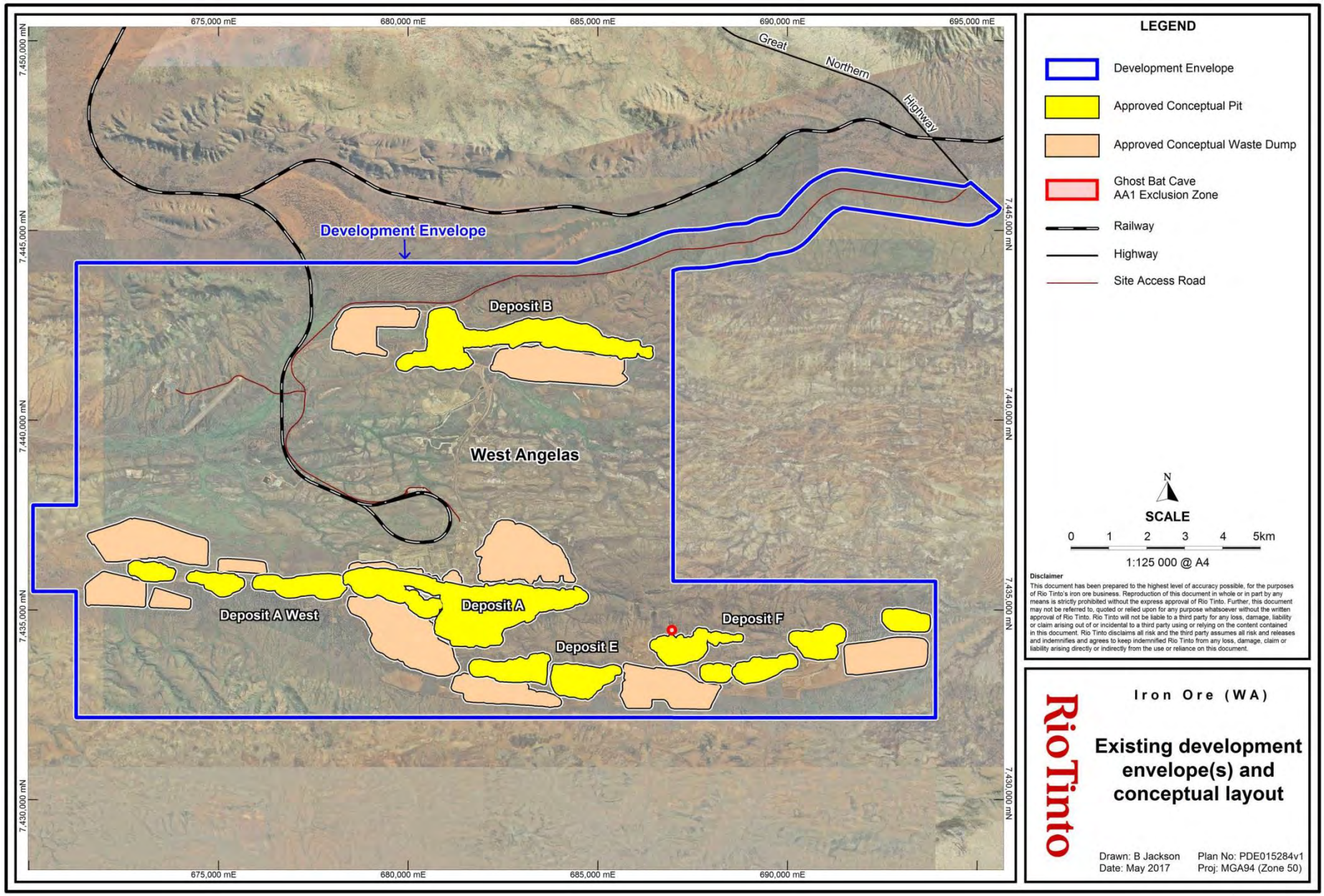

Figure 2-1: Existing Development Envelope(s) and conceptual layout

2.1.1 Environmental Compliance

The Proponent reported two non-compliances (N/Cs) during 2015; both were related to missed groundwater quality monitoring events. The proposed corrective action was to review and update the Environmental Management Plan (EMP). Missed monitoring events were repeated for the 2016 reporting period (April 2017).

The updated EMP is provided as part of the assessment of this Proposal (Appendix 4) to ensure no repeat future N/Cs.

2.2 Proposal Description

The Proponent is seeking approval to expand the existing West Angelas Project (Figure 1-1). This Proposal includes the following:

- **Above and below water table mining of additional Deposits C, D and G** including: pits; waste dumps; stockpiles; and supporting infrastructure. Infrastructure includes, but is not limited to; dewatering and surplus water management infrastructure; surface water management infrastructure; linear infrastructure (which includes heavy and light vehicle roads, conveyor; power and telecommunications); and support facilities.
- **Additional clearing:** This Proposal is seeking approval for 4,310 hectares (ha) of additional clearing.
- **Extension of the existing Development Envelope(s):** This Proposal is seeking approval for extension of the existing Development Envelope(s) by 3,800 ha.
- **Statement rationalisation:** The Proponent is also seeking to rationalise the existing Ministerial Statements (MS 970 and MS 1015) and this Proposal. This is discussed further in Section 14**.**

2.2.1 Above and below water table mining of additional Deposits C, D and G

To sustain current production from West Angelas, development of additional ore sources is required to commence by 2019. Deposits C, D and G have been identified as the next near-mine Marra Mamba resources to be developed to sustain production from West Angelas and therefore form the scope of this Proposal.

Deposits C and D are located approximately 12 km west of the existing West Angelas Project. Deposit G is located immediately west of Deposit B (Figure 2-2). Mining of Deposits C, D or G is proposed to commence from 2020.

Specifically, this Proposal includes the following:

- **Pits** – Above and below water table mining of three additional deposits; Deposits C, D and G, by conventional drill, blast, and load and haul techniques.
- **Mineral waste management** – Topsoil will be removed prior to mining and will be stored in stockpiles for later use in rehabilitation. Waste will be transported by haul trucks to new external waste dumps (and / or stockpiles). Backfilling during operations and / or closure is proposed. Below water table pits will be backfilled to prevent post-closure exposure of the groundwater table and the formation of permanent pit lakes. The likelihood of potentially acid-forming (PAF) materials (e.g. black shale material) is considered low for all deposits however, if PAF materials are encountered then existing management strategies will be implemented.
- **Dewatering and dewatering infrastructure** – Deposits C and D are approximately 30% and 51% below water table respectively and will require dewatering of up to 8 GL/a to access the below water table resource.

Only negligible below water table resource occurs at Deposit G (approximately 3%). Infrastructure including but not limited to dewatering bores will be required.

- **Surplus water management** – Dewatering water from Deposits C and D will be used to supply local operational water demand in the first instance. Any surplus dewatering water, exceeding the local operational water requirement will be transferred to the existing operations to supply operational water demand and / or discharged into the Turee Creek East tributary (aligned with the existing West Angelas Project integrated water management strategy). Up to 6 GL/a of surplus dewatering water may be discharged to the Turee Creek East tributary. Deposit G will require water supply from the integrated water management system.
- **Surface water management and surface water management infrastructure** – Deposits C and D will intercept tributaries of Turee Creek East. Surface water management structures (diversions) will be required to redirect the surface water flows which would otherwise be captured by the pits, to maintain the continuation of natural surface water flows in Turee Creek East. Other surface water management infrastructure including but not limited to culverts may also be required to ensure appropriate surface water management.
- **Linear infrastructure** – Ore will be transported from Deposits C and D to existing central processing facilities at the West Angelas Project via either conveyor or haul trucks. Ore will be transported from Deposit G to existing central processing facilities at the West Angelas operations via haul trucks.

  The existing rail overlies Deposit G therefore realignment of the existing rail may be required to access some of the Deposit G resource.

  Other linear infrastructure including but not limited to heavy vehicle and light vehicle roads, power and communications distribution networks may also be required.
- **Processing facilities** – This Proposal will be supported by the existing central processing facilities at the West Angelas Project. Primary crushing will occur at Deposits C and D and a conveyor or haul trucks will be used to transport primary crushed ore to the existing central processing facilities. Other processing facilities include, but not limited to, materials handling infrastructure and ore stockpiles.
- **Support facilities** – including but not limited to workshops, hydrocarbon storage, explosives storage, laydown areas, offices, waste water treatment plants and waste fines storage facilities may be required.
- **Construction accommodation** – The operational workforce will be accommodated in the existing West Angelas accommodation village however, temporary construction accommodation at Deposits C and D may be required to accommodate the construction workforce.

Processed ore will be railed to Rio Tinto's port operations at Dampier and / or Cape Lambert via approved rail infrastructure.

A conceptual mine layout is included in Figure 2-2. The exact location of the components of this Proposal is still to be finalised as part of detailed studies. However, all components will be contained within the West Angelas Mine and Linear Infrastructure Development Envelope.

2.2.2 Clearing limits

Clearing of up to 7,890 ha of native vegetation is approved under existing MS 970 (4,667 ha) and MS 1015 (3,223 ha). This Proposal is seeking approval for 4,310 ha of additional clearing to support the proposed mining of the additional Deposits C, D and G.

Table 2-1 presents the approved clearing as referred to above and the proposed additional clearing.

Table 2-1: Clearing to support this Proposal

Element	Approved limit	This Proposal	Revised Proposal
Mining area	2,260 ha (MS 970) 920 ha (MS 1015)	**1,800 ha**	**4,980 ha**
Waste dumps and stockpiles	1,407 ha (MS 970) 1,853 ha (MS 1015)	**1,950 ha**	**5,210 ha**
Infrastructure, access and accommodation	1,000 ha (MS 970) 450 ha (MS 1015)	**560 ha**	**2,010 ha**
Total clearing	7,890 ha	**4,310 ha**	**12,200 ha**

The existing Ministerial Statements; MS 970 and MS 1015 specify clearing as per Table 2-1. However, in order to reflect contemporary format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations and the EPA's Environmental Impact Assessment (Divisions 1 and 2) Administrative Procedures 2016 (EPA 2016a), the Proponent proposes that the new Schedule 1, subject to approval of this Proposal, reflect clearing as per Table 2-3 (Section 2.2.5)

Linear infrastructure

The original Ministerial Statement; MS 514 (superseded by MS 970 and MS 1015), authorised the construction and operation of a rail network between the West Angelas Mine and Cape Lambert Port, the Turee B Borefield and associated infrastructure (including a pipeline and powerline). However, MS 514 (and subsequently MS 970) did not define a development envelope or specify a clearing limit for linear infrastructure. Therefore all clearing undertaken to date, for the West Angelas rail, the Turee B Borefield and associated infrastructure, has not been tracked or attributed to MS 514 (or MS 970).

Subject to approval of this Proposal, the Proponent requests that a new Ministerial Statement is published to supersede the existing Ministerial Statements, which specifies a clearing limit of 1,500 ha for linear infrastructure. The Proponent considers that this clearing limit will be sufficient to support the ongoing operation and potential future construction of the rail, the Turee B Borefield and associated infrastructure. Further, the Proponent considers that clearing associated with linear infrastructure is not subject to offsets as it is clearing that has already been approved.

2.2.3 Extension of the existing Development Envelope

An existing 22,600 ha Development Envelope has been defined and approved for the West Angelas Project (Figure 2-1).

Deposit G is located entirely within the existing Development Envelope and as such, no extension of the Development Envelope is required for this component. Some of Deposits C and D fall within the existing Development Envelope however an extension of the Development Envelope is required to include the full extent of Deposits C and D. It is therefore proposed that the existing Development Envelope be extended by 3,800 ha to reflect a revised West Angelas Mine Development Envelope of 26,400 ha (Figure 2-2).

This approach provides flexibility for the location of mine components within the proposed Mine Development Envelope while also ensuring full extent of environmental impacts have been identified and assessed.

Linear infrastructure

Subject to approval of this Proposal, the Proponent requests that a new Ministerial Statement is published to supersede the existing Ministerial Statements, which defines a Development Envelope of 19,400 ha for linear infrastructure.

The Linear Infrastructure Development Envelope will include the rail network from West Angelas Mine to Cape Lambert Port, including associated sidings and cross overs. The Linear Infrastructure Development Envelope will also include the Turee B Borefield and associated infrastructure (including a pipeline and powerline).

The proposed Linear Infrastructure Development Envelope has been designed based on the following principles:

- 80m wide corridor along the built rail line.
- 400m wide corridor along the unbuilt section between Juna Downs Siding and Rosella Siding.
- The area of Miscellaneous Licence L47/41 for the Turee B Borefield (12,000 ha).
- 40m wide corridor for the pipeline and power line.

This has resulted in a Linear Infrastructure Development Envelope of 19,400 ha.

2.2.4 Summary of this Proposal

A summary of the Proposal is provided in Table 2-2 and the preliminary key characteristics for the Proposal and changes from the existing approval are provided in Table 2-3.

Table 2-2: Summary of the Proposal

Project Title	West Angelas Iron Ore Project
Proponent Name	Robe River Mining Co. Pty. Ltd.
Short description	The existing West Angelas Iron Ore Project, located approximately 130 kilometres west of Newman in the Pilbara region of Western Australia, is the subject of Ministerial Statement 970 (dated 12 June 2014) and Ministerial Statement 1015 (dated 21 August 2015) and involves above and below water table, open-cut iron ore mining from Deposits A, A west, B, E, and F and the construction and operation of associated infrastructure. This Proposal is a revision of the existing West Angelas Iron Ore Project and includes the above and below water table, open-cut iron ore mining from Deposits C, D and G and the construction and operation of associated infrastructure.

Table 2-3: Location and proposed extent of physical and operational elements

Element	Existing approval (Ministerial Statement/s and other regulatory approvals)	Proposed change (this Proposal)	Proposed extent (Revised Proposal *[existing approval + proposed change]*)
Mine and associated infrastructure	Clearing of up to 7,890 ha within the 22,600 ha existing Development Envelope has been approved under MS 970 and MS 1015.	Additional clearing of up to 4,310 ha within an extended West Angelas Mine Development Envelope (extended by 3,800 ha).	Clearing of up to 12,200 ha within the 26,400 ha Mine Development Envelope.
Linear infrastructure	Not specified.		Clearing of up to 1,500 ha within the 19,400 ha Linear Infrastructure Development Envelope.
Dewatering	Not specified under Part IV of the EP Act. Abstraction of up to 5.4 GL/a of groundwater for dewatering purposes has been approved under GWL98740, issued under the RIWI Act.	Additional abstraction of up to 8 GL/a of groundwater for dewatering purposes (excluding potable supply).	Proposed abstraction of up to 14 GL/a of groundwater for dewatering purposes (excluding potable supply).
Surplus water management	Not specified under Part IV of the EP Act. Discharge of up to 6 GL/a of surplus dewatering water to a tributary of Turee Creek East has been approved Licence L7774/2000, issued under Part V of the EP Act.	Additional discharge of up to 6 GL/a of surplus dewatering water to a tributary of Turee Creek East.	Proposed discharge of up to 12 GL/a of surplus dewatering water to a tributary of Turee Creek East. The surface discharge extent will not extend within the boundary of Karijini National Park.
Backfilling	The Closure Plan required that below water table pits will be backfilled to above recovered groundwater levels to prevent post-closure exposure of the groundwater table or the formation of permanent pit lakes.	Below water table pits will be backfilled to a level which will not allow the formation of permanent pit lakes.	Below water table pits will be backfilled to a level which will not allow the formation of permanent pit lakes.

It is proposed that this Proposal is considered as a revision to the existing West Angelas Project. A Proponent drafted Ministerial Statement is provided as Appendix 3 for the OEPA's consideration.

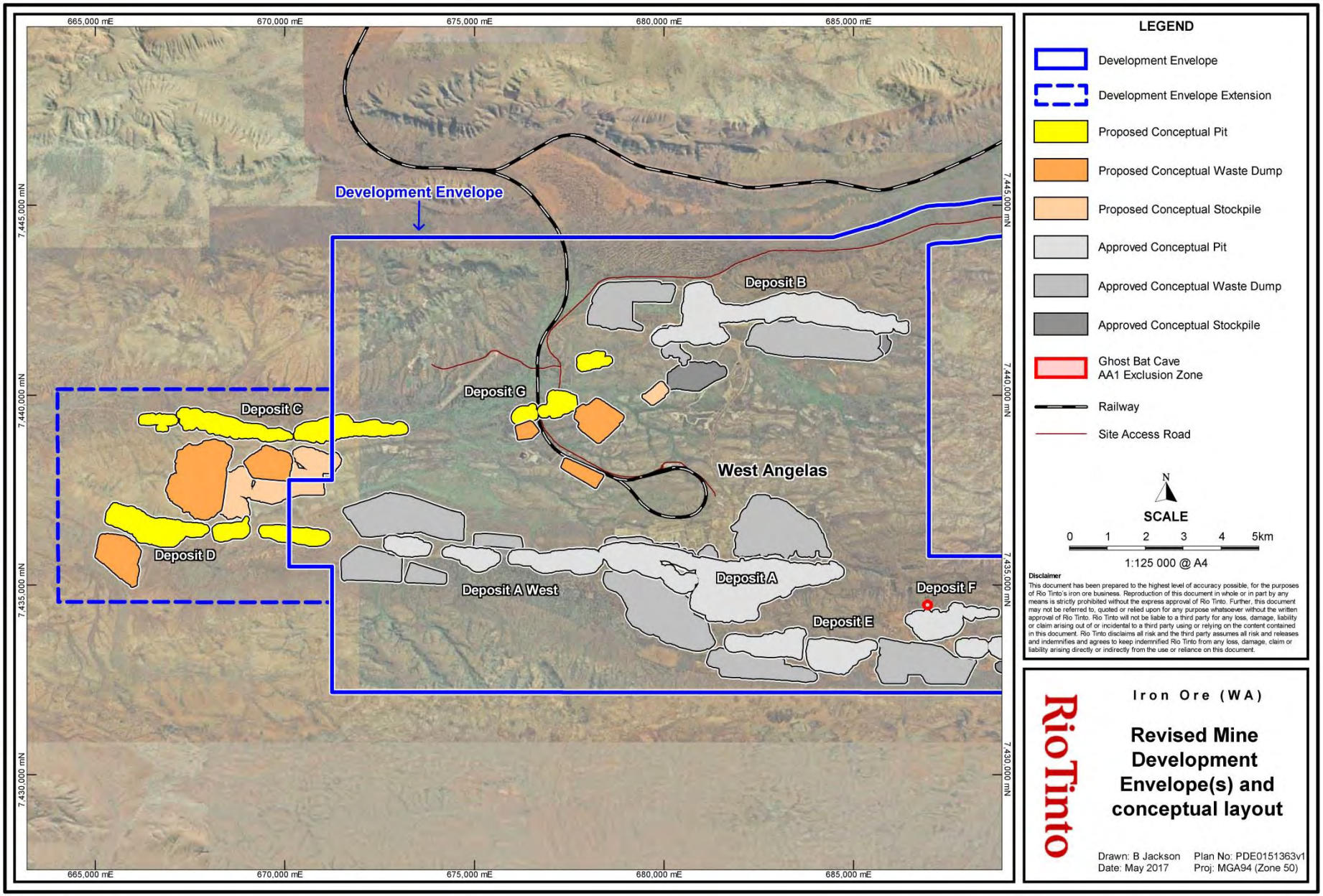

Figure 2-2: Revised Mine Development Envelope(s) and conceptual layout

2.3 Justification and alternatives considered

In accordance with Clauses 5 and 10.2.4 of the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* this section outlines the justification for this Proposal and summarises the alternative options considered. The intent of this section is to provide an overview of the options that have been considered by the Proponent to minimise the potential environmental impacts resulting from this Proposal.

2.3.1 Proposal justification

Rio Tinto operates the world's largest integrated portfolio of iron ore assets for the supply iron ore to meet global demand and the West Angelas Marra Mamba from the East Pilbara is an important contributor to Rio Tinto's Pilbara Blend product.

Production at West Angelas commenced at Deposit A in 2001 and this deposit still provides the primary ore source. Production is supplemented by Deposit E which commenced in 2011, Deposit B which commenced in 2015, and Deposit F which commenced in 2016.

Production from all existing West Angelas deposits is expected to decline from 2019 so development of additional ore sources is required to sustain current production from West Angelas beyond 2019. Given the higher strip ratios of identified future deposits, and their distance from the existing processing facilities, development of up to six additional deposits is required to sustain current production between 2020 and 2025.

Deposits C, D and G have been identified as the next near-mine Marra Mamba resources to be developed to sustain production from West Angelas and therefore form the scope of this Proposal. The Proponent proposes to commence mining these deposits in 2020. These deposits represent more than 120 Mt of saleable iron ore and will sustain production from West Angelas by more than a decade.

The Proponent will progress with a separate referral for near-mine Brockman resources and regional Marra Mamba resources and new processing facilities at a more appropriate time.

2.3.2 Proposal alternatives

The Proponent is evaluating opportunities to develop other near-mine Brockman resources and regional Marra Mamba resources at West Angelas, including:

- Deposit H, located east of Deposit B;
- Western Hill, located west of Deposit B and north of Deposit C;
- Mount Ella and Mount Ella Extension, located south of Deposits A west and D;
- Deposit J, located south of Mount Ella Extension;
- Mount Ella East, located south of Deposit E and F;
- Indabiddy, located south of Mount Ella East; and
- Angelo River deposits (including Northern Anticline, Northern Syncline, Angelo River Main Angelo River West, Central Syncline and Capricorn) and new processing facilities, located south of Deposit J and Indabiddy.

The development of these other near-mine Brockman resources and regional Marra Mamba resources will sustain production from West Angelas beyond 2025. However, studies are not progressed for these alternative new deposits and processing facilities. If this Proposal does not proceed, studies are not expected to be available in time to support the development of new deposits and new processing facilities by 2020 and therefore sustain production from the West Angelas Project.

The Proponent will progress with a separate referral for near-mine Brockman resources and regional Marra Mamba resources and new processing facilities at a more appropriate time.

If the development of alternative new deposits and new processing facilities does not proceed, the demand for iron ore could be met through the development of equivalent projects located overseas with the resultant loss of substantial economic benefits to the Pilbara, WA and Australia, including the loss of social and employment opportunities (supporting the existing workforce and local communities) and the loss of potential for future developments in the WA Iron Ore industry and downstream processing of raw materials.

2.3.3 Options Assessment

This Proposal is located adjacent to the existing West Angelas Project and wherever possible, will make use of the existing central processing facilities, support facilities (including the accommodation village), integrated water management system, roads, rail network and other assets. This will vastly reduce the disturbance that would have otherwise been required (especially when compared to the development of alternative new deposits and processing facilities in the region).

The Proponent has undertaken an assessment of options, whereby a number of alternatives are evaluated through Order of Magnitude, Pre-Feasibility and Feasibility Studies. This evaluation process integrates environmental considerations into decision-making to ensure that potential impacts to the environment are minimised. After strategic consideration of alternatives, the preferred / most optimal options are progressed. Some of the options that have been evaluated are discussed below.

Evaluation of Mine Design

As part of the mine planning process, a number of pit and waste dump designs were evaluated. The pits and waste dumps were designed to avoid as far as practicable, the following:

- Turee Creek East floodplain;
- representations of the West Angelas Cracking Clay Priority Ecological Community (PEC); and
- sites of ethnographic and / or archaeological significance to Traditional Owners.

The Proposal intersects the floodplain of the Turee Creek East tributary and one occurrence of the West Angelas Cracking Clay PEC. These environmental values overlie the deposits and as such, avoidance is not possible.

The Central Waste Dump (Figure 2-2) was redesigned to avoid sites of high ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners. Backfilling during operations is proposed, rather than all waste being stored in external waste dumps, to reduce the volume of waste being stored in the Central Waste Dump.

Evaluation of Transport and Processing Options

Options for the transport of ore from Deposits C and D to the existing central processing facilities included evaluation of alternatives: crush and convey; and haul trucks or road trains. The transport of ore by conveyor from Deposits C and D to a mid-way crusher is preferred, however both conveying and hauling are being progressed through the Feasibility Study and therefore both form part of this Proposal.

The crush and convey alternative proposes transportation of ore via conveyor to a crusher located either at Deposits C and D or mid-way between Deposits C and D and the existing central processing facilities, and transportation of crushed ore via conveyor to the existing central process facilities. Two conveyer routes have been evaluated. The preferred conveyor route avoids interaction with Deposit A west to the south and the West Angelas Cracking Clay PEC to the north.

The hauling alternative (not preferred) proposes transportation of ore via haul trucks (both manned or Autonomous Haulage System (AHS) were evaluated) to the existing process facilities.

The road train alternative has been dismissed based on the basis of environmental, safety, initial capital cost and future operating cost.

Evaluation of Surplus Water Management Options

The Proposal will require dewatering to access the below water table resources. Dewatering water will be used to supply local operational water demand in the first instance. Surplus dewatering water, exceeding the local operational water requirement, is expected to be generated.

Options for the management of surplus dewatering water, aligned with the Department of Water's water management hierarchy (outlined in the *Western Australian Water in Mining Guideline*) included evaluation of the following:

- transfer of surplus dewatering water to other users;
- storage of surplus dewatering water in mined out pit voids for infiltration / evaporation;
- reinjection of surplus dewatering water back into an aquifer; and
- discharge of surplus dewatering water to a local ephemeral tributary of Turee Creek East.

Most of the options evaluated for the management of surplus dewatering water were not considered viable. For example, the transfer of surplus dewatering water to other users was determined not viable as significant local demand for surplus dewatering water did not exist at the time, despite the escalating demand due to growth and expansion in the inland Pilbara region; prospective users were not located within reasonable distances; and the infrastructure required to transfer surplus dewatering water to other users was prohibitively capital intensive.

The preferred strategy for the management of surplus dewatering water proposes transfer to the existing operations to supply operational water demand and / or discharge of surplus dewatering water to the Turee Creek East tributary. This strategy is described further in Section 8.

2.4 Local and Regional Context

2.4.1 Social Values

Karijini National Park, Western Australia's second largest National Park covering more than 627,000 ha, is located within the Hamersley subregion of the Pilbara bioregion, and is approximately 12 km west of the existing West Angelas Project.

Existing land uses in the region are limited to mining and pastoral activities. Rio Tinto currently operates a number of iron ore mines and associated rail and port infrastructure within the Pilbara region of Western Australia (Figure 1-1), including the existing West Angelas Project.

Other operations in proximity to this Proposal include:

- BHPBIO's Mining Area C is located approximately 35 km north-north east of West Angelas.
- Rio Tinto's Hope Downs 1 is located approximately 45 km north east of West Angelas.
- BHPBIO's Yandi (Marillana Creek) is located approximately 60 km north-north east of West Angelas.
- Rio Tinto's Yandicoogina is located approximately 65 km north east of West Angelas.
- Rio Tinto's Hope Downs 4 is located approximately 85 km east of West Angelas.
- Rio Tinto's Marandoo is located approximately 90 km north west of West Angelas.
- BHPBIO's Mount Whaleback is located approximately 95 km north east south-east of West Angelas.

Aside from mining, the West Angelas region is largely undeveloped. Inland regions are sparsely populated, with the largest inland towns (such as Tom Price, Paraburdoo and Newman) established specifically to support the mining industry. The nearest town, Newman, is located approximately 130 km south-east of West Angelas.

Pastoral activity in the region has historically been limited to grazing of cattle on Juna Downs Station which is located approximately 20 km to the north and Rocklea Station which is located approximately 75 km to the west of West Angelas.

2.4.2 Environmental Values

West Angelas is situated within the upper reaches of the Turee Creek Catchment, immediately west of the regional catchment divide separating the Ashburton River Catchment from the Fortescue River Catchment. The regional Turee Creek Catchment is approximately 7,400 km^2.

Turee Creek, an ephemeral tributary of the Ashburton River, represents the most significant named watercourse in the region. The east branch of Turee Creek (Turee Creek East) is an ephemeral watercourse which flows depending on the occurrence of high intensity rainfall events, typical of Pilbara watercourses. Turee Creek East flows generally westward across the West Angelas operation, continuing west south-westerly through the Karijini National Park, before merging with Turee Creek (Turee Creek merges with the Hardey River, which flows into the Ashburton River). Immediately upstream of the confluence with Turee Creek, Turee Creek East has a catchment area of approximately 2,050 km^2. For further information on hydrology refer to Section 8.

The West Angelas Project is situated within the Pilbara (PIL) bioregion and the Hamersley subregion (IBRA 2012). The Hamersley subregion is characterised by mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by gorges.

The West Angelas Project lies entirely within the Pilbara region of the Eremaean Botanical Province as defined by Beard (1975) and the vegetation of this Province is typical of arid landscapes with the predominant vegetation associations being Low woodland and Low scattered tree steppe. At a scale of 1: 1,000,000 the vegetation unit's described by Beard (1975) within the West Angelas region are considered well represented elsewhere. For further information on vegetation refer to Section 5.

Rio Tinto has defined Environmental Values across the Pilbara (following the approach that BHP Billiton Iron Ore's (BHPBIO) has taken in its strategic assessment).

Two Tier 1 Assets[1] are present in the West Angelas region:

- Karijini National Park is located approximately 12 km west of the existing West Angelas Project, representing the most significant Environmental Value in the Hamersley subregion of the Pilbara bioregion.
- Threatened fauna, listed under the *Wildlife Conservation Act 1950* (WA) and the EPBC Act have been recorded in the region, including: the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*); Ghost Bat (*Macroderma gigas*); and Fork-tailed Swift (*Apus pacificus*) (Figure 6-1). For further information on Threatened fauna refer to Section 6 and Section 12.

Three Tier 2 Assets[2] are present in the West Angelas region:

- The West Angelas Cracking Clay PEC occurs extensively throughout the West Angelas region (Figure 5-3). For further information on the West Angelas Cracking Clay PEC refer to Section 5.
- Priority fauna, listed under the *Wildlife Conservation Act 1950* (WA) have been recorded in the region, including the Pilbara Barking Gecko*, Underwoodisaurus seorsus* (P2); and Western Pebble-mound Mouse, *Pseudomys chapmani* (P4) (recorded from secondary evidence only) (Figure 6-1). For further information on Priority fauna refer to Section 6.
- Critical habitat for protected (Threatened) fauna has been recorded in the region. Ghost Bats have been recorded roosting in five caves within 'gorge and gully' habitat in the West Angelas region; four roosts; Caves A1, A2, L2 and L3 to the north of Deposit B and one cave to the north of Deposit F; Cave AA1. These roosts represent the most significant faunal habitat in the region, and are generally the primary focus of conservation and / or monitoring (Figure 6-1). For further information on critical habitat for protected (Threatened) fauna refer to Section 6.

[1] A Tier 1 Asset is defined by Rio Tinto as 'Environment Values (species / communities / ecosystems) directly protected under State and/or Commonwealth legislation.'

[2] A Tier 2 Asset is defined by Rio Tinto as 'Environment Values (species / communities / ecosystems) recognised as being of conservation interest.'

3. STAKEHOLDER ENGAGEMENT

3.1 Key Stakeholders

The Proponent identified the following government agencies and non-government organisations as key stakeholders for this Proposal:

- Government agencies:
  - Office of the Environmental Protection Authority (OEPA);
  - Department of Parks and Wildlife (Parks and Wildlife);
  - Department of Environment and Regulation (DER);
  - Department of Water (DoW);
  - Department of Mines and Petroleum (DMP);
  - Department of State Development (DSD);
  - Department of Aboriginal Affairs (DAA); and
  - Shire of East Pilbara.
- Traditional Owners:
  - Yinhawangka Traditional Owners.

3.2 Stakeholder Engagement Process

Consultation with stakeholders has been ongoing since operations commenced at West Angelas. The Proponent will continue to consult with relevant stakeholders during the environmental approval process and implementation of this Proposal.

3.3 Stakeholder Consultation

A summary of stakeholder consultation relevant to this Proposal is provided in Table 3-1.

On 28 April 2017 the Government announced amalgamations of numerous State agencies.

- The OEPA, DER and DoW were amalgamated to become the Department of Water and Environmental Regulation (DWER).
- Parks and Wildlife was amalgamated with other agencies to become the Department of Biodiversity Conservation and Attractions (DBCA).
- DMP was amalgamated with components of the Department of Commerce to become the Department of Mines, Industry Regulation and Safety (DMIRS).
- DSD was amalgamated with the remainder of the Department of Commerce and another agency to become the Department of Jobs, Tourism, Science and Innovation (DJTSI).

As stakeholder consultation relevant to this Proposal was undertaken prior to the amalgamation announcement, the previous agency nomenclature is retained in Table 3-1 and throughout this ER document.

Table 3-1: Summary of stakeholder consultation relevant to this Proposal

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
Office of the Environmental Protection Authority (OEPA)		
27 November 2014	The OEPA, Assessments and Compliance Division received feedback from the DMP on the West Angelas Closure Plan and provided comments to the Proponent. The OEPA considered that the Closure Plan required amendments to address the following comments before it could be approved for implementation: • It is unclear how potential post mining impacts have been determined and it is therefore difficult to determine whether all post mining impacts have been identified and addressed. The proponent is required to identify potential post mining impacts through a risk analysis process as outlined in the *Guidelines for Mine Closure Plans*. • The management and mitigation measures presented in this Closure Plan are from other Rio Tinto Management Plans and do not address how this particular site will be closed. If mitigation measures used on other Rio Tinto mine sites are used in this Closure Plan, the Plan should include details on how those measures will be implemented at this site. • A rehabilitation plan should be developed for long term low grade stockpiles as these stockpiles are not in the life of mine schedule for processing and it is therefore assumed that they will be present at closure. • No consultation has been undertaken with DMP regarding closure of the site. The proponent needs to liaise with DMP prior to preparation of the next revision of the Closure Plan. • As the proposal is located on Vacant Crown Land and is in close proximity to Karijini National Park, the return of a native ecosystem is supported by DMP and the OEPA. A decision to proceed with Pastoralism as the post mining land use would need to be reached through consultation with relevant stakeholders. • The closure objectives do not encompass all aspects of the site. The closure objectives should be revised in consultation with the *Guidelines for Mine Closure Plans* to ensure closure objectives link to closure criteria. • Pits at Deposits A, A west and E will be highly erodible and unstable post closure. No information has been provided regarding the zone of instability for these pits. If this information is unknown, investigations should be conducted as soon as practicable and all waste dumps should be located outside of the zone of instability at all pits.	The Closure Plan was amended to address the specific concerns raised, and was submitted to the OEPA Assessments and Compliance Division on 4 March 2015.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
27 November 2014	• A new hydrological regime will be established post closure. The proponent should consult with DoW prior to preparation of the next revision of the Plan. • The completion criteria and associated performance indicators are generic and unclear. While detailed completion criteria are not expected at this stage of mine life, it is expected that the completion criteria provided will include all aspects of the site and are specific towards final landforms that will be present at the site. The *Guidelines for Mine Closure Plans* outline the detail that is expected of indicative completion criteria.	
1 November 2016 22 November 2016	The Proponent met with the OEPA on 1st and 22nd November 2016 to present an overview of the Proposal and to discuss the EPA Policies and Procedures Review. The following preliminary key environmental factors associated with the Proposal were discussed: • The proposed additional clearing of approximately 4,000 ha and the proposed extension of the Mine Development Envelope up to 3,800 ha. The cumulative clearing of up to 12,200 ha and cumulative Mine Development Envelope up to 26,400 ha for West Angelas was considered comparable with other iron ore projects in the Pilbara. • The proposed intersection of one 15.5 ha occurrence of the West Angelas Cracking Clay PEC which overlies Deposit D given that this occurrence represents approximately 3.5% of the community identified. • The proposed intersection of the 1% AEP (100 year ARI) floodplain of the Turee Creek East tributary or the proposed diversion of the Turee Creek East tributary. • The OEPA sought to understand the extent of groundwater drawdown beneath Karijini National Park and the potential for groundwater drawdown to impact one community of approximately 4.2 ha which possessed co-dominant populations of the potentially low to moderately groundwater dependant species (*Eucalyptus camaldulensis)*. • The occurrence of conservation significant fauna including Pilbara Leaf-nosed Bats recorded foraging in the Proposal area was discussed. The Proponent noted that the timing of the calls and the relatively low number of calls suggest the individual/s had flown into the area from a roost outside the West Angelas Mine Development Envelope and further, given the absence of permanent surface water in the area, the potential foraging habitat was not considered significant. The OEPA advised that assessment of potential foraging habitat was required.	The Proponent will continue to consult with the OEPA throughout the environmental approvals process.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
1 November 2016 22 November 2016	• The occurrence of both troglofauna and stygofauna was discussed. Given the extent of suitable geological habitats located nearby, it would be reasonably expected that stygofauna would be well represented across the region and therefore, they are considered to be at low risk of impact. Based on the information provided by the Proponent, the OEPA were supportive of the use of habitat to infer potential impacts to subterranean fauna species given that there is habitat continuity beyond the proposed pit boundaries and drawdown extent. No formal advice regarding the Level of Assessment for this Proposal was provided given that the EPA Policies and Procedures are due for release on 13 December 2016. Based on the information provided by the Proponent, the OEPA suggested that an Environmental Review Level of Assessment could be set however, groundwater drawdown beneath Karijini National Park could require public consultation and as such, a Public Environmental Review Level of Assessment could be set.	
Department of Environmental Regulation (DER)		
Ongoing	An Operating Licence (L7774/2000, issued under Part V of the EP Act) and Works Approvals have been granted for the existing West Angelas Project. Given that detailed design required to support the Operating Licence amendment application is still being undertaken, there has been limited consultation with DER specifically regarding this Proposal to date. Once the detailed design work is complete, the Proponent, in consultation with DER, will submit an amendment application summarising the proposed activities in accordance with established procedures.	The Proponent will continue to consult with DER throughout the environmental approvals process and will apply for relevant licencing as required under Part V of the *Environmental Protection Act 1986*.
Department of Parks and Wildlife (Parks and Wildlife)		
22 September 2016 30 September 2016	The Proponent had previously (14 September 2016) written to Parks and Wildlife requesting to conduct low-impact Electrical Resistivity Imaging (ERI) in Karijini National Park to support the Pre-Feasibility Study and upcoming section 38 Referral of future deposits at West Angelas. The Proponent proposed that the request and the methodology were non-invasive and were in line with works undertaken in Karijini National Park near the Marandoo mine in 2009. Parks and Wildlife requested contextual information relating to the ERI proposal. The Proponent met with Parks and Wildlife on 30 September 2016 to present an overview of the ERI proposal and discuss this Proposal:	The Proponent committed to meet with Parks and Wildlife (30 September 2016) to provide an overview of the Proposal to context the proposed ERI in Karijini National Park.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
22 September 2016 30 September 2016	• The proposed additional clearing of approximately 4,000 ha and the proposed extension of the Mine Development Envelope up to 3,800 ha. The cumulative clearing of up to 12,200 ha and cumulative Mine Development Envelope up to 26,400 ha for West Angelas was considered comparable with other iron ore projects in the Pilbara. • The proposed intersection of one 15.5 ha occurrence of the West Angelas Cracking Clay PEC which overlies Deposit D was discussed in detail. Parks and Wildlife sought to understand the extent of local and other regional representations of Cracking Clay PEC given the age of the mapping which informs the Parks and Wildlife dataset. • The proposed intersection of the 1% AEP (100 year ARI) floodplain of the Turee Creek East tributary, the proposed diversion of the Turee Creek East tributary and the absence of riparian vegetation along the Turee Creek East tributary was discussed in detail. • The extent of groundwater drawdown beneath Karijini National Park and the potential for groundwater drawdown to impact one community of approximately 4.2 ha which possessed co-dominant populations of the potentially low to moderately groundwater dependant species, *Eucalyptus camaldulensis* were discussed in detail. • Parks and Wildlife sought confidence in the groundwater modelling. The Proponent discussed the hydraulic barriers to groundwater flow (no-flow) associated with the geological formations in the region. • Based on the information provided by the Proponent, Parks and Wildlife were supportive of the conservative approach of assumed drawdown and also the process for determination of a 'low to moderate' risk for the community which possessed co-dominant populations of *Eucalyptus camaldulensis*. Parks and Wildlife indicated that they considered that consultation with the Conservation Commission would be required. Parks and Wildlife also indicated that they considered that further detailed consultation would be required to understand the potential for drawdown to impact potentially groundwater dependant vegetation within Karijini National Park. • Parks and Wildlife also sought to understand the recovery of groundwater. The Proponent discussed the limited recharge expected and further, the concept that modern climate has no effect on ancient groundwater and as such, it is considered likely that the groundwater will not recover.	The Proponent proposed to undertake ERI, a non-invasive imaging technique to understand the subsurface profile within Karijini National Park, specifically; to confirm the depth to the groundwater table, to determine any subsurface features which may be influencing groundwater occurrence (i.e. the presence of a groundwater divide) and to inform the mode of occurrence of *Eucalyptus camaldulensis.* Parks and Wildlife were receptive to the proposed ERI given the contextual information presented. The Proponent also committed to a formal presentation with both Parks and Wildlife and the OEPA on the outcomes of the studies undertaken to further understand the potential for drawdown to impact potentially groundwater dependant vegetation within Karijini National Park. Parks and Wildlife declined to attend a presentation pending their review of the studies. The Proponent will provide Parks and Wildlife with a copy of the Referral and Environmental Review document post referral to OEPA in order to provide Parks and Wildlife with detailed information regarding the Proposal. The Proponent will discuss any specific concerns once Parks and Wildlife have had an opportunity to review the Referral and Environmental Review document and will provide a copy of any concerns raised and responses to the OEPA.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
22 September 2016 30 September 2016	• Parks and Wildlife were also interested in understanding the interaction between the Proposal and conservation significant species (particularly fauna and subterranean fauna). The Proponent discussed that: Pilbara Leaf-nosed Bats had been recorded foraging in the Proposal area but the timing of the calls and the relatively low number of calls suggest the individual/s had flown into the area from a roost outside the West Angelas area and further, given the absence of permanent surface water in the area, the potential foraging habitat was not considered significant. Parks and Wildlife advised that assessment of potential foraging habitat was required. Subterranean fauna had been recorded in the Proposal area, but the SRE status of the subterranean fauna recorded was to be determined. Parks and Wildlife advised that assessment of potential impacts to subterranean fauna was required.	The Proponent committed to understand the potential impacts on potential foraging habitat for Pilbara Leaf-nosed Bats (Section 6 of this document). The Proponent committed to understand the potential impacts on subterranean fauna (Section 7 of this document).
Department of Water (DoW)		
15 November 2016	The Proponent met with DoW on 15 November 2016 to present an overview of the Proposal and to discuss any concerns. The Proponent discussed the preliminary key environmental factors associated with the proposal, being hydrological processes (both groundwater and surface water) and vegetation. Specifically: • The proposed additional clearing of approximately 4,000 ha (including the intersection of one 15.5 ha occurrence of the West Angelas Cracking Clay PEC which overlies Deposit D) and the proposed extension of the Mine Development Envelope up to 3,800 ha. • The proposed intersection of the 1% AEP (100 year ARI) floodplain of the Turee Creek East tributary or the proposed diversion of the Turee Creek East tributary but sought to understand the closure strategy for the proposed diversion. • The groundwater modelling was discussed in detail, including the hydraulic barriers to groundwater flow (no-flow) associated with the geological formations in the region and the extent of groundwater drawdown beneath Karijini National Park. The Proponent also discussed the potential for groundwater drawdown to impact one community of approximately 4.2 ha which possessed co-dominant populations of the potentially groundwater dependant species, *Eucalyptus camaldulensis*.	The Proponent committed to understand the closure scenario for the proposed diversion of the Turee Creek East tributary. The Proponent will provide DoW with a copy of the Referral and Environmental Review document post referral to OEPA in order to provide DoW with detailed information regarding the Proposal. The Proponent will discuss any specific concerns once DoW have had an opportunity to review the Referral and Environmental Review document and will provide a copy of any concerns raised and responses to the OEPA.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
15 November 2016	• DoW sought to understand the potential effect of removal of the dolerite dyke structure through Deposit C, which forms a hydraulic barrier to groundwater flow and expressed concern about the Proponents ability to return the groundwater to a natural regime at closure. • DoW sought to understand groundwater quality. The Proponent discussed that the groundwater quality is excellent due to the ancient age of the groundwater associated with the geological formations in the region. • DoW sought to understand the strategy for the management of surplus dewatering water. The Proponent discussed the use of dewatering water locally in the first instance, the transfer of dewatering water to the existing operations for further use and/or the discharge of surplus dewatering water exceeding the operational requirement through the existing discharge point to a local ephemeral tributary of Turee Creek East. DoW were supportive of the continued implementation of the integrated surface water management strategy. • DoW also sought to understand the interaction between the Proposal and subterranean fauna (specifically stygofauna). The Proponent briefly discussed that there are potentially restricted stygofauna taxa present however given the extent of suitable geological habitats located nearby, it would be reasonably expected that stygofauna would be well represented across the region.	
Department of State Development (DSD)		
28 June 2016	The Proponent met with DSD on 28 June 2016 and provided a brief summary of this Proposal. Key points included the context for the development and an indication of the scope and timing for the State Agreement proposal/s. It was noted that approval would be required under Part IV of the *Environmental Protection Act 1986*.	The Proponent will keep DSD informed in relation to the status of the Part IV EP Act process and the timing of planned submissions of State Agreement proposal/s under the *Iron Ore (Robe River) Agreement Act 1964.*
Shire of East Pilbara		
28 October 2016	The Proponent met with the Shire of East Pilbara on 28 October 2016 to present an overview of the Proposal and to discuss any concerns. No significant concerns were raised.	The Proponent will continue liaising with the Shire of East Pilbara and will discuss Proposal specific matters as required.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
Department of Mines and Petroleum (DMP)		
21 January 2015	The DMP reviewed the West Angelas Closure Plan and provided technical advice to the OEPA (27 November 2014). The Proponent met with DMP on 21 January 2015 to discuss the DMP review of the West Angelas Closure Plan. DMP acknowledged that there are likely to be some gaps in closure knowledge but that this is acceptable given Ministerial conditions require regular Closure Plan updates.	The Proponent committed to continue to consult with DMP and to amend the Closure Plan to address specific concerns.
11 February 2015	The Proponent met with DMP on 11 February 2015 to discuss the West Angelas Closure Plan and to determine: • which of the concerns raised by the OEPA had originated from DMP; • whether the OEPA's response accurately reflected DMP's review of the West Angelas Closure Plan; and • whether the response was indicative of dissatisfaction with the West Angelas Closure Plans or Rio Tinto mine sites more broadly. DMP indicated that it had raised some concerns about the closure plan with the OEPA, but in the context of issues to be addressed in the next closure plan update. It had not recommended that the closure plan be rejected. DMP indicated that whilst there are some improvements that need to be made to the closure plan, it considers the document to be generally acceptable. Clarification was provided on DMP expectations in relation to the closure plan improvements to be implemented in 2015.	The Closure Plan was amended to address the specific concerns raised, and was submitted to the OEPA Assessments and Compliance Division on 4 March 2015. The Proponent will provide DMP with a copy of the Referral and Environmental Review document in order to provide DMP with detailed information regarding the Proposal. The Proponent will discuss any specific concerns once DMP have had an opportunity to review the Referral and Environmental Review document and will provide a copy of any concerns raised and responses to the OEPA.
Department of Aboriginal Affairs (DAA)		
Ongoing	Given that heritage surveys are still being undertaken and therefore, that the number, type and significance of heritage sites which may be impacted by the Proposal are not yet known, there has been limited consultation with DAA specifically regarding the Proposal to date.	The Proponent's considers that they have a good working relationship with DAA and provides ongoing updates on relevant Proposals and heritage matters at regular liaison meetings.

Date of communication	Topics/Issues Raised	Proponent Response/Outcome
Ongoing	Heritage surveys are scheduled to continue in 2017. Upon completion, the Proponent will consult DAA on Proposal specific heritage matters including submissions for section 16 (s16) consent under the *Aboriginal Heritage Act 1972* (AHA) to undertake archaeological research to understand and assess the significance of identified rock shelters. Direct and indirect impacts to heritage sites will be avoided as far as practicable. The Proponent will seek section 18 (s18) consent under the AHA to disturb any heritage sites that cannot be avoided. The Proponent will consult DAA at regular liaison meetings regarding any planned submissions for s18 consent in advance of submission.	The Proponent will continue regular liaison meetings with DAA and will discuss Proposal specific matters as required. The Proponent will consult with DAA regarding any planned submissions for approval under s18 of the AHA to disturb any heritage sites that cannot be avoided.
Yinhawangka Traditional Owners		
Ongoing	Issues relevant to the Yinhawangka Traditional Owners are discussed at biannual Local Implementation Committee (LIC) meetings, as agreed to in the Yinhawangka Claim Wide Participation Agreement. An overview of this Proposal was presented to the Yinhawangka LIC meetings on 29 February 2016, 14 September 2016 and 22 March 2017. This Proposal was also discussed at the Yinhawangka - Rio Tinto Heritage Sub-committee (HSC) meetings on 1 March 2016, 22 June 2016 and 23 March 2017. Rio Tinto informed the committee at these forums of the proposed archaeological and ethnographic survey work (site recording and consultation) planned and that the results of these surveys may lead to submissions requesting section 16 (s16) consent under the AHA to undertake archaeological research to understand and assess the significance of identified rock shelters and / or s18 consent under the AHA to disturb any heritage sites that cannot be avoided. The cumulative impact of surface water diversions continues to be a key issue for ongoing discussion. The Yinhawangka Traditional Owners have requested ongoing consultation regarding regional surface water management. The diversion of Turee Creek East to redirect surface water flows which would otherwise be captured by Deposit C northwards (resulting in the continuation of flow along its natural path) was presented to the Yinhawangka LIC meeting 22 March 2017. Specific surface water management and cultural landscape consultation was proposed for September 2016 however this was unable to be completed and is rescheduled to be conducted in 2017.	The Proponent will provide the Yinhawangka Group with a copy of the Referral and Environmental Review document (this document) within 5 business days of referral to the OEPA. The Proponent will discuss any specific concerns once the Yinhawangka Group have had an opportunity to review the Referral and Environmental Review document and will provide a copy of any concerns raised and responses to the OEPA. The Proponent will also continue with regular consultation with the Yinhawangka Group through the LIC meetings and HSC meetings. Regional surface water management will continue to be discussed with the group during these meetings. The next LIC and HSC meetings are scheduled for September 2017.

4. ENVIRONMENTAL PRINCIPLES AND FACTORS

4.1 Principles

The Proponent acknowledges the environmental protection principles of Environmental Impact Assessment (**EIA**) listed in section 4A of the EP Act and presented in the EPA's *Statement of Environmental Principles, Factors and Objectives* (EPA 2016):

- the Precautionary Principle;
- the Principle of Intergenerational Equity;
- the Principle of the Conservation of Biological Diversity and Ecological Integrity;
- principles in relation to Improved Valuation, Pricing and Incentive Mechanisms; and
- the Principle of Waste Minimisation.

Table 4-1 describes how the Proponent has considered these environmental protection principles for this Proposal.

4.2 Environmental Factors

The Proponent has assessed the environmental factors relevant to this Proposal, in accordance with the approach in the EPA's *Statement of Environmental Principles, Factors and Objectives* (2016) and the EPA's Environmental Factor Guidelines and Environmental Factor Technical Guidance. The outcome of this assessment is presented in Table 4-2.

The preliminary key environmental factors relating to this Proposal are considered to be: *Flora and Vegetation*; *Terrestrial Fauna; Subterranean Fauna*; and *Hydrological Processes.* The following sections provide information specific to these preliminary key environmental factors, including:

- a description of the EPA objective for the environmental factors, as defined in the EPA's *Statement of Environmental Principles, Factors and Objectives* (2016);
- a description of the relevant policy and guidance for the environmental factors, as defined in the EPA's *Framework for Environmental Consideration in EIA* (2016);
- a summary of the existing environmental values for the environmental factors;
- a summary of the potential direct, indirect and cumulative impacts on the environmental values for the environmental factors;
- an assessment of the significance of potential direct, indirect and cumulative impacts on the environmental values for the environmental factors;
- a summary of the proposed mitigation strategies; and
- a description of the predicted outcome against the EPA objective for the environmental factors.

The Proponent used extensive regional data sets to undertake environmental impact assessment for each of the preliminary key environmental factors relating to this Proposal, resulting in a high degree of confidence in the identification of potential impacts. Where residual impacts have been assessed as significant the application of the mitigation hierarchy has resulted in a reduction of potential impacts and the EPAs objectives being met.

Closure and *Offsets* are also considered relevant to this Proposal and are described in the following sections.

The Proponent considers that the remaining environmental factors are not of significance to warrant further assessment by the EPA, or are impacts that can be regulated by other statutory processes to meet the EPA's objectives, outlined in the EPA's *Statement of Environmental Principles, Factors and Objectives* (2016) and have therefore been classed as 'other environmental factors'. Each of these 'other environmental factors' have been addressed in Section 11.

Table 4-1: Environmental protection principles of the EP Act

Principle	Consideration
The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b) an assessment of the risk-weighted consequences of various options.	The Proponent has undertaken comprehensive baseline studies, investigations and modelling to understand and assess potential threats of serious or irreversible damage to the surrounding environment. A precautionary approach has been taken when threats to the surrounding environment are uncertain. Where threats of serious or irreversible damage to the surrounding environment were identified, management strategies have been, and will continue to be, implemented to avoid or minimise those threats wherever possible. Examples of application of the precautionary principle to *avoid, where practicable, serious or irreversible damage to the environment* include the following: • This Proposal is located adjacent to the existing West Angelas operations and wherever possible, will make use of the existing central processing facilities, support facilities (including the West Angelas accommodation village), integrated water management system, roads, rail network and other assets. • The conveyor to transport ore to the central processing facilities has been designed to avoid interaction with the West Angelas Cracking Clay PEC; PEC-2015-5. • The Central Waste Dump has been redesigned to avoid sites of high ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners. • Backfilling of pits during operations is proposed, rather than all waste being stored in external waste dumps. An assessment of options to avoid, where practicable, serious or irreversible damage to the environment is included Section 2.3.
The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	The Proponents HSECQ Policy incorporates the principle of sustainable development (to ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations) and includes the following commitments: • Prioritising research and implementation programs through technology to reduce impacts to land, enhancing our contribution to biodiversity and improving our efficiency in water and energy use. • Identifying climate change improvement solutions through dedicated optimisation work programs. • Contributing to the health and well-being of local communities. A Closure Plan has also developed to ensure that West Angelas is closed in a manner to ensure that the environmental is maintained for the benefit of future generations. Where, significant residual impacts were identified, offsets are proposed.

Principle	Consideration
The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The Proponent has undertaken comprehensive baseline studies to understand and assess potential threats to biological diversity and ecological integrity. Management strategies have been, and will continue to be, implemented to avoid or minimise threats to biological diversity and ecological integrity wherever possible. Examples of management strategies proposed for *the conservation of biological diversity and ecological integrity* include the following: • Dewatering shall be managed so that there is no irreversible impact to groundwater dependant vegetation within Karijini National Park. • Discharge of excess dewatering water shall be managed so that there is no irreversible impact to the health of riparian vegetation of Turee Creek East.
Principles relating to improved valuation, pricing and incentive mechanisms 1) Environmental factors should be included in the valuation of assets and services. 2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. 3) The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. 4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	The Proponent has, and will continue to, evaluate (and implement wherever possible) opportunities to reduce impact to land, reduce waste and improve efficiencies in water and energy use during the implementation, operation and closure of West Angelas in accordance with the Proponents HSECQ Policy. The Proponent has, and will continue to operate under an operating licence, issued under Part V of the EP Act, that will ensure that pollution (when or if generated) is paid for in line with legislation.
The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	All reasonable and practicable measures have been and will continue to be undertaken by the Proponent to minimise the generation of waste at its Pilbara operations. The Proponent also has, and will continue to operate under an operating licence, issued under Part V of the EP Act, that will manage wastes.

Table 4-2: Significance Framework for Preliminary Key Environmental Factors for this Proposal

Factor		EPA Objective	Relevance of the Proposal to the environmental factor	Determination of 'key' or 'other' environmental factors
Land	Flora and Vegetation	*To protect flora and vegetation so that biological diversity and ecological integrity is maintained.*	Clearing, drawdown and / or discharge are expected to result in the loss or declining health of vegetation (including vegetation communities which are considered to be of local conservation significance; the West Angelas Cracking Clay PEC and riparian vegetation of Turee Creek East) and potential loss of some individuals of Priority flora species.	Preliminary key environmental factor (addressed in Section 5 of this document).
	Landforms	*To maintain the variety and integrity of physical landforms so that environmental values are protected.*	Mining is expected to result in permanent changes to local landforms. These landforms are not of elevated conservation significance or other special interest and are not unique to the West Angelas region.	Other environmental factor (addressed in Section 11 of this document).
	Subterranean Fauna	*To protect subterranean fauna so that biological diversity and ecological integrity is maintained.*	Clearing, mining and / or drawdown are expected to result in the loss or degradation of subterranean fauna habitat and potential loss of subterranean fauna individuals (including individuals of elevated conservation significance if present).	Preliminary key environmental factor (addressed in Section 7 of this document).
	Terrestrial Environmental Quality	*To maintain the quality of land and soils so that environment values are protected.*	Wastes are expected to be generated. Rio Tinto has well established strategies for the management of wastes at its Pilbara operations. Wastes are primarily regulated under Part V of the EP Act, unless the environmental impact is significant and warrants EIA by the EPA under Part IV of the EP Act (EPA 2012). Wastes have been, and will continue to be, managed using existing facilities, in accordance with the existing Operating Licence issued under Part V of the EP Act.	Other environmental factor (addressed in Section 11 of this document).

Factor		EPA Objective	Relevance of the Proposal to the environmental factor	Determination of 'key' or 'other' environmental factors
Land	Terrestrial Fauna	*To protect terrestrial fauna so that biological diversity and ecological integrity is maintained.*	Clearing is expected to result in the loss of potential fauna habitat (including habitats for conservation significant fauna species) and potential loss of some individuals of conservation significant species recorded in the region: the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*); Ghost Bat (*Macroderma gigas*); Fork-tailed Swift (*Apus pacificus*); Pilbara Barking Gecko (*Underwoodisaurus seorsus*); and Western Pebble-mound Mouse (*Pseudomys chapmani*) or assessed as having a moderate to high likelihood of occurrence within the region: the Northern Quoll (*Dasyurus hallucatus*); Pilbara Olive Python (*Liasis olivaceus barroni*); Rainbow Bee-eater (*Merops ornatus*); Grey Falcon (*Falco hypoleucos*); Peregrine Falcon (*Falco peregrinus*); Blind Snake (*Ramphotyphlops ganei*); and Short-tailed Mouse (*Leggadina lakedownensis*).	Preliminary key environmental factor (addressed in Section 6 of this document).
Water	Hydrological processes	*To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.*	Mining and / or discharge are expected to result in changes to the hydrological regime of Turee Creek East from an ephemeral hydrologic regime to a perennial hydrologic regime for the surface discharge extent. Dewatering is expected to result in groundwater drawdown of between 3m and 9m beneath Karijini National Park.	Preliminary key environmental factor (addressed in Section 8 of this document).
	Inland Waters Environmental Quality	*To maintain the quality of groundwater and surface water so that environmental values are protected.*	Mining and / or dewatering could expose PAF materials, causing AMD, impacting groundwater quality. However, the likelihood of encountering PAF material is considered low. Rio Tinto has well established management strategies for the management of PAF materials at its Pilbara operations. PAF materials, if encountered, can be appropriately managed via existing legislation (in particular the *Contaminated Sites Act 2003*) and existing management strategies (the Rio Tinto Iron Ore (WA) Mineral Waste Management Plan, and the Spontaneous Combustion and ARD Management Plan) to ensure waste material is adequately geochemically characterised, and PAF material that poses an AMD risk is appropriately managed.	Other environmental factor (addressed in Section 11 of this document).

Factor		EPA Objective	Relevance of the Proposal to the environmental factor	Determination of 'key' or 'other' environmental factors
Air	Air Quality	*To maintain air quality and minimise emissions so that environmental values are protected.*	Clearing and / or mining are expected to result in the generation of dust and greenhouse gas emissions. Rio Tinto has well established strategies for the management of emissions at its Pilbara operations. Emissions are primarily regulated under Part V of the EP Act, unless the environmental impact is significant and warrants EIA by the EPA under Part IV of the Act (EPA 2012). Emissions have been, and will continue to be, managed under the existing Operating Licence issued under Part V of the EP Act.	Other environmental factor (addressed in Section 11 of this document).
People	Social Surroundings	*To ensure that social surroundings are not materially affected.*	Mining is expected to result in permanent changes to local landforms. However, visual impacts associated with permanent changes to local landforms are not expected to be particularly prominent in the regional landscape given the proximity to the existing operations. The Proposal is remote from communities or other sensitive receptors (such as scenic outlooks). Clearing and / or mining is also expected to result in disturbance to some sites of archaeological significance however, any disturbance will be in accordance with approval under section 18 of the *Aboriginal Heritage Act 1972* and will have the support of the Yinhawangka Traditional Owners.	Other environmental factor (addressed in Section 11 of this document).
	Human Health	*To ensure that human health is not materially affected.*	Mining is expected to result in noise levels occasionally exceeding assessment criteria however, noise levels are not expected to result in any significant impacts to human health at the nearest noise sensitive receptor; the village, located within the mine operation premises. The Proposal is remote from communities or other noise sensitive receptors.	Other environmental factor (addressed in Section 11 of this document).
Note: factors relating to Sea (Benthic Communities and Habitat, Coastal Processes, Marine Environmental Quality and Marine Fauna) were not considered as part of this Proposal.				

5. FLORA AND VEGETATION

This Section describes the flora and vegetation that occur within the Proposal area, provides details regarding the potential impacts to conservation significant flora species and vegetation communities from the proposed clearing that forms part of this Proposal and management to ensure that the Proposal meets the EPA's objectives for flora and vegetation.

5.1 EPA Objective

The EPA applies the following objective from the *Statement of Environmental Principles, Factors and Objectives* (2016) in its assessment of proposals that may affect vegetation and flora:

> *To protect flora and vegetation so that biological diversity and ecological integrity is maintained.*

5.2 Policy and Guidance

The following EPA guidelines and guidance have been considered in the assessment of flora and vegetation with respect the above EPA objective:

- EPA *Statement of Environmental Principles, Factors and Objectives* (2016).
- EPA *Environmental Factor Guideline: Flora and Vegetation* (2016).
- EPA Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment* (2016).

5.3 Receiving Environment

IBRA Bioregions and Subregions

West Angelas is situated within the Pilbara (PIL) bioregion as defined in the Interim Biogeographic Regionalisation of Australia (IBRA) Report (2012). The Pilbara biogeographic region comprises four subregions: Chichester; Fortescue Plains; Hamersley; and Roebourne. West Angelas is situated within the Hamersley subregion. The Hamersley subregion is characterised by mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by gorges.

Beards Vegetation Mapping

West Angelas lies entirely within the Pilbara region of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this Province is typical of arid landscapes. According to Beard (1975), the predominant vegetation associations in the West Angelas region are:

- Low woodland; continuous Mulga *Acacia aneura* woodland communities over spinifex *Triodia basedowii* and *Triodia epactia* hummock grasslands on stony undulating plains; and

- Low scattered tree steppe; Snappy Gum *Eucalyptus leucophloia* over spinifex *Triodia wiseana* hummock grassland on stony undulating plains.

At a scale of 1: 1,000,000 the vegetation units described by Beard (1975) within the West Angelas region are well represented elsewhere.

Flora and vegetation surveys have been undertaken across the West Angelas region since 1979, covering an area in excess of 61,600 ha. The combined coverage of these surveys has enabled a detailed understanding of the existing vegetation and a considerable reference for the distribution of species (including Threatened and Priority Flora) in the West Angelas region. Table 5-1 summarises the key flora and vegetation surveys relevant to this Proposal.

Table 5-1: Summary of supporting flora and vegetation studies

Report Title Author (Year)	Summary and guidance	Appendix
An ecological appreciation of the West Angelas environment, Western Australia 1979. Integrated Environmental Services (1979)	Strategic biological survey of vegetation conducted in all seasons of the years 1978 and 1979 across West Angelas. The vegetation of the West Angelas region was described in 1979 as: • *Triodia sp.* Hummock Grassland (on ridges, steep slopes and lower slopes); • *Acacia aneura* Mulga Low Woodland (on valley floors); • *Acacia kempeana* Low Scrub (on ridges and lower slopes); • *Eucalyptus kingsmillii* Open Shrub Mallee (on ridges); • *Callitris columellaris* Stands (on fire protected slopes and gorges); and • Eucalyptus Fringing Woodland (riverine areas). None of the vegetation was considered to be rare.	-
A flora survey of Orebody A near West Angela Hill, with description of vegetation of flora collecting sites. M. Trudgen (1995)	Single phase collection of flora species conducted at Deposit A, undertaken in 1995 following particularly good rainfall. The vegetation of the West Angelas region was described in 1995 as: • *Acacia aneura* low woodland on gentle slopes and plains*;* • *Eucalyptus leucophloia* low open woodland in gullies, flowlines and broad creeklines. The survey recorded a total of 206 species. Three of these were species of interest: *Goodenia stellata Eremophila phyllopoda* ssp. *Oblique;* and *Acacia* aff. *citrinoviridis*. None of these remain on the Priority Flora list.	-
Flora and vegetation surveys of Orebody A and Orebody B in the West Angela Hill area, an area surrounding them, and of rail corridor options considered to link them to the existing rail line M. Trudgen (1998)	Desktop review and four phase survey of the vegetation and flora present at Deposits A and B and surrounds. Phase 1 conducted between 8 and 29 April 1997, Phase 2 conducted between 13 May and 11 June 1997, Phase 3 conducted between 30 June and 20 July 1997 and Phase 4 conducted between 18 and 28 September 1997, covering a total area of approximately 42,000 ha. The vegetation has been mapped at a broad scale. Seven broad vegetation associations were described in 1998, based on vegetation and landforms: • Vegetation of major and moderate flowlines; • Vegetation of iron bearing formations; • Vegetation of valleys, plains, low foothills and escarpments; • Vegetation of volcanic formations; • Vegetation of the Lyre Creek Agglomerate Member;	-

Report Title Author (Year)	Summary and guidance	Appendix
Flora and vegetation surveys of Orebody A and Orebody B in the West Angela Hill area, an area surrounding them, and of rail corridor options considered to link them to the existing rail line M. Trudgen (1998) cont.	• Vegetation of recent epoch flood deposits and travertine areas; and • Vegetation of the Wittenoom Formation. The intensity of flora searches differs over survey areas dependent on accessibility. The survey recorded a total of 635 species of flora. Twenty-one of these were Priority Flora, however, only four remain on the Priority Flora list: • *Olearia mucronata* (Lander) (Parks and Wildlife Priority (**P**) 3); • *Dampiera metallorum* (Lepschi & Trudgen), previously *Dampiera* sp. Mt Meharry (M.E. Trudgen 1178) (P3); • *Indigofera gilesii* Peter G. Wilson & Rowe (P3); and • *Eremophila magnifica*. *Lepidium catapycnon* (formerly Declared Rare Flora (DRF)) was also recorded at the southern base of West Angela Hill. The total population recorded was in excess of 100 individuals in several patches, with populations extending upslope.	-
Vegetation and Flora Survey of West Angelas Deposits E and F. Biota (2006)	Desktop review and single phase survey of the vegetation and flora present at Deposits E and F conducted between 6 and 11 May 2004, covering a total area of approximately 2,000 ha; rare flora searches conducted in June 2004 and between August and October 2005 in accordance with the following: • EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002). • EPA Guidance Statement No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a). Twelve vegetation types were identified in 2006, broadly these vegetation types included: • Hard Spinifex *Triodia wiseana* and Soft Spinifex *Triodia pungens* or *Triodia* sp. Mt. Ella (M.E. Trudgen 12739) hummock grasslands with a scattered to moderately dense shrub overstorey dominated by varying proportions of *Acacia maitlandii, A. bivenosa* and *A. hamersleyensis* on stony hills in the northern section of the survey area; • Low woodlands to tall shrublands of *Acacia catenulata* in gorges; • Hummock grasslands of *Triodia* aff. *basedowii*, with some *T. pungens*, on stony baseslopes; • Woodlands to tall shrublands of various forms of Mulga *Acacia aneura* over open hummock grasslands, usually of *Triodia pungens*, on clayey soils of the broad valleys in the southern section of the survey area; and • Creeklines supporting tall shrublands dominated by various combinations of *Acacia maitlandii, Gossypium robinsonii, Petalostylis labicheoides* and *Rulingia luteiflora* over open hummock grasslands of *Triodia pungens*.	-

Report Title Author (Year)	Summary and guidance	Appendix
Vegetation and Flora Survey of West Angelas Deposits E and F. Biota (2006) cont.	None of the vegetation types identified were considered to be sufficiently rare or restricted to warrant designating them as being of high conservation significance. The following vegetation types were considered to have moderate conservation significance: • Mulga vegetation types M1-M5: these mapping units include the vegetation unit 6adb213 of Trudgen and Casson (1998), which was considered to be relatively restricted in the area, and also comprise ecosystems at risk in the form of grove/intergrove and valley floor mulga. • Vegetation types Hi and H3 of stony hills and gorges respectively: these comprised the main mapping units from which the undescribed spinifex species *Triodia* sp. Mt Ella was recorded. This Priority 3 taxon was known only from the vicinity of West Angelas, and was uncommon and restricted in distribution however, it is now more widespread in distribution. The remainder of the vegetation types were considered to be of low conservation significance, representing units that are likely to be widely distributed and relatively well represented in the Hamersley Range subregion. The survey recorded a total of 429 species of flora. Eight of these were Priority Flora, however, currently only four remain on the Priority Flora list: • *Josephinia* sp. Marandoo (M.E. Trudgen 1554) (P1); • *Indigofera gilesii* subsp. *gilesii* (P3); • *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3); and • *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3). All of these Priority Flora have been recorded previously from West Angelas.	-
Greater West Angelas Vegetation and Flora Assessment. ecologia (2013)	Desktop review and two phase, Level 2 survey conducted; Phase 1 conducted between 9 and 18 July 2012, Phase 2 conducted between 21 and 26 August 2012, covering a total area of approximately 17,600 ha in accordance with the following: • EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002). • EPA Guidance Statement No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a). The results of this survey are outlined below.	**Appendix 5**

Ecologia Environment (*ecologia*) most recently conducted a two phase flora and vegetation assessment in 2012, covering a survey area (the survey area) of approximately 17,600 ha. The survey area is considerably broader than the Proposal area. The survey was undertaken to support an environmental impact assessment and was conducted in accordance with EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (2002) and EPA Guidance Statement No. 51 - *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (2004a). The *ecologia* (2013) report is provided as Appendix 5.

Twenty-two vegetation types were described within the survey area (Figure 5-1). Seventeen of the vegetation types are associated with this Proposal (Table 5-2, Figure 5-2);

Table 5-2: Vegetation types associated with this Proposal (*ecologia* 2013a)

Vegetation Mapping Code	**Vegetation Description** (NVIS Level V)
Gravely Plains	
ApTb	***Acacia* open woodland over *Triodia* open hummock grassland**. *Acacia aptaneura* and *A. pruinocarpa* open woodland over *A. bivenosa* isolated shrubs *Triodia basedowii* and *T. pungens* open hummock grassland.
SggAbTp	***Senna* and *Acacia* open shrubland over *Triodia* hummock grassland.** *Acacia pruinocarpa* and *Eucalyptus leucophloia* subsp. *leucophloia* or *Corymbia hamersleyana* isolated trees over *Senna glutinosa* subsp. *glutinosa, Acacia bivenosa* and *Gossypium robinsonii* open shrubland over *Triodia pungens* hummock grassland.
Gullies	
AaPoTp	***Acacia* open woodland over *Ptilotus* isolated shrubs over *Triodia* open tussock grassland.** *Acacia aptaneura* open woodland over *Ptilotus obovatus* isolated shrubs over *Themeda triandra* and *Eriachne mucronata* open tussock grassland.
Rocky Footslopes / Rises	
AaTssp	***Acacia* open woodland over *Triodia* open hummock grassland.** *Acacia aptaneura* and *A. pruinocarpa* open woodland over *A. tetragonophylla, Senna glutinosa* subsp. *glutinosa* and *S. artemisioides* subsp. *oligophylla* isolated shrubs over *Triodia wiseana* and *T. pungens* open hummock grassland.
Rocky Hilltops	
EllSggTw	***Eucalyptus* open woodland over *Senna* open shrubland over *Triodia* open hummock grassland.** *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia aptaneura* open woodland over *Senna glutinosa* subsp. *glutinosa* and *S. artemisioides* subsp. *oligophylla* open shrubland over *Triodia wiseana* or *T. pungens* open hummock grassland.

Vegetation Mapping Code	Vegetation Description (NVIS Level V)
EllSggTp	***Eucalyptus* open woodland over *Senna* open shrubland over *Triodia* open hummock grassland.** *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia marramamba* open woodland over *Senna glutinosa* subsp. *glutinosa* open shrubland over *Triodia pungens* open hummock grassland.
Rocky Midslope	
AaEffTp	***Acacia* open woodland over *Eremophila* sparse shrubland and *Triodia* sparse hummock grassland.** *Acacia aptaneura* and *A. pruinocarpa* open woodland over sparse *Eremophila fraseri* subsp. *fraseri* and *Acacia marramamba* sparse shrubland over *Triodia pungens* sparse hummock grassland.
Tp	***Triodia* hummock grassland.** *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia pruinocarpa* isolated trees over *Senna glutinosa* subsp. *glutinosa, A. bivenosa* and *Ptilotus rotundifolius* isolated shrubs over *Triodia pungens* or *T. basedowii* or *T.* sp. Mt Ella hummock grassland.
ApTssp	***Acacia* open woodland over *Triodia* open hummock grassland.** *Acacia pruinocarpa* and *Eucalyptus leucophloia* subsp. *leucophloia* open woodland over *Senna glutinosa* subsp. *glutinosa* and *A. maitlandii* isolated shrubs over *Triodia basedowii* or *T. pungens* or *T. wiseana* open hummock grassland.
Sandy Floodplains / Dry Rivers	
AaPoTt	***Acacia* open woodland over *Ptilotus* sparse shrubland over *Themeda* open tussock grassland.** *Acacia aptaneura* open woodland over *Ptilotus obovatus* sparse shrubland over *Themeda triandra* open tussock grassland.
AaTt	***Acacia* woodland over *Themeda* open tussock grassland.** *Acacia aptaneura* and *Eucalyptus xerothermica* woodland over *Ptilotus obovatus* isolated shrubs over *Themeda triandra* open tussock grassland.
Floodplains / Drainage Lines	
AaAc	***Acacia* open woodland over *Aristida* sparse tussock grassland.** *Acacia aptaneura* and *A. pruinocarpa* open woodland over *Aristida contorta* sparse tussock grassland over *Pterocaulon sphacelatum* and *Ptilotus nobilis* subsp. *nobilis* isolated forbs.
AaSaoTp	***Acacia* open woodland over *Senna* sparse shrubland over *Triodia* open hummock grassland.** *Acacia aptaneura* and *A. ayersiana* open woodland over *Senna artemisioides* subsp. *oligophylla, S. glutinosa* subsp. *glutinosa* and *Eremophila forrestii* subsp. *forrestii* sparse shrubland over *Triodia pungens* open hummock grassland.

Vegetation Mapping Code	Vegetation Description (NVIS Level V)
EgSggTb	***Eucalyptus* open woodland over *Senna* sparse shrubland over *Triodia* open hummock grassland.** *Eucalyptus gamophylla* and *Corymbia deserticola* subsp. *deserticola* open woodland over *Senna artemisioides* subsp. *oligophylla* and *Indigofera monophylla* sparse shrubland over *Triodia basedowii* and *T. pungens* open hummock grassland.
Sandy Plain	
ApEcTp	***Acacia* open woodland over *Eremophila* isolated shrubs over *Triodia* open hummock grassland.** *Acacia aptaneura* and *A. pruinocarpa* open woodland over *Eremophila caespitose* and *Tribulus suberosus* isolated shrubs over *Triodia pungens* open hummock grassland.
AlAp	***Aristida* and *Astrebla* tussock grassland.** *Aristida latifolia, Astrebla pectinata* and *Brachyachne convergens* tussock grassland with isolated *Salsola australis, Boerhavia paludosa* and *Ptilotus nobilis* subsp. *nobilis* forbs.
Sandy Undulating Plain	
AaTp	***Acacia* woodland over *Triodia* open hummock grassland.** *Acacia pruinocarpa, A. aptaneura* and *A. ayersiana* woodland over *Triodia pungens* open hummock grassland.

West Angelas is not located within a pastoral lease and, as a result, is not actively grazed. Subsequently, the vegetation was assessed to be in very good to excellent condition (*ecologia* 2013a). The disturbance most commonly observed was the presence of weed species.

5.3.1 Conservation Significant Vegetation

No Threatened Ecological Communities (TECs) are known to occur within the West Angelas region. The single vegetation TEC that has been recorded from the Hamersley subregion (*Themeda* sp. Hamersley Station grasslands; listed as Vulnerable) has not been recorded within the Proposal area.

The following vegetation communities were considered to be of elevated local and / or regional conservation significance:

- **West Angelas Cracking Clay Priority Ecological Community**

  The Priority (**P**)1 West Angelas Cracking Clay Priority Ecological Community (**PEC**) PEC occurs extensively within the West Angelas region with approximately 440 ha of this community mapped (Trudgen 1998) (Figure 5-3). These communities are considered significant because they are relatively uncommon in the Pilbara and because they are in very good condition, attributed to the absence of historic cattle grazing in the West Angelas region. The West Angelas Cracking Clay PEC is defined as:

  > 'Open tussock grasslands of *Astrebla pectinata, Astrebla elymoides*, *Aristida latifolia* in combination with *Astrebla squarrosa* and low scattered shrubs of *Sida fibulifera*, on basalt derived cracking clay loam depressions and flowlines'.

Mapping of this community is generally of a scale which does not recognise that significant proportions of the mapped area are actually represented by other less significant grassland communities.

The vegetation unit *AlAp* (*Aristida* and *Astrebla* tussock grassland) (ecologia 2012) has been determined to be equivalent to the West Angelas Cracking Clay PEC. This community is described as '*Aristida latifolia*, *Astrebla pectinata* and *Brachyachne convergens* tussock grassland with isolated *Salsola australis*, *Boerhavia paludosa and Ptilotus nobilis subsp. nobilis forbs'.* Approximately 303 ha of this vegetation community was mapped during the 2012 survey, representing approximately 1.7% of the survey area (*ecologia* 2013a).

Astrebla squarrosa has not been recorded in Cracking Clay communities of the West Angelas region since surveys by Trudgen (1998). *Astrebla elymoides* was also not recorded in Cracking Clay communities during surveys by *ecologia* (2013) although this species has been recorded in all recent surveys by Rio Tinto. It is thought that the 2012 survey timing for tussock grasses may not have been optimal with reproductive material for this species often being absent and identifications problematic for this group.

Only one representation of approximately 15.5 ha of the West Angelas Cracking Clay PEC occurs within the Proposal area. This occurrence represents approximately 3.5% of the West Angelas Cracking Clay PEC mapped by Trudgen (1998) throughout the West Angelas region and less than 5.2% of the vegetation unit *AlAp* mapped by *ecologia* (2012) within the survey area.

The condition of the West Angelas Cracking Clay PEC has previously been described as poor following a number of years of below average rainfall suggesting that surface water (sheet) flow generated by incident rainfall are important for recruitment and regeneration of the associated tussock grass communities.

Threats to West Angelas Cracking Clay PEC include: clearing for mining; changes in hydrological regimes; changes in fire regimes and weed invasion.

- **Riparian vegetation** within the Proposal area

  Riparian ecosystems are characterised by the presence of species that rely on groundwater, known as phreatophytic species. Three common Pilbara species are known to be phreatophytic: *Melaleuca argentea* (obligate phreatophyte), *Eucalyptus camaldulensis* (facultative phreatophyte) and *Eucalyptus victrix* (facultative phreatophyte or vadophyte). Riparian vegetation along Turee Creek East (within the modelled extent of surface water discharge) supports two of these species: *Eucalyptus victrix* and potentially *Eucalyptus camaldulensis*. *Melaleuca argentea* was not recorded in the survey area (*ecologia* 2013a)

  Eucalyptus victrix are common within riparian vegetation communities of Turee Creek East. *Eucalyptus victrix* are conservatively assumed to represent groundwater dependent species, however groundwater elevation beneath these riparian vegetation communities is typically between 20m and 70m below ground level (bgl), and therefore inaccessible to *Eucalyptus victrix*.

  Riparian vegetation communities at West Angelas are represented by the vegetation unit *AaPoTt* (*Acacia* open woodland) (*ecologia* 2013a). This community is described as '*Acacia* open woodland (*Acacia aptaneura*) over *Ptilotus* sparse shrubland over *Themeda* and *Eriachne* open tussock grassland with scattered *Eucalyptus* trees'. Approximately 706 ha of this vegetation community was mapped during the 2012 survey, representing approximately 4% of the survey area (*ecologia* 2013a).

Riparian vegetation communities are not locally restricted; they also occur relatively extensively throughout the Hamersley Ranges and when considering other riparian vegetation communities present throughout the Hamersley Ranges (such as those of Weeli Wolli Creek), the riparian vegetation communities at West Angelas are considered of relatively low conservation significance.

Threats to riparian vegetation communities include: clearing, changes in hydrological regimes and weed ingress.

- **Potentially groundwater dependant vegetation** within Karijini National Park

Groundwater Dependent Ecosystems (GDE) are characterised by the presence of species that rely on groundwater for their continued survival, known as phreatophytic species (Maunsell Australia 2006 in *ecologia* 2013a). Such species only inhabit areas where they have access to groundwater in order satisfy at least some proportion of their environmental water requirements (EWR) (Eamus *et al.* 2006 in Rio Tinto 2017). Phreatophytic species may be classified as either obligate or facultative phreatophytes depending on their reliance on groundwater. 'Obligate phreatophyte' describes those species for which access to groundwater is critically important to their presence in the landscape. Obligate phreatophytes are commonly associated with surface expressions of groundwater (rather than subsurface presence of groundwater). 'Facultative phreatophyte' describes those species which may opportunistically utilise groundwater to satisfy a proportion of their EWR but, if required (i.e. during extended dry periods), may also satisfy their EWR via stored soil water reserves (Eamus *et al.* 2006 in Rio Tinto 2017). Facultative phreatophytes are commonly associated with the subsurface presence of groundwater (rather than surface water expression of groundwater).

Three common Pilbara species are known to be groundwater dependant / phreatophytic: *Melaleuca argentea* (obligate phreatophyte)*; Eucalyptus camaldulensis* subsp. *refulgens* (facultative phreatophyte); and *Eucalyptus victrix* (facultative phreatophyte or vadophyte).

Due to its exclusive dependence on groundwater, the obligate phreatophyte *Melaleuca argentea* is considered the best indicator of consistently shallow groundwater or permanent (perennial) surface water and as such, this species is also widely considered the best indicator of a GDE. *Melaleuca argentea* was not recorded in the 2017 survey area and are not known from the West Angelas region (Rio Tinto 2017).

Perennial to sub-perennial moisture indicating or mesic species such as *Melaleuca glomerata, Melaleuca bracteata* and *Acacia ampliceps* also often indicate shallow groundwater. Evidence of relatively common mesic indicator species was not recorded from the 2017 survey area. Semi-mesic species like *Acacia pyrifolia* and *Androcalva luteiflora* were recorded but these species are common in creeks in the Pilbara and are not generally recognised as dependent on or indicative of shallow groundwater (Rio Tinto 2017).

Eucalyptus victrix commonly occur along ephemeral creeklines in the Pilbara and were common at variable densities within riparian vegetation communities of Turee Creek East. *Eucalyptus victrix* are conservatively assumed to represent groundwater dependent species and therefore indicate a potential GDE, however, the degree to which *Eucalyptus victrix* is groundwater dependant / phreatophytic is not well defined. This species is typically considered to be a facultative phreatophyte or occasionally, a vadophyte. Groundwater elevation beneath the riparian vegetation communities of Turee Creek East (within the Proposal area) is typically between 20m and 70m bgl, and therefore inaccessible to *Eucalyptus victrix* such that the potential for groundwater dependence is considered negligible.

Further, the riparian vegetation communities of Turee Creek East (within the Proposal area) support variable densities of *Eucalyptus victrix;* 'scattered' individuals to 'low open woodland' would typically represent a vadophytic or occasionally phreatophytic ecosystem; such ecosystems may access groundwater to satisfy a proportion of their EWR but do not rely entirely on groundwater and hence are not considered likely to represent a GDE. Approximately 22 ha (within a 4 km reach) of riparian vegetation within Karijini National Park was found to contain *Eucalyptus victrix* at densities which could represent GDEs. Groundwater elevation below the riparian vegetation communities of Turee Creek East within Karijini National Park is typically between 2m and 6.5m bgl, and therefore accessible to *Eucalyptus victrix* such that the potential for groundwater dependence is elevated.

Eucalyptus camaldulensis is one of the most iconic and broadly distributed Eucalyptus species in Australia and commonly occur along ephemeral creeklines in the Pilbara (Western Australian Herbarium 1998 – 2016). This species was not recorded within riparian vegetation communities of Turee Creek East within the Proposal area. Approximately 4.8 ha of riparian vegetation within Karijini National Park was co-dominated by *Eucalyptus victrix* and *Eucalyptus camaldulensis*. *Eucalyptus camaldulensis* is typically considered to be a facultative phreatophyte (Mensforth *et al*. 1994 in Rio Tinto 2017). Groundwater elevation below the riparian vegetation communities of Turee Creek East within Karijini National Park is typically between 2m and 6.5m bgl, and therefore accessible to *Eucalyptus camaldulensis* such that the potential for groundwater dependence (or the presence of a GDE) is elevated.

Facultative phreatophytes (*Eucalyptus victrix* and *Eucalyptus camaldulensis)* are typically considered to be moderately groundwater dependent. Threats to potentially groundwater dependant vegetation communities include: groundwater drawdown.

- **Groved and banded Mulga communities**

  The term 'mulga' describes a group of *Acacia* species that were previously referred to as varieties of *Acacia aneura*. The species currently in this group include: *Acacia aneura; Acacia aptaneura; Acacia caesaneura; Acacia fuscaneura; Acacia incurvaneura; Acacia macraneura*; *Acacia mulganeura;* and *Acacia pteraneura*.

  The formation of a mosaic pattern of mulga groves or bands with relatively bare areas in between (intergroves) and the retention of mulga groves or bands is directly dependent upon patterns of surface water (sheet) flows. Both groved and banded mulga communities are susceptible to shadowing effects when sheet flow is disrupted or water logging effects when sheet flow is concentrated within the landscape (University of Western Australia 2010 in *ecologia* 2013a). Groved and banded Mulga communities are deemed to be an '*ecosystem at risk*' (Kendrick 2003).

  Groved and banded mulga communities are common at West Angelas. Groved mulga communities at West Angelas are represented by vegetation unit *AaEcTp.* These communities are described as '*Acacia aptaneura* and *Acacia pruinocarpa* open woodland over *Eremophila* isolated shrubs over *Triodia* open grassland'. These communities occur extensively within the West Angelas region with approximately 1,770 ha of groved mulga communities mapped, representing approximately 10% of the survey area (*ecologia* 2013a). These communities also occur relatively extensively nearby at Angelo River and Juna Downs and throughout the Hamersley subregion however, groved mulga communities at West Angelas are in very good condition, attributed to the absence of historic cattle

grazing and as such, these communities are considered to be of elevated conservation significance.

Threats to groved and banded mulga communities include: clearing for mining; changes in fire regimes; grazing and trampling; and weed ingress, particularly by Ruby Dock (*Rumex vesicarius,* formerly *Acetosa vesicaria*). These communities are also recognised as being dependent on patterns of surface water flow (sheet flow) and are therefore, sensitive to changes to the hydrological regime.

Vegetation was also considered by *ecologia* (2013) to be locally significant if it had "a role as a key habitat for threatened species". The Proposal intersects some of the vegetation considered to be locally significant due to the presence of Priority Flora. The Proponent considers that the assessment of community significance based on the presence of Priority Flora could be considered valid for vegetation containing habitat restricted flora, however, this approach is considered misleading and questionable for vegetation containing Priority Flora that is not habitat restricted.

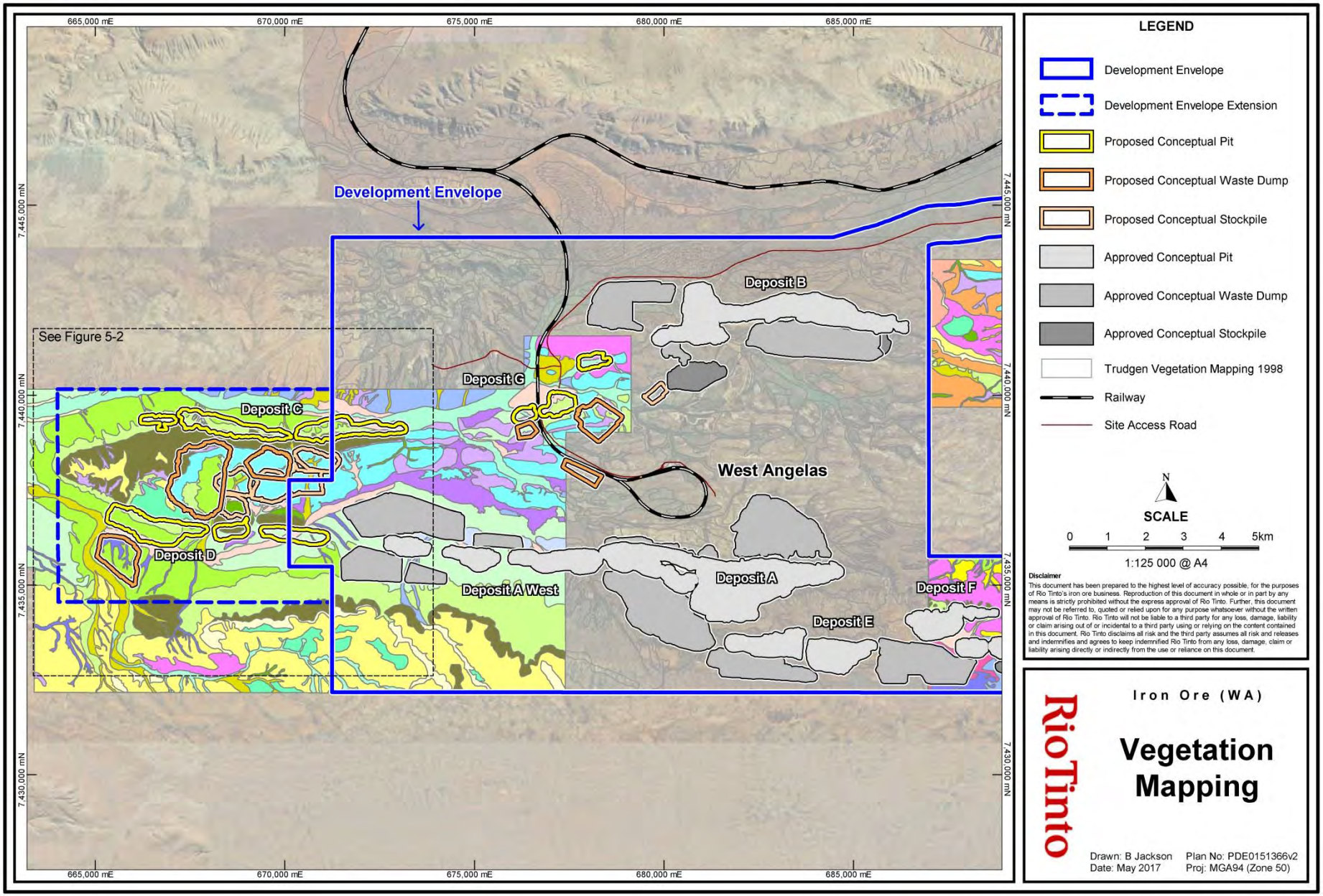

Figure 5-1: Vegetation Mapping

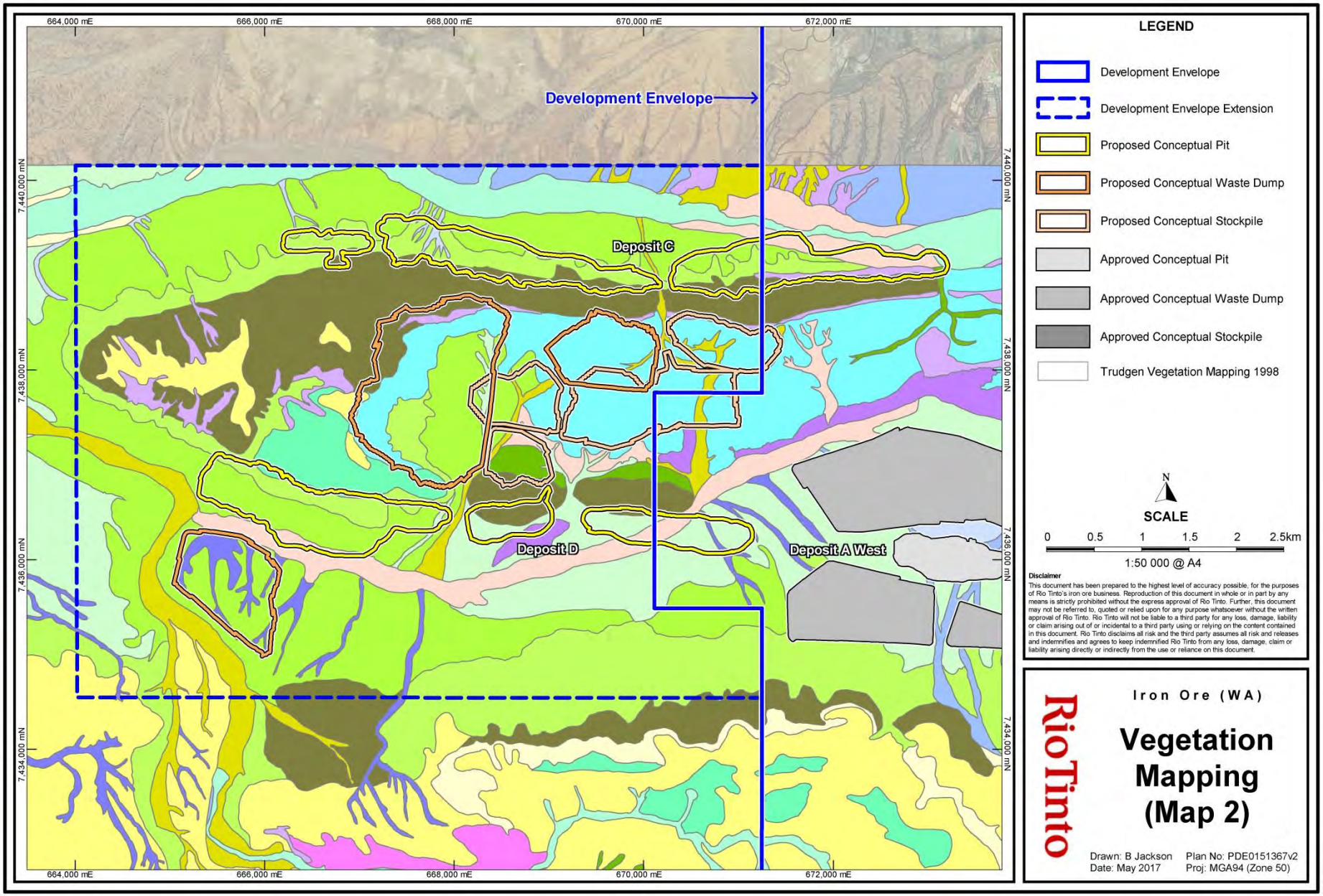

Figure 5-2: Vegetation Mapping (Map 2)

Rio Tinto

Vegetation Mapping Legend

AaAc - Acacia aptaneura and A. pruinocarpa open woodland over Aristida contorta sparse tussock grassland over Pterocaulon sphacelatum and Ptilotus nobilis subsp. nobilis isolated forbs.

AaEcTp - Acacia aptaneura and A. pruinocarpa open woodland over Eremophila caespitosa and Tribulus suberosus isolated shrubs over Triodia pungens open hummock grassland.

AaEffTp - Acacia aptaneura and A. pruinocarpa open woodland over sparse Eremophila fraseri subsp. fraseri and Acacia marramamba sparse shrubland over Triodia pungens sparse hummock grassland.

AanAxTe - Acacia aneura, A. xiphophylla tall o pen scrub over mixed open shrubland over Triodia epactia open hummock grassland.

AaPoTp - Acacia aptaneura open woodland over Ptilotus obovatus isolated shrubs over Themeda triandra and Eriachne mucronata open tussock grassland.

AaPoTt - Acacia aptaneura open woodland over Ptilotus obovatus sparse shrubland over Themeda triandra open tussock grassland.

AaSaoTp - Acacia aptaneura open woodland over Senna artemisioides subsp. oligophylla sparse shrubland over Triodia pungens open hummock grassland

AaTb - Acacia aptaneura and A. pruinocarpa open woodland over A. bivenosa isolated shrubs Triodia basedowii and T. pungens open hummock grassland.

AaTp - Acacia pruinocarpa, A. aptaneura and A. ayersiana woodland over Triodia pungens open hummock grassland.

AaTssp - Acacia aptaneura and A. pruinocarpa open woodland over A. tetragonophylla, Senna glutinosa subsp. glutinosa and S. artemisioides subsp. oligophylla isolated shrubs over Triodia wiseana and T. pungens open hummock grassland.

AaTt - Acacia aptaneura and Eucalyptus xerothermica woodland over Ptilotus obovatus isolated shrubs over Themeda triandra open tussock grassland

AlAp - Aristida latifolia, Astrebla pectinata and Brachyachne convergens tussock grassland with isolated Salsola australis, Boerhavia paludosa and Ptilotus nobilis subsp. nobilis forbs.

AmTw - Eucalyptus leucophloia subsp. leucophloia isolated trees over Acacia maitlandii sparse shrubland over Triodia wiseana and T. longiceps hummock grassland.

ApTssp - AcAcacia pruinocarpa and Eucalyptus leucophloia subsp. leucophloia open woodland over Senna glutinosa subsp. glutinosa and A. maitlandii isolated shrubs over Triodia basedowii or T. pungens or T. wiseana open hummock grassland.

EgSggTb - Eucalyptus gamophylla and Corymbia deserticola subsp. deserticola open woodland over Senna artemisioides subsp. oligophylla and Indigofera monophylla sparse shrubland over Triodia basedowii and T. pungens open hummock grassland.

EllAmTssp - Eucalyptus leucophloia subsp. leucophloia and E. gamophylla open woodland over Acacia maitlandii, A. hamersleyensis, Keraudrenia velutina and Senna glutinosa subsp. glutinosa open shrubland over Triodia wiseana and/or T. pungens and/or T. basedowii o

EllSggTp - Eucalyptus leucophloia subsp. leucophloia and Acacia marramambra open woodland over Senna glutinosa subsp. glutinosa open shrubland over Triodia pungens open hummock grassland.

EllSggTw - Eucalyptus leucophloia subsp. leucophloia and Acacia aptaneura open woodland over Senna glutinosa subsp. glutinosa and S. artemisioides subsp. oligophylla open shrubland over Triodia wiseana or T. pungens open hummock grassland.

PsTp - Acacia aptaneura or A. ayersiana open woodland over Pterocaulon sphacelatum and Dysphania kalparri sparse forbland with Triodia pungens open hummock grassland.

SggAbTp - Acacia pruinocarpa and Eucalyptus leucophloia subsp. leucophloia or Corymbia hamersleyana isolated trees over Senna glutinosa subsp. glutinosa, Acacia bivenosaand Gossypium robinsonii open shrubland over Triodia pungens hummock grassland

SggIrTw - Acacia inaequilatera isolated trees over Senna glutinosa subsp glutinosa and Indigofera rugosa open shrubland over Triodia wiseana hummock grassland.

SggTp - Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana isolated trees over Senna glutinosa subsp. glutinosa and Acacia maitlandii sparse shrubland over Triodia pungens open hummock grassland.

Tp -Eucalyptus leucophloia subsp. leucophloia and Acacia pruinocarpa isolated trees over Senna glutinosa subsp. glutinosa, A. bivenosa and Ptilotus rotundifolius isolated shrubs over Triodia pungens or T. basedowii or T. sp. Mt Ella hummock grassland.

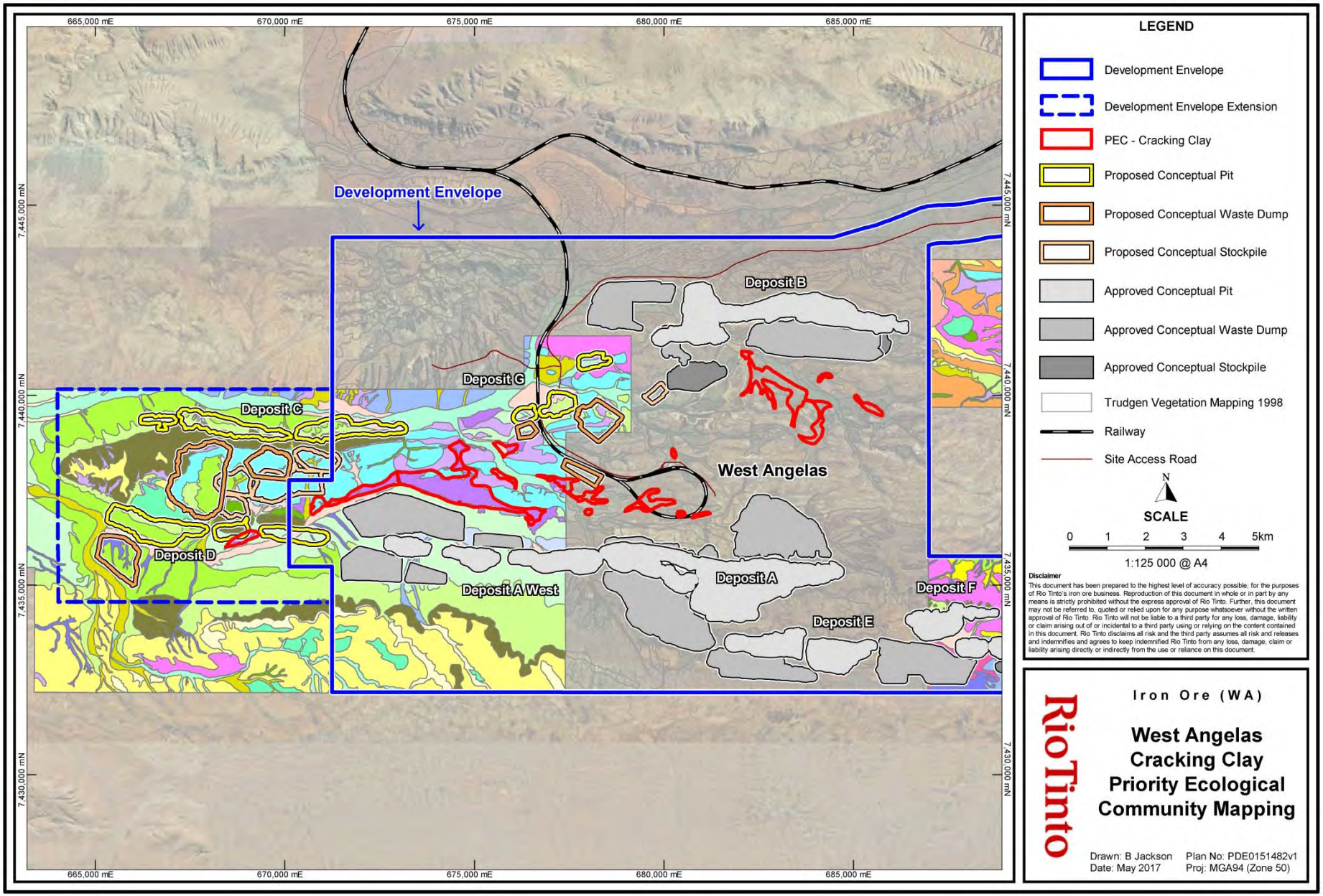

Figure 5-3: West Angelas Cracking Clay Priority Ecological Community Mapping

5.3.2 Conservation Significant Flora

No flora listed under the under the EPBC Act, or gazetted as Threatened (formerly Declared Rare Flora (DRF)) under the Western Australian *Wildlife Conservation Act 1950* (WC Act) were recorded or are expected to occur within the Proposal area.

A total of 29 individuals of *Lepidium catapycnon* (EPBC Vulnerable) were collected opportunistically from four locations within the West Angelas region where vegetation and landforms are consistent with this species' habitat. *Lepidium catapycnon* is also known to occur more broadly in the Pilbara bioregion. The main threat to *Lepidium catapycnon* is mining and exploration activities as the majority of recorded populations occur within mining and exploration tenements, although records are also known from Karijini National Park. The spread of the introduced species *Rumex vesicarius* (formerly known as *Acetosa vesicaria* or Ruby Dock) has been suggested to prevent establishment of this species in some areas. None of the *Lepidium catapycnon* records within the West Angelas region were relevant to this Proposal. The closest record of this species is at the southern base of West Angelas Hill with populations extending upslope.

The following Priority (P) Flora species were recorded during the survey:

- two P1 species (*Aristida jerichoensis* var. *subspinulifera* and *Brachyscome* sp. Wanna Munna Flats (S. van Leeuwen 4662));
- two P2 species (*Aristida lazaridis* and *Eremophila pusilliflora Buirchell & A.P.Br.* (formerly *Eremophila forrestii* subsp*. Pingandy* (M.E. Trudgen 2662)));
- six P3 species (*Acacia subtiliformis, Indigofera gilesii* Peter G. Wilson & Rowe*, Rhagodia* sp. Hamersley (M. Trudgen 17794), *Sida* sp. Barlee Range (S. van Leeuwen 1642), *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) and *Triodia* sp. Mt Ella (M.E. Trudgen 12739);
- one P4 species (*Goodenia nuda*); and
- one species of special interest (*Eulalia sp.* (Three Rivers Station, B.Forsyth AQ6789133)).

Seven of these species have previously been recorded within the region. Additionally, four Priority Flora species were assessed as having a high likelihood of occurrence, based on previous records: *Tetratheca fordiana* (P1); *Dampiera metallorum* (P3); *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (P3); and *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3).

New clearing for the Proposal potentially intersects six of the recorded Priority Flora species and one species of potential interest (SPI), as follows:

- *Aristida lazaridis* (P2);
- *Eremophila pusilliflora Buirchell & A.P.Br.* (formerly *Eremophila forrestii* subsp*. Pingandy* (M.E. Trudgen 2662)) (P2);
- *Acacia subtiliformis* (P3);
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3);
- *Sida* sp*. Barlee Range* (S. van Leeuwen 1642) (P3);
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3); and
- *Eulalia* sp. (Three Rivers Station, B.Forsyth AQ6789133) (SPI).

Invasive Species

There are 32 invasive species listed as Weeds of National Significance (based on their invasiveness, potential for spread and environmental, social and economic impacts). Of these species, three species are currently recorded within the Pilbara: *Prosopis spp*. (Mesquite), *Tamarix aphylla* (Athel pine); and *Parkinsonia aculeata* (Parkinsonia). No Weeds of National Significance have been recorded within the Proposal area (*ecologia* 2013a).

Seventeen weeds have been recorded in the West Angelas region (*ecologia* 2013a). Seven of these were recorded within or in the vicinity of this Proposal: *Biden's bipinnata* (bipinnate beggartick, which is by far the most abundant weed species recorded); *Cenchrus ciliaris* (buffel grass); *Flaveria trinervia* (speedy weed); *Malvastrum americanum* (spiked Malvastrum); *Setaria verticillata* (whorled pigeon grass); *Sigesbeckia orientalis* (Indian weed); and *Tribulus terrestris* (*ecologia* 2013a). *Rumex vesicarius* (formerly known as *Acetosa vesicaria* or Ruby Dock) is known from the region but was not recorded during the ecologia survey (*ecologia* 2013a).

The Parks and Wildlife *Weed Prioritisation Process* (2013) prioritises weeds in each region, based on their invasiveness, ecological impacts, potential and current distribution, and feasibility of control. The resulting management priorities ('Very High', 'High', 'Medium', 'Low' or 'Negligible') focus on weeds considered to be rapidly invasive, high impact and still at a population size that can feasibly be eradicated or contained to a manageable size. Weed species which are already widespread are not ranked as a high priority. None of the species recorded were ranked as 'Very High' or 'High' management priorities for the Pilbara. *Rumex vesicarius* is ranked as a 'Medium' management priority. All other species were ranked as 'Low' or 'Negligible' management priority or were not listed.

Most weed species were recorded in creeklines which represent the major source of distribution for the most prevalent weed species in the West Angelas region: *Rumex vesicarius; Bidens bipinnata;* and *Cenchrus ciliaris*.

5.4 Assessment of Potential Impacts

Potential impacts to flora and vegetation include the following:

- Loss of vegetation (including vegetation communities of elevated conservation significance) as a result of clearing.
- Loss or degradation of vegetation (including vegetation communities of elevated conservation significance) as a result of altered hydrological regimes.
- Loss or degradation of riparian vegetation as a result of surface water discharge.
- Loss or degradation of potentially groundwater dependant vegetation as a result of groundwater drawdown.
- Loss of conservation significant flora species as a result of clearing.
- Degradation of vegetation (including vegetation communities of elevated conservation significance) as a result of ingress of weeds.

Assessment of each of these potential impacts is included below. Mitigation to address these potential impacts and predicted outcomes is presented in Table 6-2.

5.4.1 Loss of vegetation as a result of clearing

The Proposal will require additional clearing of up to 4,310 ha of native vegetation.

The Proposal intersects one 15.5 ha occurrence of the West Angelas Cracking Clay PEC which overlies Deposit D. This occurrence of the Cracking Clay PEC is within the proposed pit boundary and as such, avoidance is not possible; 15.5 ha of West Angelas Cracking Clay PEC will be cleared to access the Deposit D resource.

The West Angelas Cracking Clay PEC occurs extensively within the West Angelas region with approximately 440 ha of this community mapped (Trudgen 1998).

The Proponent suggests that the existing mapping of the West Angelas Cracking Clay PEC includes other less significant grassland communities and that the occurrence of the Cracking Clay PEC within the proposed pit boundary is comprised of approximately 9.9 ha of tussock grassland representative of West Angelas Cracking Clay PEC and approximately 8.3 ha of other, more variable and less representative tussock grassland associations. The Proponent has conservatively assumed that the 15.5 ha is representative of West Angelas Cracking Clay PEC and it represents approximately 3.5% of the West Angelas Cracking Clay PEC mapped within the West Angelas region.

The Proposal also intersects the floodplain of the Turee Creek East tributary which overlies Deposit C. The riparian vegetation of this tributary is within the proposed pit boundary and as such, avoidance is not possible. The Proponent has conservatively assumed 25 ha of riparian vegetation will be cleared to access the Deposit C resource. Riparian vegetation communities occur relatively extensively throughout the Hamersley Ranges. The riparian vegetation communities at West Angelas are considered of relatively low conservation significance.

5.4.2 Loss or degradation of vegetation as a result of altered hydrological regimes

This Proposal is expected to contribute to alteration of the natural hydrological regime, disrupting natural surface water flows and / or patterns of surface water flow. The impounding of surface water flows is likely to cause inundation and / or shadowing effects on vegetation communities dependent on those natural surface water flows and / or patterns of surface water flow.

The West Angelas Cracking Clay PEC is recognised as being dependent on natural patterns of surface water flow. 2D hydraulic modelling was previously undertaken to understand the interactions between the West Angelas Cracking Clay PEC, PEC-2015-5 and patterns of surface water flow in the area (Figure 5-4).

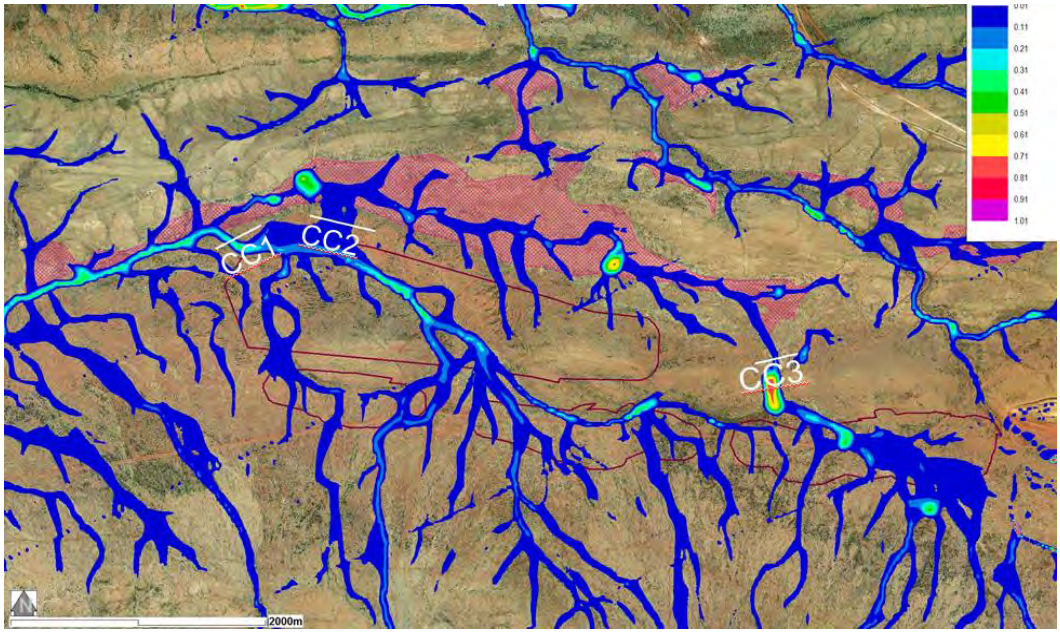

Figure 5-4: Peak flow depths in the West Angelas Cracking Clay PEC, PEC-2015-5 during a 20% AEP flood event.

Under existing conditions, flow from rainfall events spreads across the valley floor in shallow, broad channels. Based on the modelling, three flow paths from the southern catchments cross PEC-2015-5 (CC1, CC2 and CC3), however, these flow paths do not cover the entire extent of the West Angelas Cracking Clay PEC and flows at two of the three channels (CC2 and CC3) are insignificant. Flows at the third and most significant channel (CC1) interact with less than 1% of the extent of PEC-2015-5. As such, modelling suggests that incident rainfall and surface water (sheet) flow from local catchments are the significant hydrological factors sustaining the West Angelas Cracking Clay PEC.

This Proposal will intercept the flow channel/s which interact with the PEC-2015-5, impounding surface water flows downstream of PEC-2015-5 and potentially inundating the PEC. Surface water management structures (culverts) will be installed to maintain natural patterns of surface water flow which would otherwise be impounded.

The riparian vegetation of the Turee Creek East tributary is also dependant on surface water flows, groundwater elevation beneath these communities is typically between 20m and 70m bgl, and therefore inaccessible to eucalypts. This Proposal will intercept tributaries of Turee Creek East. Surface water management structures (diversions) will be constructed to redirect the surface water flows which would otherwise be captured by the pits, to maintain the continuation of natural surface water flows in Turee Creek East.

The proposed surface water management structures will ensure the natural surface water flows and / or patterns of surface water flow are maintained such that vegetation (including vegetation communities of elevated conservation significance; West Angelas Cracking Clay PEC and riparian vegetation communities) is considered unlikely to be significantly adversely affected.

5.4.3 Loss or degradation of riparian vegetation as a result of surface water discharge

Three common Pilbara species are known to be phreatophytic: *Melaleuca argentea* (obligate phreatophyte)*; Eucalyptus camaldulensis* (facultative phreatophyte) and *Eucalyptus victrix* (facultative phreatophyte or vadophyte). The water strategies of these species influence their patterning and abundance within the riparian ecosystem and also their response to discharge. *Melaleuca argentea*, which most often occurs in permanently inundated pools and springs, are adapted to a perennial hydrologic regime. *Eucalyptus victrix* and *Eucalyptus camaldulensis*, are adapted to an ephemeral hydrologic regime. Trees are subjected to flooding following high intensity rainfall events and then potentially waterlogging for several months afterwards.

Discharge will result in a change to the hydrological regime of Turee Creek East from an ephemeral hydrologic regime to a perennial hydrologic regime for the surface discharge extent (modelled to extend up to 22 km, Section 8). Riparian vegetation along Turee Creek East (within the modelled extent of surface water discharge) supports two of the three common Pilbara species known to be phreatophytic: *Eucalyptus victrix* and potentially *Eucalyptus camaldulensis*. *Melaleuca argentea* was not recorded in the survey area (*ecologia* 2013a).

Eucalyptus victrix and *Eucalyptus camaldulensis* display a moderate level of flooding tolerance, and are able to tolerate temporary inundation. Prolonged / permanent inundation of ephemeral creeks as a result of discharge is expected to result in inevitable changes to riparian vegetation including the following:

- changes in riparian vegetation community structure;
- changes in the health of the dominant riparian tree species *Eucalyptus victrix* and *Eucalyptus camaldulensis* (if present)*,* which may include:

- declining health (decreasing biomass / abundance) or death of species susceptible to waterlogging stress (*Eucalyptus victrix*); and
- increasing biomass / abundance or artificial recruitment of species tolerant to waterlogging (*Eucalyptus camaldulensis*).

- establishment or increasing biomass / abundance of other species which are tolerant to waterlogging (particularly sedges and rushes);
- enhanced potential for weed ingress / proliferation; and
- drought stress and potential mass senescence on cessation of discharge.

Riparian vegetation communities are expected to be much sparser prior to the change to the hydrological regime of Turee Creek East from an ephemeral hydrologic regime to a perennial hydrologic regime. After the cessation of discharge, riparian vegetation communities are expected to gradually revert to a pre-impact condition.

The Proponent proposes to monitor the structure, cover and health of riparian vegetation communities (both native and introduced species) within the extent of surface water discharge. Monitoring results are expected to show, at worst, changes to riparian vegetation community structure, declining health of 'scattered' *Eucalyptus victrix* (including dead trees), artificial recruitment of *Eucalyptus camaldulensis*, establishment of other species which are tolerant to waterlogging and increasing abundance of weeds.

Despite the expected changes to structure, cover and health of riparian vegetation communities (both native and introduced species) within the extent of surface water discharge, the health of the riparian vegetation community can be maintained by monitoring the relationship between native and introduced species. Increased cover of introduced species as a result of the perennial hydrologic regime is likely to be mirrored by native species (Figure 5-5), and hence seedbank for recruitment will be maintained, minimising the risk of future loss of native vegetation at the cessation of discharge. Accordingly, trends in the presence of native species throughout the extent of surface water discharge shall be analysed in parallel to the presence of introduced species, to detect any threats which weeds may pose to native vegetation.

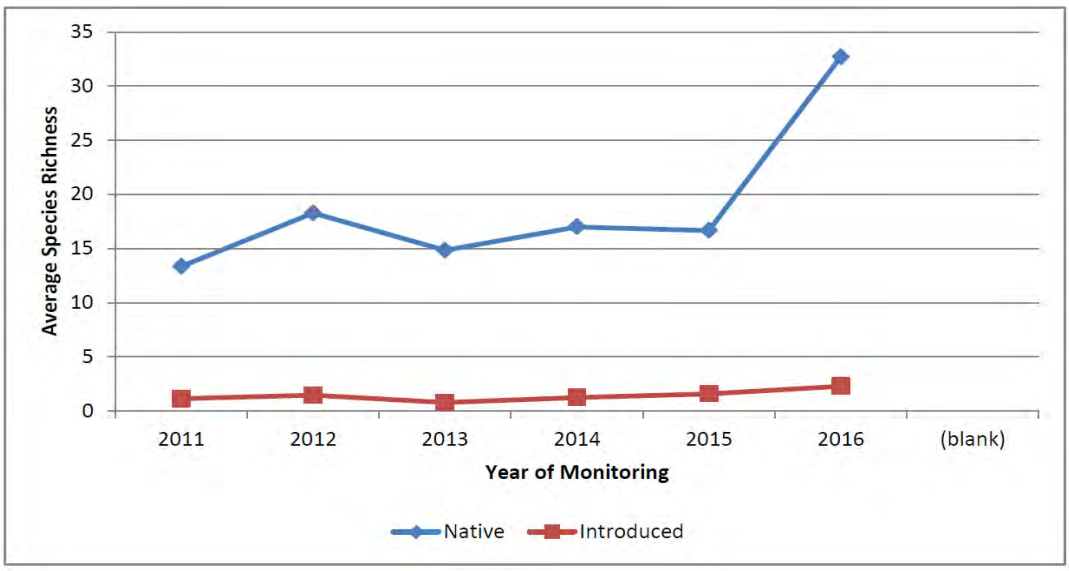

Figure 5-5: Average Species Richness (aggregate)

The presence of introduced species will be monitored in isolation as an early warning indicator, though the threshold criteria take into account the balance of all species, to ensure that the increased productivity as a result of perennial water supply is not misinterpreted as a negative impact to the health of riparian vegetation.

5.4.4 Loss or degradation of potentially groundwater dependant vegetation as a result of groundwater drawdown

Significant work has been undertaken to understand the potential for loss or degradation of local potentially groundwater dependant vegetation as a result of groundwater drawdown. Work to date has included:

- **Ecological assessment** – to determine the presence of any potentially Groundwater Dependent Species (GDS) and Groundwater Dependent Vegetation (GDV) likely to represent a potential GDE; attribute significance to any potential GDE and further, to understand their degree of sensitivity to potential surface water (hydrological) and groundwater (hydrogeological) changes (Appendix 6). The assessment included:
    - vegetation mapping;
    - basal area mapping; and
    - Riparian vegetation risk mapping using data from the vegetation mapping and basal area mapping to determine the risk of impact to 'zones' of potentially groundwater dependant vegetation as a result of potential groundwater drawdown.
- **Surface water modelling** – to understand potential changes to the hydrological regime reporting to local potential GDE; and
- **Groundwater modelling** – to understand potential changes to groundwater elevation from dewatering and the maximum extent of drawdown beneath local potential GDE.

Given inherent difficulties in accurately interpolating groundwater table elevation from limited data, the structure and composition of riparian vegetation communities is often the most reliable alternative indicator of groundwater access and the resulting potential groundwater dependency of local riparian vegetation communities. Historically, the presence of traditionally accepted groundwater dependent species was the most reliable indicator of the potential presence of shallow groundwater and associated groundwater dependant vegetation. As previously stated, three common Pilbara species are known to be groundwater dependant (phreatophytic): *Melaleuca argentea* (obligate phreatophyte)*; Eucalyptus camaldulensis* subsp. *refulgens* (facultative phreatophyte); and *Eucalyptus victrix* (facultative phreatophyte or potential vadophyte). Riparian vegetation communities containing common facultative phreatophytes: *Eucalyptus victrix* and *Eucalyptus camaldulensis* are typically not considered to be more than moderately groundwater dependent. More recently, basal area (an index of standing biomass), which can be inferred to represent a quantitative measure of water demand per unit of area, has been investigated as an additional quantitative indicator for assessments of potential groundwater dependency of riparian vegetation communities. Previous studies in arid environments have demonstrated that there is often a relationship between basal area and groundwater, whereby a basal area of less than 5 - 10 m^2/ha is often associated with a depth to groundwater greater than 15m. Alternatively a basal area of greater than 10 m^2/ha is often associated with a depth to groundwater less than 10m. Based on the relationship indicated by such studies, a threshold basal area of 9 m^2/ha was chosen to indicate vegetation reliance on groundwater to meet a substantial proportion of EWR (per unit of area). It is acknowledged that this threshold is not well accepted; however, in lieu of groundwater table elevation data and alternative quantitative measures to inform likely groundwater dependence, it was deemed a valuable indicator for assessing groundwater dependence (Rio Tinto 2017).

Riparian vegetation along Turee Creek East (within the survey area) supports two of the three common Pilbara species known to be groundwater dependant (phreatophytic): *Eucalyptus camaldulensis* subsp. *refulgens* (facultative phreatophyte considered to be moderately groundwater dependant) and *Eucalyptus victrix* (facultative phreatophyte or vadophyte considered to be low to moderately groundwater dependant).

Five 'zones' of potentially groundwater dependant vegetation were defined throughout the survey area (Figure 5-6). The Proponent has conservatively assumed unmitigated groundwater drawdown of up to 8m extending beneath potentially groundwater dependant vegetation within Karijini National Park, predicted to persist beyond 100 years (Section 8) and as such, risk mapping has been completed for each of these 'zones' based on vegetation mapping (presence of groundwater dependant / phreatophytic species), basal area assessments and considering any other local factors likely to contribute to risk of impact to potential groundwater dependant vegetation as a result of groundwater drawdown (Figure 5-7, Figure 5-8).

Approximately 93% of the survey area is represented by potentially groundwater dependant vegetation considered to be of 'Negligible' to 'Very Low' risk of impact as a result of groundwater drawdown. Approximately 2% (22 ha) of the survey area is represented by potentially groundwater dependant vegetation considered to be of 'Low to Medium' risk of impact as a result of groundwater drawdown and only approximately 0.4% (4.2 ha) of the survey area is represented by potentially groundwater dependant vegetation considered to be of 'Medium' risk of impact as a result of unmitigated groundwater drawdown of up to 8m.

Risk Mapping

Groundwater throughout the West Angelas region is naturally deep and is not expected to support groundwater dependant / phreatophytic vegetation. A 'scattered' to 'low open woodland' of *Eucalyptus victrix* is common within riparian vegetation communities of Turee Creek East within the Proposal area ('Zone A'), often co-occurring with *Eucalyptus xerothermica* and *Acacia citrinoviridis.* However, groundwater elevation beneath these riparian vegetation communities is typically between 20m and 70m bgl, and therefore inaccessible to *Eucalyptus victrix* such that the potential for groundwater dependence and subsequent risk of impact as a result of groundwater drawdown is considered **'Negligible'**.

Topographic elevation falls trending westerly such that the groundwater table elevation is nearer to the surface nearer to the boundary of Karijini National Park. Limited hydrogeological information exists within the Karijini National Park. One bore, located approximately 2.5 km within the boundary of Karijini National Park (WANG14), suggests that the groundwater elevation is approximately 6.5m bgl. As topographic elevation continues to fall trending westerly, groundwater elevation is expected between 2m and 6.5m bgl and therefore accessible to riparian vegetation such that the potential for groundwater dependence and subsequent risk of impact as a result of groundwater drawdown increases.

'Low open woodlands' of *Eucalyptus victrix* were also common in riparian vegetation communities within the reach of Turee Creek East within Karijini National Park upstream of the confluence of the eastern and north-western tributaries of Turee Creek East ('Zone B'). The basal area recorded in 'Zone B' ranged from 1 m²/ha to 6 m²/ha, below the basal area threshold of 9 m^2/ha such that the potential for groundwater dependence to meet water demand, and subsequent risk of impact to potential groundwater dependant vegetation in 'Zone B' as a result of groundwater drawdown is considered **'Very Low'** to **'Low'**.

The density of *Eucalyptus victrix* within riparian vegetation communities of Turee Creek East within Karijini National Park increases in the reach of Turee Creek East (approximately 4 km in length) downstream of the confluence of the eastern and north-western tributaries of Turee Creek East ('Zone C' and 'Zone E').

The initial 2 km of this reach ('Zone C') contains a woodland of *Eucalyptus victrix* (the C3B community) at elevated densities (often above the basal area threshold of 9 m^2/ha); the basal area recorded in 'Zone C' ranged from 6 m²/ha to 16 m²/ha which could indicate potential for groundwater dependence to meet water demand. Based on this stand density, the Proponent conservatively assumed that approximately 22 ha of relatively dense riparian vegetation communities of Turee Creek East within Karijini National Park (the C3B community), represents a potential GDE. However, the risk of impact to potential groundwater dependant vegetation in 'Zone C' as a result of groundwater drawdown is considered **'Low'** to **'Medium'**.

700m of this reach within 'Zone C' ('Zone C-1') contains a woodland co-dominated by *Eucalyptus victrix* and *Eucalyptus camaldulensis* (the C2B community) at elevated densities (above the basal area threshold of 9 m^2/ha); the basal area recorded in 'Zone C-1' ranged from 9.5 m²/ha to 16 m²/ha which could indicate potential for groundwater dependence to meet water demand. Based on this structure and stand density, the Proponent conservatively assumed that approximately 4.2 ha of relatively dense and diverse riparian vegetation communities of Turee Creek East within Karijini National Park, co-dominated by *Eucalyptus victrix* and *Eucalyptus camaldulensis* (the C2B community), represents a potential GDE. The risk of impact to the potential GDE in 'Zone C-1' as a result of groundwater drawdown is considered **'Medium'**.

In general, 'Zone C' is characterised by shallow groundwater and a topographically confined channel profile (discussed further below). These factors are considered in the assignment of 'Medium' risk to potential groundwater dependant vegetation as a result of groundwater drawdown.

- The accessibility of groundwater provides valuable insight into the potential sensitivity of a riparian vegetation community to changes in groundwater elevation. Previous studies suggest that reliance on groundwater is reduced in areas where the water table exceeds a threshold depth of 10m bgl (Eamus, Froend *et al.* 2006; Loomes 2010 in Rio Tinto 2017). However, studies in the Pilbara (including Department of Water 2010; Loomes 2010) have confirmed *Eucalyptus victrix* roots to a depth of 21m bgl. Studies in the Pilbara by Loomes (2010) also suggest that *Eucalyptus camaldulensis* are unlikely to occur where average depth to groundwater is beyond 10m bgl, however, studies in the Hamersley Ranges have confirmed *Eucalyptus camaldulensis* established where depth to groundwater is beyond 15m bgl (Rio Tinto 2017).

  Although hydrogeological modelling indicates that unmitigated groundwater drawdown of up to 8m is expected to extend beneath potentially groundwater dependant vegetation within Karijini National Park (and is predicted to persist beyond 100 years), the resultant groundwater depth is such that groundwater would remain accessible to local potentially groundwater dependant vegetation.

  Furthermore, gradual groundwater drawdown (i.e. slow rates of vertical decline in groundwater elevation and associated reduced water availability) enables greater opportunity for potentially groundwater dependant species to adapt. In theory, roots can maintain a functional connection with groundwater as long as the rate of groundwater drawdown does not exceed the rate of root growth (Naumburg *et al*. 2005 in Rio Tinto 2017). Literature suggests that phreatophytic species would be expected to maintain a functional connection with groundwater as long as the rate of groundwater drawdown does not exceed 1 cm per day (Kranjcec, Mahoney and

Rood 1998; Scott, Shafroth, and Auble 1999; Horton and Clark 2001; Canham 2011 in Rio Tinto 2017). Rapid groundwater drawdown (exceeding 1 cm per day) results in the acceleration of reduced water availability and reduced opportunity for plants to adapt (Froend *et al*. 2004 in Rio Tinto 2017).

Modelled rates of groundwater drawdown within Karijini National Park (predicted to be 10 – 20cm per year base case, up to 40cm per year worst case) are such that potentially groundwater dependant species are expected to be able to successfully adapt.

- *Eucalyptus victrix* and *Eucalyptus camaldulensis* both have extensive lateral root systems near the surface (typically to 2m bgl) from which these groundwater dependant species are thought to obtain a substantial proportion of their EWR and nutrients. These lateral root systems typically extend at least 20m (*Eucalyptus victrix*) and 40m (*Eucalyptus camaldulensis*) from the trunk of mature individuals. As such (assuming only moderate stand densities), surface water from local catchment flows (following incident rainfall) are considered likely to support groundwater dependant vegetation. Small local catchments are considered unlikely to support dense or structurally complex groundwater dependant vegetation. The local catchment contributing to 'Zone B' (at the boundary of Karijini National Park), attributable to the eastern tributary of Turee Creek East, is only approximately 340 km^2, however, the local catchment contributing to potential groundwater dependant vegetation in 'Zone C' (within Karijini National Park) is approximately 570 km^2, attributable to the confluence of the eastern and north-western tributaries of Turee Creek East. This catchment is relatively small compared to the catchment of most named creeks in the Hamersley Ranges (Turee Creek, Seven Mile Creek, Marillana Creek, Bungaroo Creek, Duck Creek and Beasley River have catchments of more than 2000 km^2) and would typically be considered unlikely to support dense or structurally complex GDE. The density of *Eucalyptus victrix* within 'Zone C' (basal area up to 16 m²/ha and often above the basal area threshold of 9 m^2/ha) likely indicates reliance on groundwater to meet water demand. However, surface water flows from both the eastern and north-western tributaries (channel profiles of 350 - 500m) are channelled through topographically confined local gorge features (channel profile of 150m). The increased and concentrated nature of surface water flows contributing to the potential groundwater dependent vegetation within Karijini National Park are thought likely to at least partially account for this density.

The latter 2 km of the reach of riparian vegetation communities of Turee Creek East (downstream of the confluence of the eastern and north-western tributaries of Turee Creek East) within Karijini National Park ('Zone E') contains *Eucalyptus victrix* at elevated densities (often above the basal area threshold of 9 m^2/ha); the basal area recorded in 'Zone E' ranged from 4 m²/ha to 9 m²/ha which could indicate some potential for groundwater dependence to meet water demand. However, the risk of impact to potential groundwater dependant vegetation in 'Zone E' as a result of groundwater drawdown is considered **'Very Low'** to **'Low'**.

Eucalyptus victrix were also common in riparian vegetation communities within the reach of Turee Creek East near the southern boundary of Karijini National Park ('Zone D') at densities which could suggest groundwater dependence. The risk of impact to potential groundwater dependant vegetation in 'Zone D' as a result of groundwater drawdown is considered **'Very Low' to 'Low'**. However, the extent of groundwater drawdown is limited beyond 'Zone E' given the presence of the impermeable Mount McRae Shale and other intrusive geological formations (such as dolerite dykes) such that the risk of impact to potential groundwater dependant vegetation in 'Zone D' as a result of groundwater drawdown is **'Negligible'**.

It is difficult to predict how a potentially groundwater dependant ecosystem will respond to changes in water availability over time. The likely maintenance of contact between local potentially groundwater dependant vegetation and the groundwater within and downstream of Zone C following the change in groundwater elevation (up to 8m) and slow rate of drawdown (up to 40cm per year, allowing for adaptation of potentially groundwater dependant species) suggests that the risk of significant impact to potentially groundwater dependant vegetation of Turee Creek East within Karijini National Park as a result of groundwater drawdown is lower than the 'Medium' risk attributed in the risk mapping.

Significant structural changes to vegetation and compositional changes to the dominant potentially groundwater dependant species: *Eucalyptus victrix* and *Eucalyptus camaldulensis* within resident potentially groundwater dependent vegetation of Turee Creek East are considered unlikely. *Eucalyptus victrix* and to a lesser extent, *Eucalyptus camaldulensis* appear to be opportunistic in their water use and growth strategies, enabling survival in an apparently wide range of eco-hydrological settings (Pfautsch *et al*. 2014; Colloff 2014 in Rio Tinto 2017). These species are expected to continue to use the near surface soil water resource to meet a substantial proportion of their EWR. Surface water inputs with potential to sustain local populations of *Eucalyptus victrix* and *Eucalyptus camaldulensis* are expected to continue to be replenished by local catchment flows following incident rainfall. During extended dry periods, *Eucalyptus victrix* and *Eucalyptus camaldulensis* are expected to continue to be able to opportunistically access groundwater. Facultative phreatophytes susceptible to water stress have physiological and / or morphological adaptations to reduce their water requirements during extended dry periods. As a result, reasonable resilience is expected if access to groundwater is removed.

The Proponent has conservatively assumed that changes in the health of resident potentially groundwater dependant species (albeit low-to moderate in significance and extent) are likely to occur. Such changes are considered unlikely to be beyond natural variation since riparian vegetation communities along Pilbara watercourses occur in a dynamic environment with episodic occurrences of severe flood, drought and defoliating / high-mortality wildfire.

The Proponent proposes to monitor the health of potentially groundwater dependant vegetation utilising satellite based Digital Multi Spectral Imagery (DMSI). Monitoring results are expected to show, at worst, declining health (decreasing biomass / abundance) or death of some individuals of the dominant potentially groundwater dependant species; *Eucalyptus victrix* and *Eucalyptus camaldulensis* beyond natural variation.

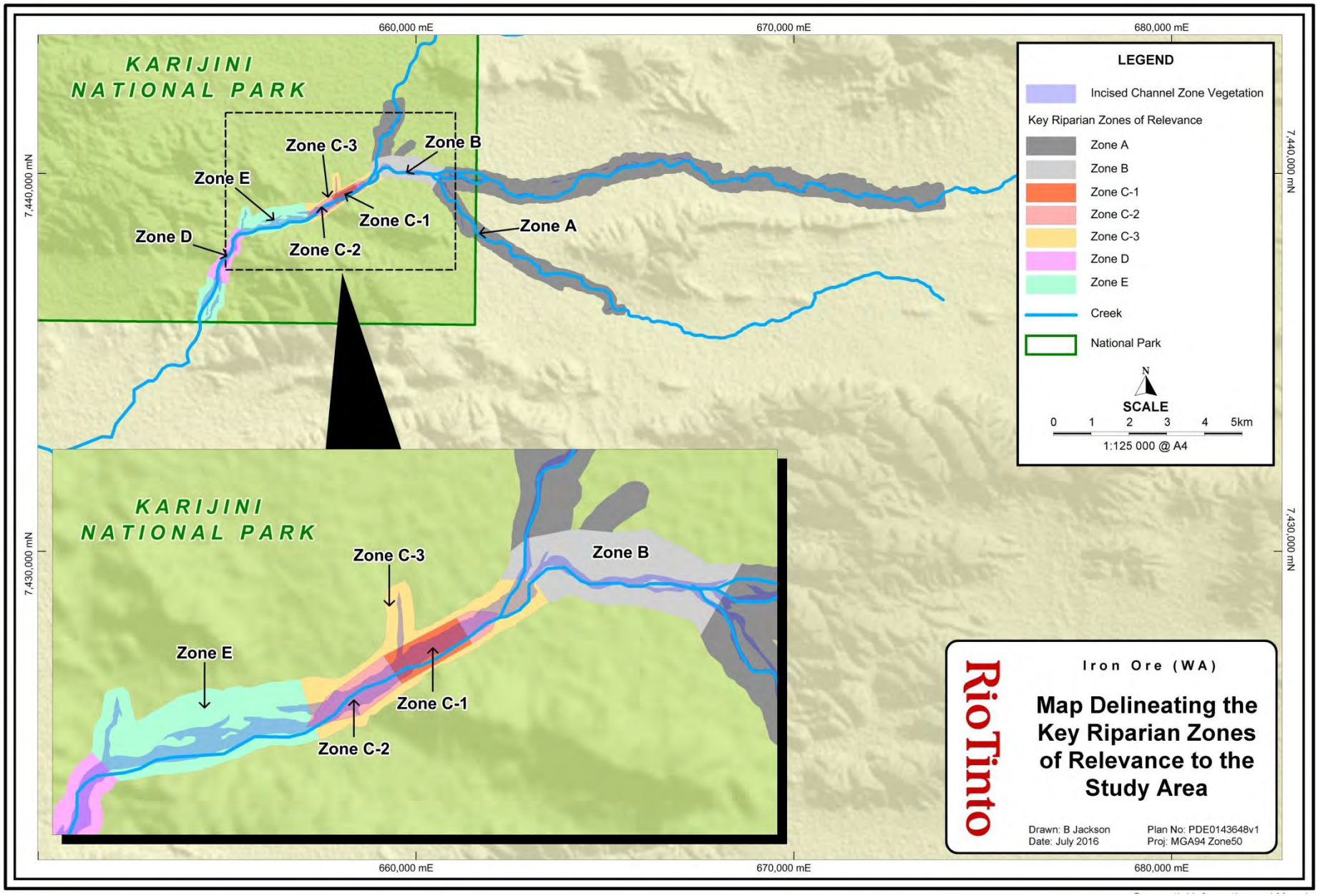

Figure 5-6: Riparian Vegetation Zone Mapping

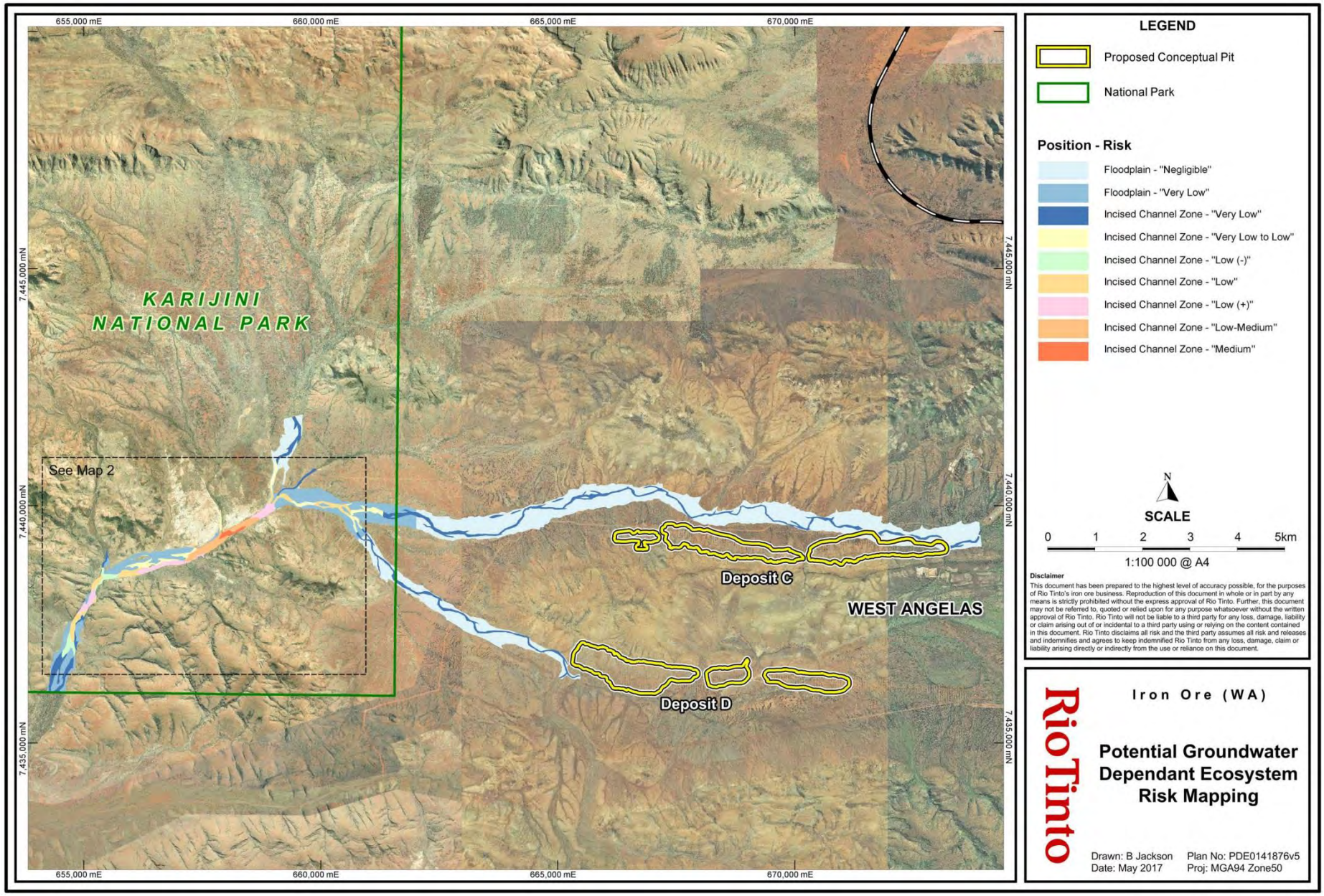

Figure 5-7: Potential Groundwater Dependant Ecosystem Risk Mapping

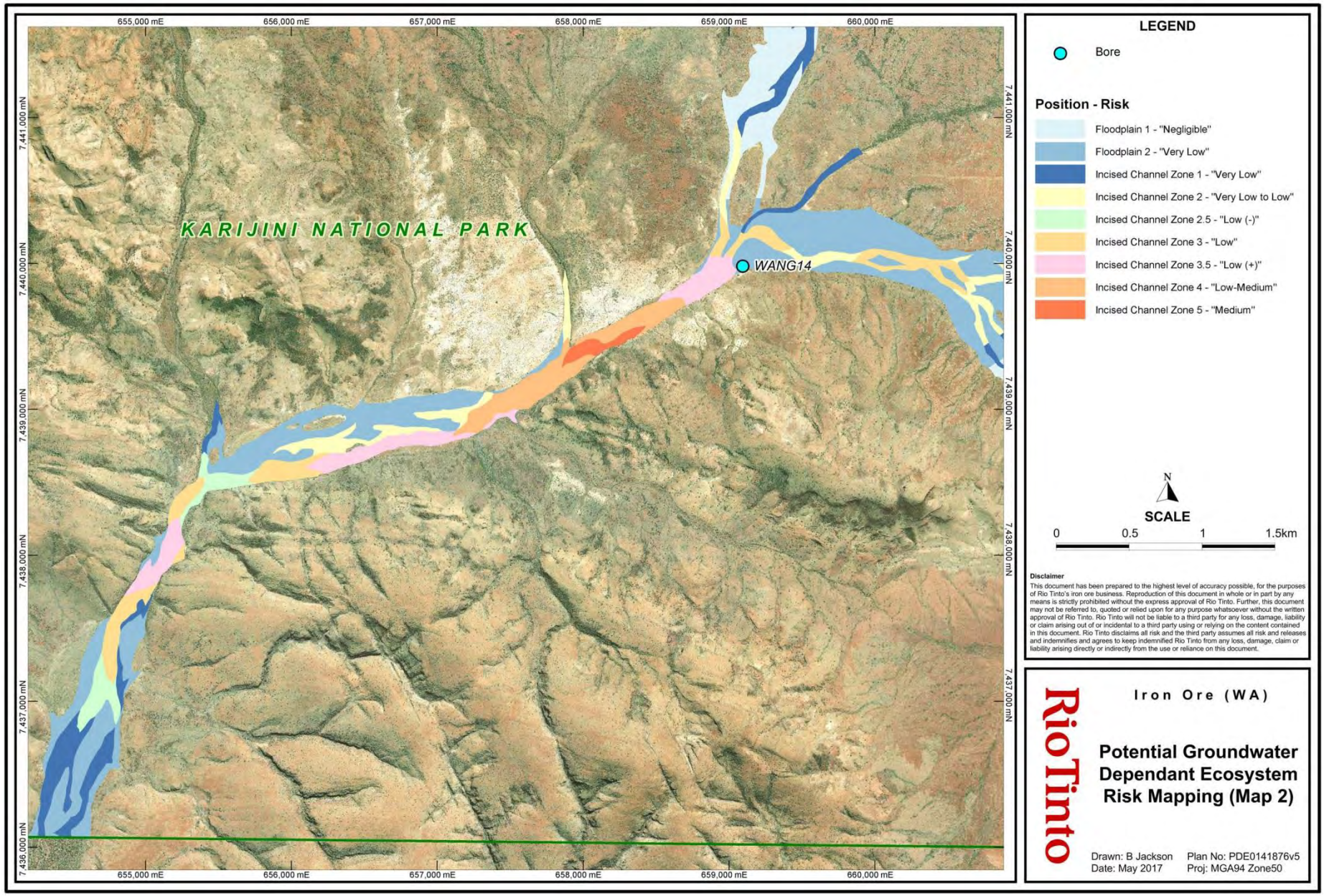

Figure 5-8: Potential Groundwater Dependant Ecosystem Risk Mapping (Map 2)

5.4.5 Loss of conservation significant flora as a result of clearing

The Proposal will preferentially avoid known locations of Priority Flora as far as practicable however clearing is expected to result in the direct loss of some individuals of the following conservation significant flora species (six Priority Flora and one SPI) occurring or assessed as having a high likelihood of occurrence within the Proposal area:

- Two P2 flora species (*Aristida lazaridis* and *Eremophila pusilliflora Buirchell & A.P.Br.*);
- Four P3 flora species (*Acacia subtiliformis, Rhagodia* sp. Hamersley (M. Trudgen 17794), *Sida* sp*. Barlee Range* (S. van Leeuwen 1642) and *Triodia* sp. Mt Ella (M.E. Trudgen 12739)); and
- One SPI (*Eulalia* sp. (Three Rivers Station, B.Forsyth AQ6789133)).

These six species are all well represented in the West Angelas region and the Pilbara bioregion. It is therefore considered that the potential loss of these species is unlikely to result in a significant decline in their regional representation and as such would not be considered significant. Potential impacts to these species are discussed below and presented in Table 5-3.

- ***Aristida lazaridis* (P2):** This species has a range of 100 km across the Hamersley Ranges on NatureMap (Parks and Wildlife 2013c) and 60 km from the Rio Tinto Priority Flora database. In addition to these records, this species occurs over a range of 2,500 km range across the Northern Territory and Queensland.

  This species has a total population count of 334 plants, from 43 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded from the West Angelas locality from the Rio Tinto Priority Flora database, and on NatureMap from West Angelas, Rhodes Ridge and Karijini National Park.

  With inexperience identifying this species, *Aristida lazaridis* is thought to be significantly under-collected. While current Herbarium records are limited, more recent recordings indicate *Aristida lazaridis* occurs in clayey floodplain zones and small clay terraces fringing creek systems with significant representations of banded mulga woodlands in the West Angelas, Angelo River, Juna Downs and Rhodes Ridge areas and Karijini National Park. This species is expected to occur within creek terraces and mulga woodlands across a wider range in the Pilbara. As such, the known range of this species is thought likely to be underestimated.

  It is estimated that 20 individuals of this species (representing up to 5.99% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). Given that populations of this species have been recorded from within Karijini National Park, this Proposal is not expected to adversely affect the conservation status, representation or viability of this species.

- ***Eremophila pusilliflora Buirchell & A.P.Br.* (P2)** (formerly *Eremophila forrestii* subsp. *Pingandy* (M.E. Trudgen 2662): This species has a range of 115 km across the Pilbara region on NatureMap (Parks and Wildlife 2013c) and 60 km from the Rio Tinto Priority Flora database.

  This species, which is thought to be significantly under-collected, has a total population count of 4,638 plants from 237 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded from the West Angelas and Angelo River localities from the Rio Tinto Priority Flora database, and on NatureMap from West Angelas, Angelo River, Juna Downs and Ophthalmia Range.

Only one individual of this species (representing up to 0.02% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). This Proposal is therefore, not expected to adversely affect the conservation status, representation or viability of this species.

- ***Acacia subtiliformis* (P3):** This species has a range of 125 km across the Hamersley Ranges on NatureMap (Parks and Wildlife 2013c) and 100 km from the Rio Tinto Priority Flora database.

  This species, which is thought to be significantly under-collected, has a total population count of 80,563 plants, from 478 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded from: West Angelas; Angelo River; Juna Downs; Yandicoogina; Rhodes Ridge; Giles; Hope Downs 1; Hope Downs 4; and Ophthalmia Range locality from the Rio Tinto Priority Flora database, and on NatureMap from these localities as well as Karijini National Park.

  It is estimated that 250 individuals of this species (representing up to 0.31% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). The primary habitat of *Acacia subtiliformis* (calcrete formations) is not present in the Proposal area, so records of this species there are outliers. Given that large populations of this species exist nearby that do not intersect with proposed clearing and that populations of this species have been recorded from within Karijini National Park, this Proposal is not expected to adversely affect the conservation status, representation or viability of this species.

- ***Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3):** This species has a range of 260 km across the Pilbara region on NatureMap (Parks and Wildlife 2013c) and 325 km from the Rio Tinto Priority Flora database.

  This species has a total population count of 3,240 plants from 1,522 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded from West Angelas, Brockman, Marandoo, Juna Downs, Angelo River, Rhodes Ridge, Ophthalmia Range, Hope Downs, Shovelanna and Caramulla from the Rio Tinto Priority Flora database, and on NatureMap from West Angelas, Juna Downs, Angelo River, Hope Downs, Marandoo, Karijini National Park, Ophthalmia Range and Roy Hill Station.

  Only four individuals of this species (representing up to 0.13% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). The Proposal is therefore, not expected to adversely affect the conservation status, representation or viability of this species.

- ***Sida* sp. *Barlee Range* (S. van Leeuwen 1642) (P3):** This species has a range of 363 km across the Pilbara region on NatureMap (Parks and Wildlife 2013c) and 300 km from the Rio Tinto Priority Flora database.

  This species has a total population count of 10,846 plants from 1,657 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded in large numbers from: West Angelas; Angelo River; Koodaideri; Western Turner Syncline; Tom Price; Paraburdoo; Brockman; and Mount Wall localities from the Rio Tinto Priority Flora database, and on NatureMap from these localities as well as the Kalgan Creek locality, Millstream Chichester National Park and from the Northern Gascoigne Region.

  It is estimated that 32 individuals of this species (representing up to 0.30% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). The Proposal is therefore, not expected to adversely affect the conservation status, representation or viability of this species.

- ***Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3):** This species has a range of 78 km across the Pilbara region on NatureMap (Parks and Wildlife 2013c) and 183 km from the Rio Tinto Priority Flora database.

  This species has a total population count of 29,029 plants from 932 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded from: West Angelas; Juna Downs; Capricorn Range; Angelo River; Hope Downs; and Shovelanna from the Rio Tinto Priority Flora database, and on NatureMap from West Angelas, Mount Ella, Mount Robinson, Fork South and Jinidi. With spinifex dominating the vegetation of the Pilbara, *Triodia* sp. Mt Ella is thought to be significantly under-collected. Further, typical habitat for this species represents less easily accessible areas. As such, the known range of this species is thought likely to be underestimated.

  It is estimated that 50 individuals of this species (representing up to 0.18% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). The Proposal is therefore, not expected to adversely affect the conservation status, representation or viability of this species.

  Based on current records of the Western Australian Herbarium (Florabase), *Triodia* sp. Mt Ella is the only Priority Flora species recorded that is not represented within conservation estates. This species is therefore considered to be of higher conservation significance, irrespective of the fact that it is locally common in preferred habitat, which is considered relatively widespread within the region. However, *Triodia* sp. Mt Ella is considered by some to be a taxonomic synonym of *Triodia bitextura* which does not possess any conservation listing.

- ***Eulalia* sp. (Three Rivers Station, B.Forsyth AQ6789133) (SPI):** This species is currently undescribed, but has been considered of potential interest given that it is considered to be a distinct taxon within the Pilbara region. A formal description of *Eulalia* sp. (Three Rivers Station) is currently being progressed. It is highly likely that this taxon has been overlooked on many occasions, and therefore under-collected given its similarity to the common *Eulalia* species occurring in the Pilbara; *Eulalia aurea*. *Eulalia* sp. (Three Rivers Station) tends to inhabit areas with an elevated clay content in local soils and so is predicted to have significant populations in areas where local lithologies (such as basalt dominated formations) are contributing to soil clay contents. The current known distribution of this species (previously recorded from Ophthalmia to Western Turner Syncline), extends over an east west distance of approximately 250 km and a north south distance of approximately 100 km. Clearing of the species will be avoided / minimised where possible.

  This species has a total population count of 216 plants from 76 records, within the Rio Tinto Priority Flora database (Table 5-3). This species has previously been recorded from: West Angelas; Juna Downs; Yandicoogina; Koodaideri; Brockman; Mount Margaret and Wittenoom localities from the Rio Tinto Priority Flora database. This species is not recognised on NatureMap.

  Two individuals of this species (representing up to 0.93% of the population recorded in the Rio Tinto Priority Flora database) will potentially be cleared for the Proposal (Table 5-3). The Proposal is therefore, not expected to adversely affect the conservation status, representation or viability of this species.

Table 5-3: Summary of potential impacts to Priority Flora species

Species	Conservation Ranking	Total recorded Population on Rio Tinto Database (individuals)*	Records which fall within existing Rio Tinto Ministerial Statement boundaries		Records which intersect with already disturbed areas		Records potentially impacted by this Proposal		Records potentially impacted by the West Angelas Project	
			# of individuals	% of total recorded	# of individuals	% of total recorded	# of individuals	% of total recorded	# of individuals	% of total recorded
Aristida lazaridis	P2	334	279	83.53	18	5.39	20	5.99	204	61.08
Eremophila pusilliflora Buirchell & A.P.Br.	P2	4,638	1	0.02	218	4.70	1	0.02	2	0.05
Acacia subtiliformis	P3	80,563	57,417	71.27	1,054	1.31	250	0.31	250	0.31
Rhagodia sp. *Hamersley* (M. Trudgen 17794)	P3	3,240	559	17.25	101	3.11	4	0.13	174	5.37
Sida sp. *Barlee Range* (S. van Leeuwen 1642)	P3	10,846	4,972	45.84	91	0.84	32	0.30	32	0.30
Triodia sp. *Mt Ella* (M.E. Trudgen 12739)	P3	29,029	615	2.12	6	0.02	50	0.18	665	2.29
Eulalia sp. (Three Rivers Station, B.Forsyth AQ6789133)	SPI	216	56	25.93	0	0	2	0.93	5	2.31

* Note data is limited to records from the Rio Tinto Priority Flora Database only and is therefore not entirely representative of the regional area that is unsurveyed.

5.4.6 Degradation of vegetation as a result of ingress of weeds

Historically, weeds in the Pilbara have been introduced through pastoral activities (EPA 2014b). However, weeds are often also able to rapidly invade locations subject to disturbance, land clearing and / or altered hydrological regimes. This can result in replacement of native species and simplification of natural ecosystems.

Most weed species were recorded in creekline communities which represent the major source of distribution for the most prevalent weed species in the region: *Rumex vesicarius* (formerly known as *Acetosa vesicaria* which is known from the region but absent from the *ecologia* 2012 survey)*; Bidens bipinnata* and *Cenchrus ciliaris*.

Limited clearing will occur in creeklines communities; however, these species have the potential to spread further downstream with altered hydrological regimes, specifically, increased discharge of surplus dewatering water to the Turee Creek East tributary. Turee Creek East flows toward Karijini National Park. Under normal conditions, the discharge extent is not expected to reach the National Park.

The Proponent has well established strategies for the management of weeds at its Pilbara operations to ensure that risks of weed ingress are minimised. Weed monitoring and management strategies have been and will continue to be implemented to minimise the risk of weed ingress.

5.5 Mitigation and Predicted Outcomes

Mitigation strategies to address the above potential impacts and predicted outcomes are presented in Table 5-4.

Table 5-4: Flora and Vegetation: Assessment of Potential Impact, Mitigation and Outcome

Potential impacts	Mitigation to address potential impacts	Predicted outcome
EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity is maintained.*		
Loss of vegetation as a result of clearing: Clearing of up to 4,310 ha of native vegetation, including the following vegetation communities of elevated conservation significance: • One occurrence of approximately 15.5 ha of the West Angelas Cracking Clay PEC; and • Riparian vegetation (Turee Creek East tributary).	The following key management strategies will continue to be implemented to manage the potential loss of vegetation (including vegetation communities of elevated conservation significance) as a result of clearing: **Avoid:** The Proponent proposes that clearing be subject to a new Ministerial Statement (Appendix 3). Schedule 1 of the new Ministerial Statement shall ensure that there is no disturbance PEC-2015-5. The Proposal has been designed to avoid disturbance to the West Angelas Cracking Clay PEC; PEC-2015-5. Specifically, the preferred conveyor route to transport ore from Deposits C and D to the existing central processing facilities avoids interaction with this occurrence of the West Angelas Cracking Clay PEC. One occurrence of approximately 15.5 ha of the West Angelas Cracking Clay PEC overlies Deposit D and as such, avoidance of this representation of the West Angelas Cracking Clay PEC is not possible. Deposit C intersects the floodplain of the Turee Creek East tributary and as such, avoidance of riparian vegetation is not possible. **Minimise:** Schedule 1 of the new Ministerial Statement shall authorise:	This Proposal is expected to result in the unavoidable loss of up to 4,310 ha of vegetation (including vegetation communities of elevated conservation significance) as a result of clearing. No TEC will be affected by the Proposal as none have been recorded within the region. One occurrence of approximately 15.5 ha of the West Angelas Cracking Clay PEC will be affected by the Proposal. This represents approximately 3.5% of the West Angelas Cracking Clay PEC mapped and as such, the unavoidable loss of this community is not expected to result in a significant impact on the representation of the West Angelas Cracking Clay PEC at a local or regional level. Approximately 25 ha of riparian vegetation will be affected by the Proposal. Riparian vegetation communities occur relatively extensively throughout the Hamersley Ranges. The riparian vegetation communities at West Angelas are of relatively low conservation significance and as such, the unavoidable loss of these communities is not expected to have a significant impact on the representation of the riparian vegetation at a local or regional level. Residual impacts will be addressed via the provision of an offset in accordance with EPA requirements. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	• Clearing of no more than 12,200 ha within a 26,400 ha Mine Development Envelope. • Clearing of no more than 20 ha of the West Angelas Cracking Clay PEC. The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement an EMP (Appendix 4) to *minimise disturbance to other representations of the West Angelas Cracking Clay PEC*. Backfilling of pits during operations is proposed, rather than all waste being stored in external waste dumps. **Rehabilitate:** The contemporary conditions of the new Ministerial Statement shall also require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans*. The Closure Plan (Appendix 11) includes a Closure Objective to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the final land use. **Offset:** The Proponent also proposes the provision of an environmental offset ($750 per hectare) for the unavoidable clearing of vegetation, and an environmental offset at the higher offset rate ($1,500 per hectare) for the unavoidable clearing of conservation significant vegetation; the West Angelas Cracking Clay PEC and riparian vegetation. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA).*	

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Loss or degradation of vegetation as a result of altered hydrological regimes: This Proposal is expected to contribute to alteration of the natural hydrological regime, disrupting natural surface water flows and / or patterns of surface water flow, potentially resulting in the following: • Inundation of the West Angelas Cracking Clay PEC, dependent on natural patterns of surface water (sheet) flow; and • Shadowing of the riparian vegetation of the Turee Creek East tributary, dependant on surface water flows.	The following key management strategies will continue to be implemented to manage the alteration of the natural hydrological regime: **Avoid:** The Proposal has been designed to avoid disturbance to the West Angelas Cracking Clay PEC; PEC-2015-5. Specifically, • Surface water management structures (culverts) have been designed to maintain natural patterns of surface water flow which would otherwise be impounded, sustaining the West Angelas Cracking Clay PEC. • Surface water management structures (diversions) have also been designed to maintain the continuation of natural surface water flows which would otherwise be captured by the pits, sustaining the riparian vegetation of Turee Creek East. **Minimise:** The Proponent proposes that the alteration of natural hydrological regimes be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans*. The Closure Plan will consider the closure strategy for the proposed surface water management structures once detailed designs are available however, the diversions are likely to be permanent, ensuring the continuation of natural surface water flows, sustaining the riparian vegetation of Turee Creek East.	This Proposal is expected to result in alteration of the natural hydrological regime, disrupting natural surface water flows and / or patterns of surface water flow. However, the proposed surface water management structures will ensure the natural surface water flows and / or patterns of surface water flow are maintained such that vegetation (including vegetation communities of elevated conservation significance; West Angelas Cracking Clay PEC and riparian vegetation communities) is unlikely to be significantly adversely affected. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome

Loss or degradation of riparian vegetation as a result of surface water discharge:
 	
Discharge of surplus dewatering water to the Turee Creek East tributary is expected to change the hydrological regime of Turee Creek East from an ephemeral hydrologic regime to a perennial hydrologic regime for the surface discharge extent, potentially resulting in the following:
• changes in riparian vegetation community structure;
• changes in the health of the dominant riparian tree species *Eucalyptus victrix* and *Eucalyptus camaldulensis* (if present), which may include:
  ○ declining health (decreasing biomass / abundance) or death of species susceptible to waterlogging stress (*Eucalyptus victrix*); and
  ○ increasing biomass / abundance or artificial recruitment of species tolerant to waterlogging (*Eucalyptus camaldulensis*).
• establishment or increasing biomass / abundance of other species which are tolerant to waterlogging (particularly sedges and rushes);
• enhanced potential for weed invasion; and
• drought stress on cessation of discharge.
	The following key management strategies will be implemented to manage the potential loss or degradation of up to 25 ha of riparian vegetation as a result of discharge:
	
	Avoid:
	
	The conservative cumulative balance of surplus dewatering water requiring management is up to approximately 12 GL/a. Based on discharge of up to 12 GL/a, the surface discharge extent is modelled to extend up to 22 km.
	
	The surface discharge extent will not extend as far as Karijini National Park.
	
	Minimise:
	
	Cumulative water balance modelling has been and will continue to be, undertaken to facilitate understanding of current and future operational water demands. Dewatering water will be used on-site in the first instance to supply supply operational water requirements. Only surplus dewatering water that exceeds the operational water requirement will be discharged to the Turee Creek East tributary.
	
	The Proponent proposes that the discharge of surplus dewatering water be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement an EMP (Appendix 4) to *ensure that there is no irreversible impact to the health of riparian vegetation of Turee Creek East and its tributaries as a result of the discharge of excess water.*
		This Proposal is expected to result in changes to riparian vegetation community structure, declining health of 'scattered' *Eucalyptus victrix*, artificial recruitment of *Eucalyptus camaldulensis*, establishment of other species which are tolerant to waterlogging and increasing abundance of weeds as a result of discharge of surplus dewatering water, exceeding the operational requirement, to an ephemeral tributary of Turee Creek East.
		
		Residual impacts will be addressed via the provision of an offset in accordance with EPA requirements.
		
		The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	The Proponent proposes to monitor the structure, cover and health of riparian vegetation (both native and introduced species) within the surface discharge extent. Monitoring results are expected to show, at worst, changes to riparian vegetation community structure, declining health of 'scattered' *Eucalyptus victrix* (including dead trees), artificial recruitment of *Eucalyptus camaldulensis*, and establishment of other species which are tolerant to waterlogging and increasing abundance of weeds in response to the change from an ephemeral hydrologic regime to a perennial hydrologic regime. The EMP proposes that a significant upward trend in introduced species and a significant decline in native species indicate that the environmental objective is not being met. **Offset:** The Proponent also proposes the provision of an environmental offset at the higher offset rate ($1,500 per hectare) for potential changes in riparian vegetation community structure and/or changes in the health of the dominant riparian tree species *Eucalyptus victrix* and *Eucalyptus camaldulensis* (if present). **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA)*. Riparian vegetation along Turee Creek East has been subject to discharge of surplus dewatering water from existing operations since 2011. Discharge of surplus dewatering water has been, and will continue to be, managed in accordance with the existing Operating Licence L7774/2000, issued under Part V of the EP Act, and any amendments as required.	

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Loss or degradation of potentially groundwater dependant vegetation as a result of groundwater drawdown: Unmitigated groundwater drawdown of up to 8m is predicted to persist beyond 100 years, potentially resulting in, at worst, declining health (decreasing biomass / abundance) or death of individuals of the dominant groundwater dependant species; *Eucalyptus victrix* and *Eucalyptus camaldulensis* within riparian vegetation communities within Karijini National Park, conservatively assumed to represent a potential GDE.	The following key management strategies will be implemented to manage the potential loss or degradation of potentially groundwater dependant vegetation as a result of groundwater drawdown: **Minimise:** Hydrogeological modelling has been and will continue to be, undertaken to facilitate understanding of current and future dewatering requirements. Dewatering will be minimised to that required to access the below water table resource. The Proponent proposes that groundwater drawdown be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement an EMP (Appendix 4) to *ensure that there is no irreversible impact to potentially groundwater dependant vegetation within Karijini National Park as a result of dewatering*. The Proponent proposes to monitor the health of the dominant groundwater dependant species: *Eucalyptus victrix* and *Eucalyptus camaldulensis* within riparian vegetation communities within Karijini National Park, conservatively assumed to represent a potential GDE, utilising satellite based DMSI. Monitoring results are expected to show, at worst, declining health (decreasing biomass / abundance) or death of individuals of the dominant groundwater dependant species: *Eucalyptus victrix* and *Eucalyptus camaldulensis* beyond natural variation. The EMP proposes that a greater than 2 Standard Deviation change in the mean vegetation index for the upper canopy of the dominant groundwater dependant species *Eucalyptus victrix* and *Eucalyptus*	This Proposal could potentially result in declining health (decreasing biomass / abundance) or death of individuals of the dominant groundwater dependant species *Eucalyptus victrix* and *Eucalyptus camaldulensis* within riparian vegetation communities within Karijini National Park as a result of unmitigated groundwater drawdown of up to 8m beneath potentially groundwater dependant vegetation within Karijini National Park. Residual impacts will be addressed via the provision of an offset in accordance with EPA requirements. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	camaldulensis over consecutive monitoring events indicates that the environmental objective is not being met. **Offset:** The Proponent also proposes the provision of an environmental offset at the highest offset rate ($50,000 per hectare) for the potential declining health of individuals of the dominant groundwater dependant species: *Eucalyptus victrix* and *Eucalyptus camaldulensis* within riparian vegetation communities within Karijini National Park. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA)*. Groundwater abstraction for dewatering purposes has been, and will continue to be, managed in accordance with the existing Groundwater Licence GWL98740, issued under the RIWI Act and associated Groundwater Operating Strategy, and any amendments as required.	
Loss of conservation significant flora species as a result of clearing: Clearing is expected to result in the direct loss of some individuals of the following conservation significant flora species occurring or assessed as having a high likelihood of occurrence within the Proposal area: • Two P2 flora species (*Aristida lazaridis* and *Eremophila pusilliflora Buirchell & A.P.Br.*); • Four P3 flora species (*Acacia subtiliformis, Rhagodia* sp. Hamersley (M. Trudgen 17794), *Sida* sp. *Barlee Range* (S. van Leeuwen 1642) and *Triodia* sp. Mt Ella (M.E. Trudgen 12739)); and	The following key management strategies will continue to be implemented to manage the potential loss of conservation significant flora species as a result of clearing: **Avoid:** The Proposal has been designed to avoid known locations of Priority Flora as far as practicable. **Minimise:** The Proponent proposes that clearing be subject to a new Ministerial Statement (Appendix 3). Schedule 1 of the new Ministerial Statement shall authorise: • Clearing of no more than 12,200 ha within a 26,400 ha Mine Development Envelope.	This Proposal is expected to result in the unavoidable loss of conservation significant flora species as a result of clearing. Six conservation significant flora species (and one species of potential interest) occurring or assessed as having a high likelihood of occurrence within the Proposal area will be affected by the Proposal. These species are all well represented in the West Angelas region and the Pilbara bioregion and as such, the unavoidable loss of some individuals of these species is not expected to have a significant impact on the conservation status or representation of these species at a local or regional level.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
• One species of potential interest (*Eulalia* sp. (Three Rivers Station, B.Forsyth AQ6789133)).	**Rehabilitate:** The contemporary conditions of the new Ministerial Statement shall also require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans.* The Closure Plan (Appendix 11) includes a Closure Objective to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the final land use. **Offset:** The Proponent also proposes the provision of an environmental offset ($750 per hectare) for the unavoidable clearing of vegetation, which could include individuals of conservation significant flora species. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA)*.	Residual impacts will be addressed via the provision of an offset in accordance with EPA requirements. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.
Degradation of vegetation as a result of ingress of weeds: Clearing and / or change to the hydrological regime of Turee Creek East from an ephemeral hydrologic regime to a perennial hydrologic regime as a result of discharge are expected to result in increasing abundance of weeds.	Rio Tinto has well established strategies for the monitoring and management of the risk of weed ingress at its Pilbara operations. The following key management strategies will continue to be implemented to manage weeds: **Avoid:** The surface discharge extent will not extend as far as Karijini National Park. **Minimise:** The Proponent proposes that clearing and discharge of surplus dewatering water be subject to a new Ministerial Statement (Appendix 3). Schedule 1 of the new Ministerial Statement shall authorise:	The Proposal is expected to result in the unavoidable degradation of vegetation (including vegetation communities of elevated conservation significance) as a result of ingress of weeds. Residual impacts will be addressed via the provision of an offset in accordance with EPA requirements. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	• Clearing of no more than 12,200 ha within a 26,400 ha Mine Development Envelope. The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement an EMP (Appendix 4) to *ensure that there is no irreversible impact to the health of riparian vegetation of Turee Creek East and its tributaries as a result of the discharge of excess water.* Dewatering water will be used onsite in the first instance to supply water for operational purposes. Only surplus dewatering water that exceeds the operational water requirement will be discharged to the Turee Creek East tributary. The Proponent proposes to monitor the structure, cover and health of riparian vegetation (both native and introduced species) within the surface discharge extent. Monitoring results are expected to show increasing abundance of weeds in response to the change from an ephemeral hydrologic regime to a perennial hydrologic regime. The EMP (Appendix 4) proposes that a significant upward trend in the number of introduced species and a significant decline in native species indicate that the environmental objective is not being met. **Rehabilitate:** The contemporary conditions of the new Ministerial Statement shall also require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans.* The Closure Plan (Appendix 11) includes a Closure Objective to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the final land use.	

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	Offset: The Proponent also proposes the provision of an environmental offset ($750 per hectare) for the the degradation of vegetation, and an environmental offset at the higher offset rate ($1,500 per hectare) for the the degradation of riparian vegetation. **Other legislation:** Weed management will be in accordance with the requirements of the *Agriculture and Related Resources Protection Act 1976*.	

6. TERRESTRIAL FAUNA

This Section describes the terrestrial fauna that occurs within the Proposal area, provides details regarding the potential impacts to conservation significant terrestrial fauna species from the proposed clearing that forms part of this Proposal and management to ensure that the Proposal meets the EPA's objectives for terrestrial fauna.

6.1 EPA Objective

The EPA applies the following objective from the *Statement of Environmental Principles, Factors and Objectives* (2016) in its assessment of proposals that may affect terrestrial fauna:

> *To protect terrestrial fauna so that biological diversity and ecological integrity is maintained.*

6.2 Policy and Guidance

The following EPA guidelines and guidance have been considered in the assessment of terrestrial fauna with respect the above EPA objective:

- EPA *Statement of Environmental Principles, Factors and Objectives* (2016).
- EPA *Environmental Factor Guideline: Terrestrial Fauna* (2016).
- EPA Technical Guidance: *Sampling Methods for Terrestrial Vertebrate Fauna* (2016).
- EPA Technical Guidance: *Terrestrial Fauna Surveys* (2016).
- EPA Technical Guidance: *Sampling of Short Range Endemic Invertebrate Fauna* (2016).

6.3 Receiving Environment

Terrestrial fauna surveys have been undertaken across the West Angelas region since 1979, covering an area in excess of 61,600 ha. The combined coverage of these surveys has enabled a detailed understanding of the existing terrestrial fauna a considerable reference for the distribution of species in the West Angelas region. Table 6-1 summarises the key terrestrial fauna surveys relevant to this Proposal.

Table 6-1: Summary of Supporting Terrestrial Fauna Studies

Report Title Author (Year)	Summary and guidance	Appendix
An ecological appreciation of the West Angelas environment, Western Australia 1979. Integrated Environmental Services (1979)	Strategic biological survey of vertebrate fauna conducted in all seasons of the years 1978 and 1979 across West Angelas. Survey of invertebrate fauna conducted December 1979. The fauna of the Pilbara was considered little known with few previous surveys in the region. The vertebrate fauna survey recorded 15 species of mammals (including potential Western Pebble-mound Mice *Pseudomys chapmani*), an additional three species of bats, 25 species of reptiles, two species of amphibians and 48 species of birds. The fauna was considered to consist of largely common and widespread species. However the following species were considered to be of importance: populations of Rothschilds Rock-wallabies *Petrogale rothschildi*; Ingram's Planigales *planigale* sp. (*ingrami*); Pebble Mound Mice *Pseudomys* sp.; Ghost Bats *Macroderma gigas;* the skink *Lerista neader;* Australian Bustard *Ardeotis australis;* and Grey Falcon *Falco hypoleucos*. The invertebrate fauna survey mostly recorded species that were considered relatively common in the Pilbara. However, some of the species had not been previously collected. It was not possible to make statements about the status of species given that little was known about the invertebrate fauna of the Pilbara.	-
West Angelas Project Vertebrate Fauna Assessment Survey. ecologia (1998)	Extensive vertebrate fauna and fauna habitat assessment conducted between June and October 1997, across West Angelas (including the rail corridor) in accordance with EPA requirements for biological inventory and assessment and CALM biological survey guidelines for the Pilbara. Eight primary habitats, largely based on vegetation and landforms, were identified: Mulga Woodland; Rocky Gully; Cracking Clay; Creekline; Hilltop; Spinifex Plain; Riverine; and Boulder Hill. Cracking Clay habitat was considered to be regionally significant, supporting specialist fauna. Mulga Woodland forms habitat for a diverse fauna assemblage and was also considered to be of regional significance. Other areas identified as being important for fauna included caves for Ghost Bats and Pebble-mound Mouse habitat. The survey recorded 119 species of terrestrial vertebrate fauna, comprising: 21 mammals; 27 reptiles; one amphibian; and 70 birds. An additional 12 mammals; 48 reptiles; one amphibian; and 47 birds were recorded in the rail corridor. Three Priority listed species were recorded from the survey area: the Ghost Bat *Macroderma gigas* (P4); Western Pebble-mound Mouse *Pseudomys chapmani* (P4) and Short-tailed Mouse *Leggadina lakedownensis* (P4). Four additional conservation listed species: the Rainbow Bee-eater *Merops ornatus* (EPBC Migratory, WC Act Schedule 5); Grey Falcon *Falco hypoleucos* (WC Act Schedule 3, VU)*;* Bush Stone-curlew *Burhinus grallarius* (formerly P4, no longer listed); and Lined Soil-crevice Skink *Notoscincus butleri* (P4) were recorded in the rail corridor.	-

Report Title Author (Year)	Summary and guidance	Appendix
West Angelas Project Ghost Bat (Macroderma gigas) Assessment Survey. ecologia (1998)	Systematic survey of gullies adjacent to Deposits A, B, E and F undertaken between August and September 1998. This survey sought to clarify the distribution and abundance of Ghost Bats at West Angelas. One female Ghost Bat was captured in a very large cave (Cave AA1) near Deposit F. It was a mature female and may have been pregnant, as its abdomen was swollen. The abundance of scats and feeding remains in Cave AA1 suggested long term utilisation. The cave was thought to be a Ghost Bat maternity cave and was considered to be of considerable conservation significance. Although only one Ghost Bat was observed during the survey, a total of six caves contained evidence of Ghost Bat use. The condition of scat material in the other five caves suggested all had been used relatively recently, at least within the last year. It appeared that these caves were subject to only temporary, intermittent or seasonal use. Caves with only small amounts of Ghost Bat scat material and feeding remains were thought to be used as feeding sites only (A1, L2, L3, I1 and AB1).	-
West Angelas Minesite Ghost Bat Assessment Survey, September 2000. ecologia (2000)	Survey undertaken during August 2000 for evidence of Ghost Bats in caves previously surveyed to clarify the distribution and abundance of Ghost Bats at West Angelas. Of the five caves surveyed, recent evidence of Ghost Bats was recorded in two of the caves (I1 and AA1) and a Ghost Bat was sighted in cave A1. Caves L2 and L3 showed signs that Ghost Bats had been habituating these caves in the past, but it was difficult to evaluate how long ago this occurred.	-
West Angelas Minesite Ghost Bat Monitoring Survey, September 2001. ecologia (2001)	Survey of caves identified as supporting Ghost Bats during the September 2000 survey undertaken during September 2001. Bat occupation was based on the presence of scats and condition of scat material. Of the five caves known to contain evidence of Ghost Bats, recent activity was recorded at only three caves. Evidence collected in two of the caves (AA1 and A1) comprised bone fragments and scats. In the third cave (AB1) only scats were collected. No Ghost Bats were found roosting in any cave searched during the 2001 survey.	-
Ghost Bats at West Angelas: 2002 Survey, Data Review and Future Directions. Biota (2002)	All caves identified as previously supporting Ghost Bats were examined for current or recent signs of occupancy. No Ghost Bats were observed in any feature. Recent signs of occupancy ('fresh' scats) were present in three caves (AA1, AB1 and L3) and the West Angelas adit. The remainder of the caves (A1, I1 and L2) showed no signs of recent activity. Very little obvious feeding remains were observed in any cave.	-

Report Title Author (Year)	Summary and guidance	Appendix
Monitoring of Ghost Bat Roosts at West Angelas 2003 Biota (2004)	All caves identified as previously supporting Ghost Bats were examined for current or recent signs of occupancy in December 2003. Ghost Bats were observed in cave A1 adjacent to Deposit B. Recent signs of occupancy (non-degraded scat material) were present in two other caves (AA1 and AB1) indicating that they may have been used by a small number of individuals at most sometime during the year. The remainder of the caves (I1, L2 and L3) showed no signs of recent activity. Very little obvious feeding remains were observed in any cave.	-
Fauna Habitats and Fauna Assemblage of Deposits E and F at West Angelas. Biota (2005)	Desktop review and single phase survey of the fauna habitats and fauna assemblage present at Deposits E and F conducted between 4 and 12 May 2004 in accordance with the following: • EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002). • EPA Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004b). Four primary habitats, largely based on vegetation structure and landforms, were identified: • Broad colluvial valleys dominated by *Acacia aneura*; • Lower stony footslopes at the interface between *Acacia* dominated and eucalypt dominated communities; • Stony hilltops and upper slopes dominated by eucalypts over *Triodia*; and • Incised gullies and creeks. One fauna habitat is considered to have moderate conservation significance within the survey area, based on the vegetation types to which it relates; Broad colluvial valleys dominated by *Acacia aneura* comprise ecosystems at risk in the form of grove/intergrove and valley floor mulga. The survey recorded 98 species of terrestrial vertebrate fauna, comprising 12 mammals including one bat, 37 reptiles and 47 birds. Two Priority listed species were recorded from the survey area: the Australian Bustard *Ardeotis australis* (formerly P4, no longer listed) and Western Pebble-mound Mouse *Pseudomys chapmani* (P4). The survey also documented one key group of invertebrates, the Mygalomorphae (trapdoor spiders), potentially supporting narrow range taxa.	-

Report Title Author (Year)	Summary and guidance	Appendix
West Angelas – Deposit B Ghost Bat Assessment Biologic (2013)	Four caves near Deposit B identified as previously supporting Ghost Bats were surveyed for bats and their traces in October 2012. The pattern of usage of these caves is intermittent. Ghost Bat usage of caves A1 and L3 was confirmed by the presence of a significant quantity of recent scats, and by Ghost Bat calls recorded on two nights outside cave L3. However no Ghost Bats were recorded roosting in these caves during the day. These two caves were categorised as feeding / night roosts and occasional day roosts. The size and complexity of these caves, together with the quantities of scats, suggests use as occasional maternity roosts cannot be ruled out.	-
West Angelas – Deposit B Ghost Bat Assessment Biologic (2014)	Five caves identified as previously supporting Ghost Bats were surveyed for bats and their traces during the 2013 survey; caves A1, A2, L2 and L3 at Deposit B and cave AA1 at Deposit F. Evidence of Ghost Bat usage was observed at four (AA1, A1, A2 and L3) of the five monitoring caves: cave AA1 had one Ghost Bat and fresh scat piles; cave A1 contained fresh scat piles; cave A2 contained fresh scats and Ghost Bat calls recorded; cave L3 had Ghost Bat calls recorded but no scats observed.	-
Greater West Angelas Terrestrial Fauna Assessment. *ecologia* (2014)	Desktop review and two phase, Level 2 survey conducted; Phase 1 conducted between 26 September and 6 October 2012, Phase 2 conducted between 18 and 27 March 2013 in accordance with the following: • EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002). • EPA Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004b). • Technical Guide – *Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010), *Guidance Statement 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA 2009). The results of this survey are outlined below.	**Appendix 7**
West Angelas – Deposit B and F Ghost Bat Assessment 2014. Biologic (2015)	Five caves identified as previously supporting Ghost Bats were surveyed for bats and their traces during the 2014 survey; caves A1, A2, L2 and L3 at Deposit B and cave AA1 at Deposit F. Evidence of Ghost Bat usage was observed at two (AA1 and A1) of the five monitoring caves and no Ghost Bat calls were recorded.	-

Report Title Author (Year)	Summary and guidance	Appendix
West Angelas Iron Ore Mine – Deposit B and F Ghost Bat Monitoring 2015. Biologic (2016)	Five caves identified as previously supporting Ghost Bats were surveyed for bats and their traces in October 2015; caves A1, A2, L2 and L3 at Deposit B and cave AA1 at Deposit F. Evidence of Ghost Bat use was observed at four of the five monitoring caves: a single Ghost bat was flushed from the AA1 cave, and was observed by Biologic personnel to be lacking young; fresh or recent scats were collected in caves A1, A2, L3, and AA1; no fresh scats were collected in cave L2 however, a potential Ghost Bat call was detected at cave L2 (the recording was not regarded as confirmation of Ghost Bat presence as it was very faint).	-

Ecologia most recently conducted a two phase terrestrial fauna assessment in 2012 and 2013. The survey area is considerably broader than the Proposal area. The survey was undertaken to support an environmental impact assessment and was conducted in accordance with EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (2002), EPA Guidance Statement No. 56 - *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (2004b) and Technical Guide – *Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010)*, Guidance Statement 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (2009). The *ecologia* (2014) report is provided as Appendix 7.

6.3.1 Habitats

A total of nine broad-scale habitats have been identified within the broader survey area, with six of these mapped as occurring within the Proposal area (bold denotes those six within the Proposal area): '**footslope or plain'**; '**hilltop, hillslope**; **ridge or cliff'**; '**mixed Acacia woodland**'; 'mulga woodland'; 'mesa top'; '**cracking clay**'; '**major gorge and gully**'; '**major drainage**'; and 'cleared area'. The habitats recorded represent habitats that are relatively common in the West Angelas region and none of the habitats recorded were unique to the West Angelas region.

The following habitats were considered by the Proponent to be of elevated conservation significance and of relevance to this Proposal:

- **Cracking clay habitat** occupied less than 2% of the survey area and is considered to be relatively restricted in the Pilbara bioregion. The cracking clay habitat is described as;

  > 'Flat tussock grassland plain with native grasses *Aristida latifolia, Astrebla pectinata* and *Brachyachne convergens* growing in open to very dense patches. Scattered and isolated *Acacia aneura* trees with *Acacia tetragonophylla* and *Acacia synchronicia* shrubs. Soil consisting of clay with wide vertical cracks within the soil profile' (*ecologia* 2014).

  The Cracking Clay within the survey area provided habitat for the Stripe-faced Dunnart and also for the Sandy Inland Mouse. The Common Rock-rat was also recorded from this habitat type, which is considered very unusual. One conservation significant species; the Northern Short-tailed Mouse is strongly associated with Cracking Clay habitat; however, it was not recorded during the survey (*ecologia* 2014).

  The avifauna of the Cracking Clay habitat is typically extremely sparse. The lack of shelter and cover in the form of shrubs and trees does not attract many avifauna species. However, some ground dwelling birds, such as the Crested Pigeon, Common Bronzewing, and some seed eaters, such as the Budgerigar, the Zebra Finch and the Painted Finch, were recorded feeding on seeding grass species. This, combined with the lack of shelter, attracts birds of prey such as the Whistling Kite and Spotted Harrier, which were recorded hunting on these plains. The Horsefields Bushlark was the only avifauna species restricted to the Cracking Clay habitat (*ecologia* 2014).

  The herpetofauna of the Cracking Clay typically comprises ground dwelling species such as the Fat-tailed Gecko and *Nephrurus wheeleri*. The Pebble Dragon was the only herpetofauna species restricted to the Cracking Clay habitat (*ecologia* 2014).

- **Acacia woodland habitat** occupied almost 15% of the survey area and is well represented in the Pilbara bioregion. Acacia woodland habitat is considered by the Proponent to be of moderate conservation significance as this habitat is considered to support a diverse fauna assemblage. The Acacia woodland habitat is described as;

  > 'Open to moderately dense woodland consisting of Mulga (*Acacia aneura* complex) with scattered *Acacia pruinocarpa*. Few shrubs consisting of *Acacia maitlandii* and *Ptilotus* sp. over various native grasses; *Triodia wiseana* and *T. pungens* open hummock grassland. Many other *Acacia* species were present in this habitat type, including *Acacia bivenosa, Acacia ayersiana, Acacia pyrifolia, Acacia sibirica;* as well as *Senna* shrubs (mainly varieties and subspecies of *Senna artemisioides* and *Senna glutinosa*). Soil consisting of loam clay of reddish-brown colour with continuous layers of small pebbles on the surface' (ecologia 2014).

  The Acacia woodland within the survey area provided habitat for generalists such as the Pilbara Ningaui, Planigale and Euro (*ecologia* 2014).

  The avifauna assemblage of the Acacia woodland is usually most diverse after significant rainfall, and when acacia shrubs and trees are flowering. In particular, honeyeater species such as the Singing Honeyeater, Grey-headed Honeyeater and Crimson Chat were recorded and, in good conditions, Black-chinned and White-fronted Honeyeater can be common. Other species also occurred, including Crested Bellbird, Red-capped Robin, Grey-crowned Babbler, White-winged Triller, Chestnut-rumped Thornbill and Willie Wagtail. The presence of some of these species, such as Crested Bellbird, Grey-crowned Babbler, and Chestnut-rumped Thornbill, is less dependent on rainfall and flowering events, as they are more sedentary than species like Black-chinned and White-fronted Honeyeaters (ecologia 2014).

  The herpetofauna of the Acacia woodland habitat typically comprised generalists such as the Tree Dtella *Gehyra variegata*, the Spiny-tailed Geckos *Strophurus strophurus* and *Strophurus wellingtonae*, and the skink *Menetia greyii* (ecologia 2014).

  Acacia woodlands also provide suitable habitat for many SRE invertebrates. Some mygalomorph spiders are known to adapt to this habitat, creating burrows beneath the shrubs, utilising their leaves and twigs to create elaborate trap door lids (family Idiopidae) or cryptic open burrows (family Nemessiidae). Scorpions build their burrows in patches of soft soil, many individuals of the scorpion *Urodacus* sp. indet. were recorded in these habitats. The soft soil allowed this species to dig their spiralling burrows, where they shelter during the day. Pseudoscorpions and isopods often inhabit the leaf litter below the shrubs and trees while millipedes can be found in decaying logs.

In addition to habitats of elevated conservation significance, the following significant habitat features have been recorded across the West Angelas region and are of (limited) relevance to this Proposal:

- **Caves that are utilised by Ghost Bats** represent significant habitat features.

  Ghost Bats are known to require a number of suitable caves throughout their home ranges (i.e. night / feeding roosts for feeding throughout the duration of the night, day roosts for resting and maternity roosts). The presence of day roosts and / or maternity roosts in an area is considered the most important indicator of habitat for Ghost Bats, and these caves are generally the primary focus of conservation and / or monitoring (Department of Environment 2015 in Biologic 2016a).

Ghost Bats have not been recorded roosting in caves within the Proposal area. However, Ghost Bats have been recorded roosting in five caves within 'gorge and gully' habitat in the West Angelas region; four roosts; Caves A1, A2, L2 and L3 to the north of Deposit B and one cave to the north of Deposit F; Cave AA1 (Figure 6-1).

Cave A1 has consistently shown evidence of recent Ghost Bat use throughout all surveys and is classified as a day roost. Owing to its high ongoing record of use, the possibility of it being a maternity roost is difficult to rule out; therefore it is considered of moderate to high importance to the local Ghost Bat population. Cave A2 has shown evidence of recent Ghost Bat use during three out of four years of monitoring (no evidence of Ghost Bat use recorded during the 2014 survey however, scats were recorded during the 2015 survey) and is a feeding / night roost. Despite its relatively frequent use, this cave's relatively open, shallow structure would limit its use as a day roost or maternity roost, therefore it is considered of moderate importance to the local Ghost Bat population. Cave L2 has only shown reliable evidence of recent Ghost Bat use once (scats recorded in 1998) and potential evidence of a Ghost Bat call in 2015 and is classified as a feeding / night roost. This cave's collapsed entrance and relatively open, shallow structure would limit its use as a day roost or maternity roost, therefore it is considered only of low to moderate importance to the local Ghost Bat population. Cave L3 has shown evidence of recent Ghost Bat use during all surveys except for 2014 (no evidence of Ghost Bat use recorded during the 2014 survey however, scats were recorded during the 2015 survey) and is classified as a potential day roost. Owing to its relatively frequent use and the larger size and structure of this cave (particularly the presence of deeper rear passages), it is also difficult to rule out the cave's potential as a maternity roost, therefore it is considered to be of moderate to high importance to the local Ghost Bat population. Cave AA1 has shown evidence of recent Ghost Bat use or presence throughout all surveys and is considered to have the highest conservation value of all the caves in the West Angelas region as it is a suspected maternity roost (Biologic 2016a), in 1997/98 a female was captured that was considered to be pregnant. Maternity roosts are uncommon with only eleven recorded in the Pilbara bioregion and therefore, Cave AA1 is also considered to have regional significance. A 100m exclusion zone has been, and will continue to be, maintained, preventing direct or indirect disturbance to Cave AA1.

Potential new roosts were searched for within 'gorge and gully' and 'hilltop, hillslope, ridge and cliff' habitats within the survey area, with no new roosts recorded. As such, this Proposal is not expected to interact with habitat features for Ghost Bats. However, given the significance of these habitat features within the West Angelas region, the Proponent proposes that the new Ministerial Statement (Appendix 3) include contemporary conditions to prevent direct or indirect disturbance to Cave AA1, and minimise direct or indirect disturbance to Caves A1, A2, L2 and L3.

The remaining habitats and habitat features recorded within the survey area were considered to be of low conservation significance, representing habitats that are well represented in the West Angelas region and the Pilbara bioregion.

6.3.2 Conservation Significant Fauna Species

Recent biological surveys (Table 6-1) have recorded a total of 23 species of native mammal, two species of introduced mammal, 80 species of bird and 64 species of reptile in the West Angelas region.

The following conservation significant fauna species have been recorded in the West Angelas region:

- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - EPBC Vulnerable, WC Act Schedule 3, Parks and Wildlife Vulnerable.
- Ghost Bat (*Macroderma gigas*) - EPBC Vulnerable, WC Act Schedule 3, Parks and Wildlife Vulnerable.
- Fork-tailed Swift (*Apus pacificus*) - EPBC Migratory, WC Act Schedule 5.
- Pilbara Barking Gecko (*Underwoodisaurus seorsus*) - P2.
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – P4 (Recorded from secondary evidence only).

Of these conservation significant fauna species, only the **Pilbara Leaf-nosed Bat, Fork-tailed Swift** and **Western Pebble-mound Mouse** were recorded within the Proposal area (Figure 6-1).

In addition, the following conservation significant species were assessed as having a moderate to high likelihood of occurrence within the Proposal area:

- Northern Quoll (*Dasyurus hallucatus*) - EPBC Endangered, WC Act Schedule 2, Parks and Wildlife Endangered.
- Pilbara Olive Python (*Liasis olivaceus barroni*) - EPBC Vulnerable, WC Act Schedule 3, Parks and Wildlife Vulnerable.
- Rainbow Bee-eater (*Merops ornatus*) - EPBC Migratory, WC Act Schedule 5.
- Grey Falcon (*Falco hypoleucos*) - WC Act Schedule 3, Parks and Wildlife Vulnerable.
- Peregrine Falcon (*Falco peregrinus*) - WC Act Schedule 7, Parks and Wildlife 'Other Specially Protected Fauna'.
- Blind Snake (*Ramphotyphlops ganei*) - P1.
- Short-tailed Mouse (*Leggadina lakedownensis*) - P4.

6.3.3 Short Range Endemic Species

Harvey (2002) noted that Short-Range Endemic (SRE) species generally possess a series of ecological and life-history traits, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal, only active during cooler, wetter periods; and
- low levels of fecundity.

As a result, these species have a geographically restricted range, which makes them more vulnerable to changes in conservation status as a result of habitat loss or other threatening processes (EPA 2009). Harvey (2002) defined short range endemism as species having a naturally small range of less than 10,000 km². Within this distribution, the actual areas occupied may be small, discontinuous or fragmented (EPA 2009). The key groups of invertebrates that are likely to contain SRE species include: spiders and their relatives (scorpions, pseudoscorpions and others); millipedes; isopods; and land snails.

Ecologia (2014) submitted 33 invertebrate species from six different orders for identification and SRE status assessment. The likelihood of the invertebrate species to be considered a SRE was determined based on the current known distribution of each species. The EPA recognises that conclusively determining the conservation significance of potential SRE taxa is often made difficult by the absence of regional context (EPA 2009). The likelihood of the invertebrate species to be considered SRE was determined based on the current known distribution of each species. Where insufficient or no information was available to determine the SRE status, individuals were conservatively assessed as potential SRE. Further research is required to confirm the SRE status of individuals where current knowledge is very limited.

Fifteen species were identified as potential SRE species, comprised of the following: two potential SRE trapdoor spiders; one potential SRE scorpion; four potential SRE pseudoscorpions; six potential SRE isopods; and two potential SRE millipedes / centipedes. Eight of the potential SRE species recorded are considered to be of relevance to the Proposal: two species of spider; one species of scorpion; one species of pseudoscorpion and four species of isopod (Figure 6-2). Several forms of Mygalomorph spiders (Araneae) were also recorded from the Biota (2005) survey.

- **Mygalomorph spiders** - traditionally, arid and semi-arid areas were considered poor potential habitat for invertebrate fauna given species are often moisture-dependent (Harvey *et al.* 2008 in ecologia 2014). Mygalomorphae (trapdoor spiders) are largely considered 'old world' spiders and, as such, are generally adapted to past climatic regimes making them vulnerable to desiccation in arid environments. However, these spiders are burrowing ground-dwellers which often have a trapdoor at the burrow entrance to avoid desiccation.

  Due to their habitat specialisation and usually poor powers of dispersal, mygalomorph spiders are frequently identified as SREs despite being a relatively common component of the biota of the Pilbara region.

  The Western Australian mygalomorph fauna is vast and, taxonomically, many families and genera remain poorly known (*ecologia* 2014). It is difficult to assess the diversity of mygalomorph species in the Pilbara since the majority of species have not been formally described in the scientific literature. It is also difficult to assess the distribution of mygalomorph species since most species are represented by only a relatively few specimens. Assigning conservation status to species that are unnamed and poorly understood is problematic.

  Several forms of mygalomorph spiders were recorded during the Biota (2005) survey. Only mature male mygalomorph spiders can be reliably identified to species level using morphological techniques, and males comprise only approximately 5% of specimens collected, the remaining females and juveniles mostly lack the morphological features that identify species. Therefore, the conservation significance of the mygalomorph spiders that were recorded during the 2005 Biota fauna survey could not be inferred. The specimens were lodged with the WA Museum. It was intended these specimens would contribute to improved understanding of mygalomorph species found throughout the Pilbara bioregion.

  A single male *Yilgarnia* 'MYG197' (family Nemesiidae) was recorded during the ecologia (2014) survey. This species has previously been recorded from the region, and identified as a potential SRE species. A single juvenile *Aurecocrypta* sp. indet. (family Barychelidae) was also captured opportunistically during the ecologia (2014) survey. Due to the juvenile life form of this specimen, it could not be identified to species level. This specimen has been considered potential SRE due to the taxonomic uncertainty.

All mygalomorph spiders were all recorded in 'footslope and plain' habitat, which is the most extensive habitat within the survey area.

- **Scorpions** - Currently, 23 species of *Urodacus* are described; however, this may represent as little as 20% of the real diversity of this genus in Australia. *Urodacus* appears to be most diverse scorpion genus in Western Australia with few species recorded in eastern Australia. Unidentifiable *Urodacus* scorpion specimens have previously been recorded from the region.

  A total of 10 unidentifiable females and juvenile *Urodacus* were collected from the region across different habitats during the *ecologia* (2014) survey. Three of the *Urodacus* scorpion specimens were collected from the Proposal area, found within 'footslope and plain' and 'mixed Acacia woodland' habitats, which are the two most extensive habitats within the area.

  No adult male specimens were collected and therefore this species is unable to be morphologically identified to species level. As *Urodacus* includes range-restricted and widespread species, all unidentified specimens have been considered potential SRE.

- **Pseudoscorpions** - The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats (Burger *et al*. 2013).

  A total of nine olpiid pseudoscorpions (four male, four female and one juvenile) were recorded from seven separate locations across different habitats during the *ecologia* (2014) survey. Four of the olpiid pseudoscorpion specimens were collected from the Proposal area, found within 'footslope and plain' and 'mixed Acacia woodland' habitats, which are two of the most extensive habitats within the area.

  The olpiid pseudoscorpion specimens collected appear to represent a single species; *Xenolpium* sp. indet (family Olpiidae). This species requires further taxonomic investigation to determine their SRE status. This species has been considered potential SRE due to the taxonomic uncertainty.

- **Isopods** - There are currently more than 10,000 described species of isopod however, despite being highly abundant in soil and leaf litter, they are inadequately studied and relatively little is known about the distributions of each species in Australia (Judd *et al*. 2008). Several species of isopod identified in the Pilbara are known or potential SREs, including *Buddenlundia,* (Judd *et al*. 2008).

  Buddelundia sp. nov. '10' (family Armadillidae) is a species complex and is common and widespread in the Pilbara. There were at least four morphologically different forms found during the *ecologia* (2014) survey. Two of these were relevant to the Proposal: *Buddelundia* sp. nov. '10' 1458A was the most abundant, with a total of 70 individuals recorded from four locations across the region, across different habitats; and a total of 10 individuals (five male, four female and one juvenile) of the species *Buddelundia* sp. nov. '10' 1458B were recorded from three locations across the region, across different habitats. 56 of the *Buddelundia* sp. nov. '10' 1458A specimens and only one of the *Buddelundia* sp. nov. '10' 1458B specimens were collected from the Proposal area, found within 'footslope and plain' habitat, which is the most extensive habitat within the area.

  Further work on this group of species is required to understand better their true SRE status. The four forms of *Buddelundia* sp. nov. '10' have all been considered potential SRE due to the taxonomic uncertainty.

Two individuals (one male, one female) of the species *Buddelundia* sp. nov. '68WA' were recorded from two locations within the 'footslope and plain' habitat type. There are many species very similar to these specimens which are confirmed SRE species and as such, *Buddelundia* sp. nov. '68WA' is considered a potential SRE species.

These potential SRE species are vulnerable to potential impacts due to their restricted distributions.

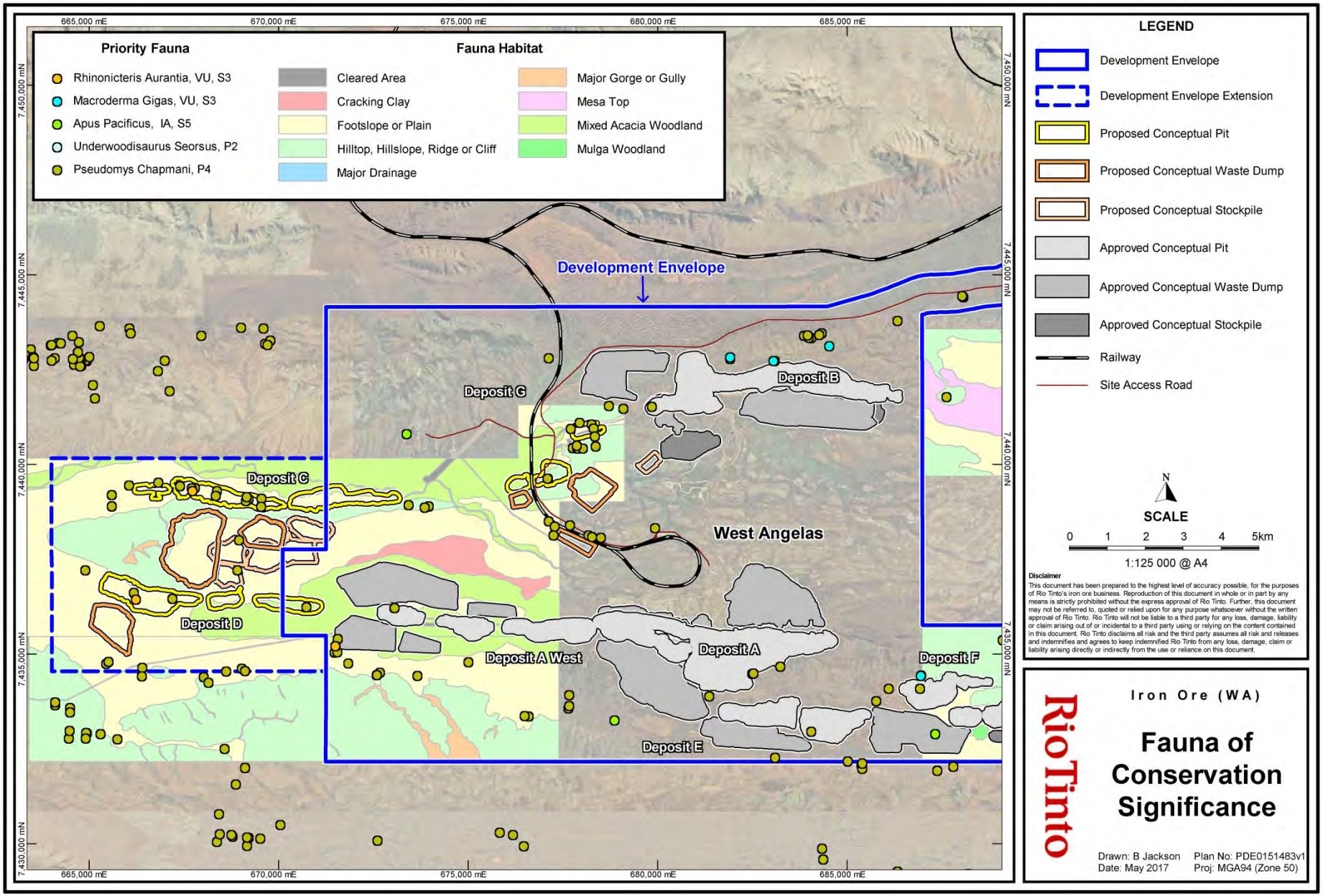

Figure 6-1: Fauna of Conservation Significance

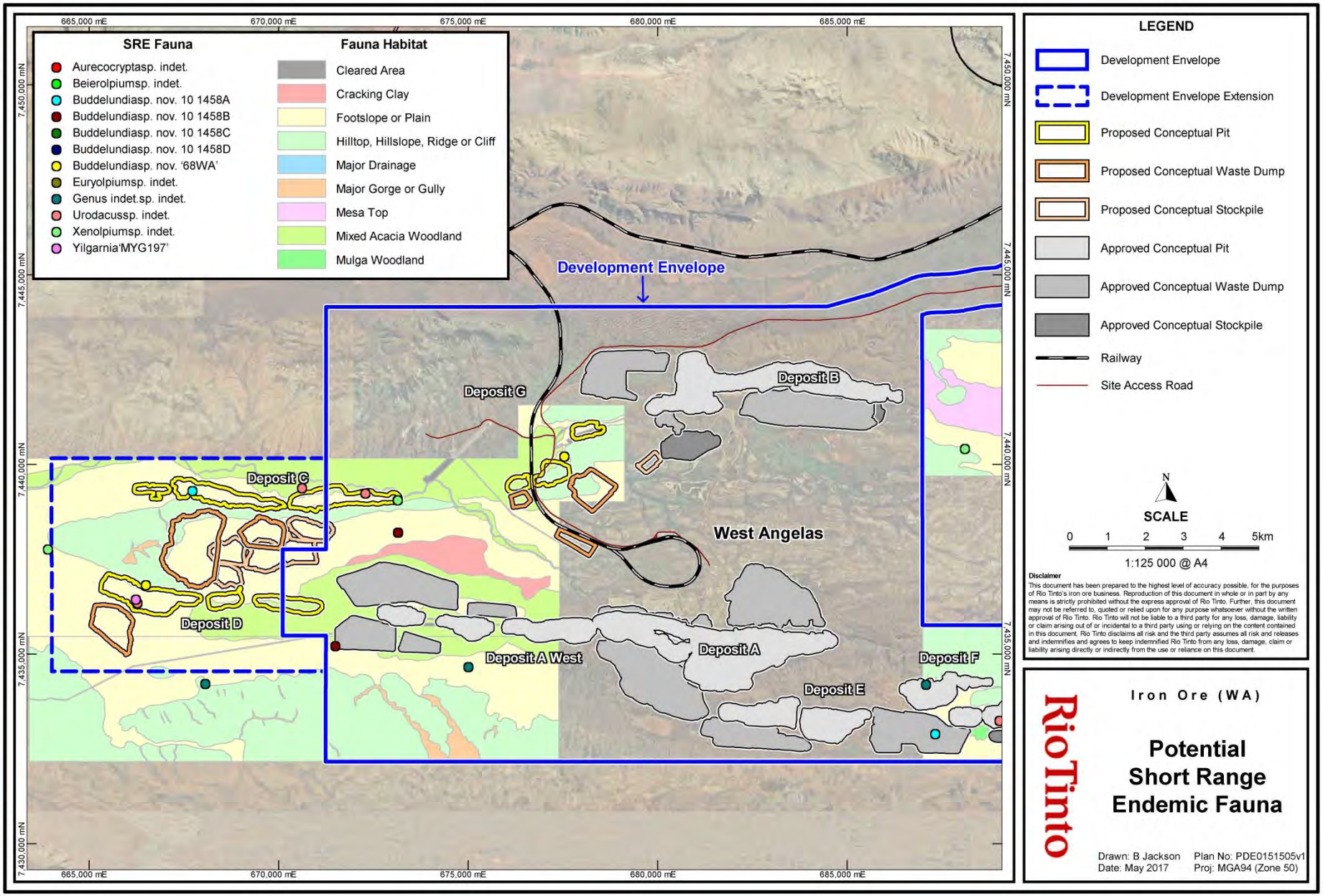

Figure 6-2: Potential Short Range Endemic Fauna

6.4 Assessment of Potential Impacts

Potential impacts to Terrestrial Fauna include the following:

- Loss of potential fauna habitat (including habitats for conservation significant fauna species) as a result of clearing; and
- Loss of fauna individuals (including individuals of elevated conservation significance, if present) as a result of clearing.

Assessment of each of these potential impacts is included below. Mitigation to address these potential impacts and predicted outcomes is presented in Table 6-2.

6.4.1 Loss of potential fauna habitat as a result of clearing

Clearing will include impacts to six potential fauna habitats: 'footslope and plain'; 'hilltop, hillslope; ridge or cliff'; 'mixed Acacia woodland'; 'cracking clay'; 'major gorge and gully'; and 'major drainage' habitat. Some of these represent habitat for conservation listed species recorded in the region.

- **'Footslope and plain' habitat** represents preferred habitat for the Western Pebble-mound Mouse (recorded) and potential foraging habitat for the Pilbara Leaf-nosed Bat (assessed as having a moderate to high likelihood of occurrence in the region). SRE species were also recorded inhabiting 'footslope and plain' habitat.

  Clearing to support this Proposal has the potential to result in the loss of up to 2,500 ha of this habitat within the Development Envelope extension area. This habitat is the most abundant habitat recorded, representing almost 46% of the survey area. This habitat is also common in the Hamersley subregion and as such, the proposed clearing of this habitat is not considered to represent a significant loss of this habitat at a local or regional scale.

- **'Hilltop, hillslope; ridge or cliff' habitat**) represents potential habitat for the Ghost Bat and Pilbara Barking Gecko (recorded in the region) and potential foraging habitat for the Northern Quoll and potential nesting habitat for the Peregrine Falcon (assessed as having a moderate to high likelihood of occurrence in the region).

  Clearing to support this Proposal has the potential to result in the loss of up to 700 ha of this habitat within the Development Envelope extension area. This represents less than 13.5% of the 'hilltop, hillslope; ridge or cliff' habitat mapped throughout the survey area. This habitat is the second most abundant habitat recorded, representing almost 30% of the survey area. This habitat is also common in the Hamersley subregion and as such, the proposed clearing of this habitat is not considered to represent a significant loss of this habitat at a local or regional scale.

- **'Mixed Acacia woodland' habitat** No conservation significant species are restricted to this habitat. 'Mixed Acacia woodland' habitat represents potential habitat for potential SRE fauna (recorded in the region).

  Clearing to support this Proposal has the potential to result in the loss of up to 550 ha of this habitat within the Development Envelope extension area. This represents approximately 20% of the 'major drainage' habitat mapped throughout the survey area. However, this habitat is not considered to be uncommon in this part of the Hamersley subregion, representing almost 15% of the survey area, and as such, the proposed clearing of this habitat is not considered to represent a significant loss of this habitat at a local or regional scale.

- **'Cracking clay' habitat** (less than 2% of the survey area). One conservation significant species is strongly associated with the cracking clay habitat: the Northern Short-tailed Mouse, however, it was not recorded during the current survey (*ecologia* 2014).

  Clearing to support this Proposal has the potential to result in the loss of up to 15.5 ha of this habitat within the Development Envelope extension area. This represents only approximately 3.5% of the 'cracking clay' habitat mapped throughout the West Angelas region and as such, the proposed clearing of this habitat is not considered to represent a significant loss of this habitat at a local or regional scale.

- **'Major gorge and gully' habitat** (less than 1% of the survey area) represents potential habitat for the Pilbara Barking Gecko (recorded in the region), preferred habitat for the Pilbara Olive Python and Blind Snake and potential denning habitat for the Northern Quoll (assessed as having a moderate to high likelihood of occurrence in the region).

  This habitat also contains caves that support the local population of Ghost Bats. Potential new roosts were searched for within 'gorge and gully' habitat, no caves were found.

  Clearing to support this Proposal has the potential to result in the loss of up to 25 ha of this habitat within the Development Envelope extension area. This represents less than 15% of this habitat mapped throughout the survey area and as such, the proposed clearing of this habitat is not considered to represent a significant loss of this habitat at a local or regional scale.

- **'Major drainage' habitat** (less than 0.3% of the survey area) represents potential foraging habitat for the Northern Quoll and migratory species, including the Grey Falcon and Peregrine Falcon (assessed as having a moderate to high likelihood of occurrence). The Rainbow Bee-eater (assessed as having a high likelihood of occurrence in the region) commonly build nest burrows in 'major drainage' habitat. The Pilbara Olive Python (assessed as having a moderate likelihood of occurrence in the region) also disperses through 'major drainage' habitat.

  Clearing has the potential to result in the loss of up to 25 ha of this habitat within the Development Envelope extension area. This represents approximately 30% of the 'major drainage' habitat mapped throughout the survey area. However, 'major drainage' habitat is not considered to be uncommon in this part of the Hamersley subregion and as such, the proposed clearing of this habitat is not considered to represent a significant loss of 'major drainage' habitat at a local or regional scale.

None of the habitats recorded are restricted to the Proposal area. The six potential fauna habitats recorded represent habitats that are relatively common in the West Angelas region and none of these habitats are unique to the West Angelas region.

Most of these habitats are also relatively common throughout the Hamersley subregion, including within Karijini National Park to the west. The loss of potential fauna habitat (including habitats for conservation significant fauna species) as a result of clearing is not considered to represent significant loss of habitat at a local or regional scale.

6.4.2 Loss of individuals as a result of clearing

Clearing also has the potential to result in the direct loss of fauna individuals. Three conservation significant fauna species; the **Pilbara Leaf-nosed Bat, Fork-tailed Swift** and **Western Pebble-mound Mouse** were recorded within the Proposal area. Potential impacts to these species are discussed below:

- **Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form))** - EPBC Vulnerable, WC Act Schedule 3, Parks and Wildlife Vulnerable (Recorded). The Pilbara Leaf-nosed Bat, the Pilbara form of the Orange Leaf-nosed Bat (*Rhinonicteris aurantia*), is found across the Pilbara bioregion with records from three of the four Pilbara sub-regions. Recent evidence suggests three main areas for the Pilbara Leaf-nosed Bat: mines of the eastern Pilbara; scattered throughout the Hamersley Range; and south of the Hamersley Range (Armstrong, 2001). The distribution of the Pilbara Leaf-nosed Bat is influenced by the availability of suitable day-time roosts and as such, the species has not been recorded from the Fortescue subregion, which lacks suitable roost caves.

  In the Pilbara, roosts are thought to be restricted to caves formed in gorges where at least semi-permanent water is nearby. Pilbara Leaf-nosed Bats are most often observed in flight over waterholes in gorges, although they are rare even where this habitat is common. Foraging habitat favoured by the Pilbara Leaf-nosed Bat is diverse. Typically, Pilbara Leaf-nosed Bats emerge at dusk from their roosting sites to forage in gorges, small gullies and large watercourses. It is estimated that the Pilbara Leaf-nosed Bat has a nightly foraging range of up to 10 km from their roost.

  This species has not been recorded during previous surveys despite extensive surveys and the presence of apparently suitable habitat. The Pilbara Leaf-nosed Bat was previously known from database searches of the region only with three previous records existing to the east and south of West Angelas. However, two records of this species have been made within the Proposal area during recent surveys (*ecologia* 2014). Records indicate the presence of a foraging individual/s. Given the absence of natural permanent or ephemeral surface water; it's unlikely that this foraging habitat is significant for the Pilbara Leaf-nosed Bat. The timing of calls in the middle of the night and a relatively low number of calls suggest the individual/s have flown into the area to forage from a roost outside the survey area. Potential roosts were searched for during the recent survey within 'major gorge and gully' and 'hilltop, hillslope, ridge or cliff' habitats, no caves were found.

  Threats to the Pilbara Leaf-nosed Bat as a result of this Proposal are limited to loss of potential foraging habitat as a result of clearing. Given the absence of natural permanent or ephemeral surface water, the large foraging range and diverse foraging habitat of this species, it's unlikely that the foraging habitat in the Proposal area is significant for the Pilbara Leaf-nosed Bat. As such, the loss of potential foraging habitat for the Pilbara Leaf-nosed Bat is not expected to adversely affect the conservation status of this species.

- **Fork-tailed Swift (*Apus pacificus*)** - EPBC Migratory, WC Act Schedule 5 (Recorded). The Fork-tailed Swift is a common trans-equatorial migrant throughout mainland Australia, occurring as an exclusively aerial, non-breeding visitor between October and April. In Western Australia the species arrives in the Kimberley in late September, the Pilbara in November and the South-west by mid-December (Johnstone and Storr 1998 in *ecologia* 2014). In Western Australia the Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts, common in the Kimberley and rare elsewhere.

  The Fork-tailed Swift occasionally utilises habitats within the Proposal area for aerial foraging. This species has previously been recorded in the West Angelas region. Observations of significant formations of Fork-tailed Swifts flying at canopy level, actively hunting aerial insects were made during the recent survey following thunderstorms and rainfall on the proceeding days, consistent with the known behaviour of the species.

Threats to the Fork-tailed Swift as a result of this Proposal are limited to loss of potential foraging habitat as a result of clearing. This species is not considered likely to rely on any particular habitat present within the Proposal area. As such, the loss of potential foraging habitat for the Fork-tailed Swift is not expected to adversely affect the conservation status of this species.

- **Western Pebble-mound Mouse (*Pseudomys chapmani*)** - P4 (Recorded from secondary evidence only). The Western Pebble-mound Mouse is endemic to the central and eastern Pilbara and extends into the smaller ranges of the Little Sandy Desert; it has a broad distribution and is considered quite common. Based on the NatureMap database and Rio Tinto data, there are over 850 records of the characteristic mounds constructed by colonies of this species within the Pilbara bioregion. Abandoned pebble mounds have been found in the Gascoyne and Murchison, indicating a recent decline in distribution. This decline is most likely attributable to foxes and exotic herbivores.

  The Western Pebble-mound Mouse inhabits gently sloping hills where the ground is stony with continuous small pebbles and is vegetated by spinifex with a sparse overstorey of eucalypts and scattered shrubs of *Senna, Acacia* and *Ptilotus* spp. This species builds mounds of small stones. In suitable habitats, pebble mounds of this species can be found in large numbers, although not all of these mounds are occupied all of the time. Pebble mounds have been recorded frequently in the West Angelas region during almost all previous surveys. The Western Pebble-mound Mouse was the most frequently recorded fauna species during recent surveys. This species was recorded by secondary evidence (pebble mounds) only, with more than 30 pebble mounds recorded in the Proposal area.

  Threats to the Western Pebble-mound Mouse as a result of this Proposal include habitat loss as a result of clearing. Clearing will include 'footslopes and plain' habitat, which represents preferred habitat for the Western Pebble-mound Mouse and will result in the loss of recorded pebble mounds. However, 'footslopes and plain' habitat is the most abundant habitat recorded (46% of the survey area) and occurs extensively throughout the Hamersley subregion (including in the conservation estate), representing less than 1% of the available habitat for this species. As such, the loss of habitat for the Western Pebble-mound Mouse is not expected to significantly adversely affect the conservation status of this species.

  Threats to the Western Pebble-mound Mouse as a result of this Proposal also include direct mortality of individuals, if present in the Proposal area. Burrowing species are more susceptible to direct mortality. This species shelters in burrow systems below ground during the day. However, this species is commonly recorded within suitable habitat throughout the Hamersley and Chichester subregions of the Pilbara bioregion and as such, any loss of individuals is not expected to adversely affect the conservation status of this species.

Additionally, two conservation significant fauna species were recorded in the West Angelas region and seven species were assessed as having a moderate to high likelihood of occurrence in the West Angelas region. Potential impacts to these species are discussed below:

- **Northern Quoll (*Dasyurus hallucatus*)** - EPBC Endangered, WC Act Schedule 2, Parks and Wildlife Endangered (Moderate likelihood of occurrence). The Northern Quoll was originally recorded across Northern Australia from the Northwest Cape, Western Australia to south-east Queensland; however its abundance has significantly declined in recent years. In the Pilbara, the Northern Quoll is widely distributed and has been recorded from all four subregions. However, consistently low population densities of Northern Quolls are recorded in the eastern Pilbara.

This species was not recorded within the West Angelas region during the recent survey and has not been recorded during previous surveys, the closest record of this species is located approximately 20 km north-east of West Angelas in 2010 (Parks and Wildlife 2013c). Given the level of survey effort, and considering the lack of records from all surveys, it is unlikely that the West Angelas region presently supports a significant Northern Quoll population.

In the Pilbara, the species is considered to favour rocky habitats (e.g. gorges, escarpments, breakaways and mesas) as denning or shelter habitat. Foraging and dispersal occurs through ridges, gullies and drainage line habitats across its range. 'Gorge and gully' habitat which represents suitable denning habitat for this species and 'major drainage system' habitat which represents suitable foraging and dispersal habitat for this species are limited within the Proposal area. 'Hilltop, hillslope, ridge or cliff' habitat which also represents suitable foraging and dispersal habitat for this species is abundant within the Proposal area.

Threats to the Northern Quoll as a result of this Proposal include loss of potential denning habitat ('gorge and gully' habitat) and foraging and dispersal habitat ('major drainage system' and 'hilltop, hillslope, ridge or cliff' habitat) as a result of clearing. Given the extensive occurrence of suitable denning and foraging and dispersal habitat for the Northern Quoll throughout the Hamersley subregion (including in the conservation estate), the large foraging range and diverse foraging habitat of this species, it's unlikely that the potential denning and foraging and dispersal habitat in the Proposal area is significant for the this species. As such, the loss of potential habitat for the Northern Quoll is not expected to significantly adversely affect the conservation status of this species.

Threats to the Northern Quoll as a result of this Proposal also include direct mortality of individuals, if present in the Proposal area. Given the lack of records of individuals of this species (despite the extent of survey work undertaken and the occurrence of suitable denning and foraging and dispersal habitat), the West Angelas region is unlikely to support a significant Northern Quoll population. Transient individuals of this species, if present in the Proposal area may disperse along 'major drainage system' habitat, which is contiguous with Karijini National Park, where significant denning and foraging habitat for the Northern Quoll exists and where this species has been recorded. As such, any loss of individuals is not expected to significantly adversely affect the conservation status of this species.

- **Ghost Bat (*Macroderma gigas*)** - EPBC Vulnerable, WC Act Schedule 3, Parks and Wildlife Vulnerable (Moderate likelihood of occurrence, recorded in the region). The Ghost Bat has a widespread distribution across northern Australia and occurs in all four Pilbara subregions with most of the population occurring in disused mines of the Chichester subregion. In the Hamersley subregion, populations are more widespread and much smaller in size with most occurring in natural roosts. The Pilbara has an estimated population size of 1,300 – 2,000 individuals (Threatened Species Scientific Committee 2016)

  The distribution of Ghost Bats is limited by the availability of roosts that provide suitable conditions. The conditions that may influence the suitability of roosts include; the stability of temperature within the cave (*vs* the external temperature), cave depth, shape and structure (including the presence of multiple chambers) (Baudinette 2000 in Biologic 2016a), the morphology and aspect of the cave entrance, the physical stability of the cave roof and walls (and their propensity to leak water), and the presence of other caves for use as night / feeding roosts nearby (Leitner & Nelson 1967; Hall *et al*. 1997; Armstrong & Anstee 2000; McKenzie & Bullen 2009; Hoyle *et al*. 2001 in Biologic 2016a).

Roosts are generally the primary focus of conservation and / or monitoring (Department of Environment 2015). Ghost Bats have previously been recorded in five caves within 'gorge and gully' habitat in the West Angelas region; four roosts; Caves A1, A2, L2 and L3 to the north of Deposit B and one roost to the north of Deposit F; Cave AA1 (Figure 6-1). Despite previous records from the West Angelas region, Ghost Bats were not recorded during the recent survey, however, owing to the previous records of this species and the presence of potential foraging habitat, it is considered likely to occur within the Proposal area. Potential new roosts were searched for within the survey area, with no new roosts recorded.

Foraging habitat favoured by the Ghost Bat is diverse. This carnivorous predator typically requires a relatively large foraging area (usually containing riparian vegetation), within 2 km of day roosts for hunting of small mammals, birds, reptiles and insects that are common and widespread in the Pilbara.

Threats to the Ghost Bat as a result of this Proposal include loss of potential foraging habitat as a result of clearing. Potential threats to foraging habitat and / or hunting habits are hard to quantify as Ghost Bats hunt over diverse foraging habitats and tend to consume species that are common and widespread in the Pilbara. Given the diverse foraging habitat of this species it's unlikely that the foraging habitat in the Proposal area is significant for the Ghost Bat. As such, the loss of potential foraging habitat for the Ghost Bat is not expected to adversely affect the conservation status of this species.

Threats to the Ghost Bat as a result of this Proposal also include direct mortality of individuals. Ghost bats are known to become entangled in barbed wire due to their low elevation flying pattern (Armstrong and Anstee 2000). The use of barbed wire has been and will continue to be avoided (except those areas where there is a statutory requirement to do so) such that the potential for entanglement is considered negligible. As such, any loss of individuals is not expected to adversely affect the conservation status of this species.

Despite limited threats to the Ghost Bat as a result of this Proposal, the Proponent proposes that the new Ministerial Statement (Appendix 3) include contemporary conditions to protect significant habitat features within the West Angelas region from recognised threats including loss of roosting and foraging habitat, either directly (removal of roosts or vegetation during clearing) or indirectly as a result of mining (blast vibration resulting in damage to roosts or abandonment).

The Proponent shall monitor direct disturbance (clearing) and indirect disturbance (blast vibration resulting in damage to roosts) to ensure that roosts are protected from permanent destruction. Monitoring is expected to confirm, at worst, insignificant damage to roosts. The Proponent shall also monitor the persistence of Ghost Bats (presence / absence) to ensure that disturbance does not result in permanent abandonment. The Ghost Bat is distinctive in being very much larger than any other cave dwelling bat in the region, and is easily identified. Scats and middens are also distinctive for this species. Monitoring results are expected to show, at worst, temporary abandonment of roosts.

- **Pilbara Olive Python (*Liasis olivaceus barroni*)** - EPBC Vulnerable, WC Act Schedule 3, Parks and Wildlife Vulnerable (Moderate likelihood of occurrence). The Pilbara subspecies of the Olive Python is endemic to Western Australia. The known distribution of the Pilbara Olive Python coincides roughly with the Pilbara bioregion, where it is widespread, distributed throughout the Burrup Peninsula, the Hamersley and Chichester Ranges, parts of the eastern Pilbara and Barlee Range Nature Reserve. There are 164 records of this species within the Pilbara bioregion on NatureMap (Parks and Wildlife 2013c).

The Pilbara Olive Python was not recorded within the West Angelas region during the recent survey and has not been recorded during previous surveys however this species has been recorded during three previous surveys within 50 km of the survey area, with the closest record of this species located only approximately 1 km north-east of West Angelas (Parks and Wildlife 2013c).

Habitat for the Pilbara Olive Python includes gorges, escarpments and rocky outcrops with natural permanent or ephemeral surface water where it may hunt and / or seek shelter in caves, beneath boulders, in pools of water and occasionally in trees overhanging water (DoE 2015b). However, the species may have a large home range and so, may also be recorded in rocky habitats some distance from surface water features, especially during cooler months.

'Gorge and gully' habitat which represents suitable habitat for this species and 'major drainage system' habitat which represents suitable dispersal habitat for this species are limited within the Proposal area.

Threats to the Pilbara Olive Python as a result of this Proposal include loss of potential habitat ('gorge and gully' habitat) and dispersal habitat ('major drainage system') as a result of clearing. 'Gorge and gully' and 'major drainage system' habitat which represent suitable habitat for this species is limited within the Proposal area. Given the absence of natural permanent or ephemeral surface water and the extensive occurrence of suitable habitat (with natural permanent or ephemeral surface water) for the Pilbara Olive Python throughout the Hamersley subregion (including in the conservation estate), it's unlikely that the potential habitat in the Proposal area is significant for this species. As such, the loss of potential habitat for the Pilbara Olive Python is not expected to adversely affect the conservation status of this species.

Threats to the Pilbara Olive Python as a result of this Proposal also include direct mortality of individuals, if present in the Proposal area. The lack of records of individuals of this species (despite the occurrence of suitable habitat) could reflect difficulties in recording this species rather than the scarcity of pythons, as the species is not easy to survey and is largely nocturnal however the West Angelas region is unlikely to support a significant Pilbara Olive Python population. Transient individuals of this species, if present in the Proposal area may disperse along 'major drainage system' habitat, which is contiguous with Karijini National Park, where significant habitat with natural permanent or ephemeral surface water for the Pilbara Olive Python exists. As such, any loss of individuals is not expected to adversely affect the conservation status of this species.

- **Rainbow Bee-eater (*Merops ornatus*) -** EPBC Migratory, WC Act Schedule 5 (High likelihood of occurrence). This migratory species has a broad distribution across Australia, except for the arid interior, and has over 11,000 records within Western Australia on the NatureMap database. This species is very common and widespread in the Pilbara bioregion, occurring in a wide range of habitats including open woodlands or lightly wooded grassland, preferring areas near natural permanent or ephemeral surface water. This species also requires sandy substrates commonly found within 'major drainage system' habitat, to build nest burrows.

  The Rainbow Bee-eater was not observed, and no evidence of nesting was recorded within the West Angelas region during the recent survey. However, this species has previously been observed foraging in suitable habitats within the region and it is considered highly likely to occur in suitable habitats within the Proposal area.

Threats to the Rainbow Bee-eater as a result of this Proposal are limited to loss of foraging and potential nesting habitat ('major drainage system' habitat) as a result of clearing. 'Major drainage system' habitat which represents suitable nesting habitat for this species is limited within the Proposal area. Given the extensive occurrence of suitable foraging and potential nesting habitat for the Rainbow Bee-eater throughout the Hamersley subregion (including in the conservation estate), it's unlikely that the potential habitat in the Proposal area is significant for this species. As such, the loss of foraging and potential nesting habitat for the Rainbow Bee-eater is not expected to significantly adversely affect the conservation status of this species.

- **Grey Falcon (*Falco hypoleucos*)** - WC Act Schedule 3, Parks and Wildlife Vulnerable (Moderate likelihood of occurrence). The Grey Falcon is a rare species endemic to Australia, typically sparsely distributed across the arid and semi-arid interiors. It has a low density and broad distribution in the Pilbara with an estimated population size of less than 1,000 individuals and only an estimated 200 to 350 breeding pairs (Garnett *et al.* 2011). As the distribution of this species is scarce over an extremely large area, sightings of this species are very uncommon.

  The Grey Falcon was not found within the West Angelas region during the recent survey however, this species has been recorded during four previous surveys of the region (Parks and Wildlife 2013c). The lack of records of individuals of this species (despite the occurrence of suitable hunting habitat) likely reflects the nomadic nature of the species. It is considered only moderately likely to occur within the Proposal area.

  The grey falcon tends to have a distribution centred on ephemeral or permanent drainage lines (Garnett *et al.* 2011). This species hunts in a variety of arid habitats ranging from wooded drainage systems through to open spinifex plains; including open woodlands and open acacia shrubland, hummock and tussock grasslands and low shrublands. The Grey Falcon is unlikely to nest in any natural habitats present within the Proposal area.

  Threats to the Grey Falcon are not well understood but are thought to include habitat degradation as a result of clearing for agriculture, grazing by introduced herbivores and introduction of watering points that may have favoured the more mesic-adapted peregrine falcon (Garnett *et al.* 2011).

  Threats to the Grey Falcon as a result of this Proposal are limited to loss of potential hunting habitat ('major drainage' habitat) as a result of clearing. The relatively small representation of suitable hunting habitat (ephemeral or permanent drainage habitat) suggests that there is unlikely to be a permanent or semi-permanent presence of the Grey Falcon. As such, the loss of potential hunting habitat for the Grey Falcon is not expected to adversely affect the conservation status of this species

- **Peregrine Falcon (*Falco peregrinus*)** - WC Act Schedule 7, Parks and Wildlife 'Other Specially Protected Fauna' (Moderate likelihood of occurrence). The Peregrine Falcon has an almost cosmopolitan distribution throughout Australia, except for the arid interior. The species is considered to be moderately common in the Stirling Range, uncommon in the Kimberley, Hamersley and Darling Ranges, and rare or scarce elsewhere.

  The Peregrine Falcon was not found within the West Angelas region during the recent survey, however, this species has been recorded during two previous surveys of the region. NatureMap lists three additional records within 100 km of the survey area (Parks and Wildlife 2013c). It is considered only moderately likely to occur within the Proposal area.

This species inhabits a wide range of habitats, including cliffs along coasts, rivers and ranges, and around wooded watercourses and lakes. Cliff edges within the 'hilltop, hillslope, ridge and cliff' habitat may provide potential habitat for nesting. Suitable habitat for hunting is also present within the survey area.

Threats to the Peregrine Falcon as a result of this Proposal are limited to loss of potential nesting habitat ('hilltop, hillslope, ridge or cliff' habitat) as a result of clearing. 'Hilltop, hillslope, ridge or cliff' habitat is the second most abundant habitat recorded (30% of the survey area). Given the extensive occurrence of suitable nesting habitat for the Peregrine Falcon throughout the Hamersley subregion (including in the conservation estate), the large foraging range and diverse foraging habitat of this species, it's unlikely that the potential nesting habitat in the Proposal area is significant for the Peregrine Falcon. As such, the loss of potential nesting habitat for the Peregrine Falcon is not expected to adversely affect the conservation status of this species.

- **Blind Snake (*Ramphotyphlops ganei*)** - P1 (Moderate likelihood of occurrence). The Blind Snake is distributed over much of the Pilbara region; however it is poorly collected. The few records of this species could be due to the elusive nature of this species and difficulties in successfully sampling individuals despite the species potentially being present or a naturally low abundance despite their wide distribution in the region.

  The Blind Snake was not found within the West Angelas region during the recent survey and has not been recorded during previous surveys, however, this species has been recorded from 11 locations during previous surveys within 100 km of the survey area (Parks and Wildlife 2013c). It is considered only moderately likely to occur within the Proposal area.

  This species occupies a range of habitats. Rocky 'gorge and gully' (and 'Mulga woodland') habitats represent core habitat for this species within the Pilbara bioregion.

  Threats to the Blind Snake as a result of this Proposal include loss of potential habitat ('gorge and gully' habitat) as a result of clearing. 'Gorge and gully' habitat which represents suitable habitat for this species is limited within the Proposal area. Given the extensive occurrence of suitable habitat for the Blind Snake throughout the Hamersley subregion (including in the conservation estate), it's unlikely that the potential habitat in the Proposal area is significant for this species. As such, the loss of potential habitat for the Blind Snake is not expected to adversely affect the conservation status of this species.

  Threats to the Blind Snake as a result of this Proposal also include direct mortality of individuals, if present in the Proposal area. Given the lack of records of this species from the region and the extensive distribution of this species in suitable habitat throughout the Pilbara bioregion, the West Angelas region is unlikely to support a significant Blind Snake population and as such, any loss of individuals is not expected to adversely affect the conservation status of this species.

- **Pilbara Barking Gecko (*Underwoodisaurus seorsus*)** - P2 (Moderate likelihood of occurrence, recorded in the region,). The Pilbara Barking Gecko is a Hamersley Range endemic, classified as P2 based on its relatively small distribution. This species is known from 14 records over a distance of approximately 240 km in gorge and ridge habitats of the Hamersley Range on NatureMap (Parks and Wildlife 2013c). It is unknown whether its distribution is continuous between these areas or if it occurs as a series of isolated populations. Given the amount of suitable habitat, it is considered very likely that there are additional occurrences of this species within its known range (including in the conservation estate).

However, it's considered unlikely that its distribution is much larger than its known range and probably does not extend beyond the Hamersley subregion.

One individual Pilbara Barking Gecko was recorded within the West Angelas region during the recent survey; this species has also been recorded during previous surveys within 20 km of the survey area (Parks and Wildlife 2013c).

The Pilbara Barking Gecko was recorded within 'mesa' habitat. 'Gorge and gully' and 'hilltop, hillslope, ridge and cliff' habitats also represent potential habitat for this species within the Pilbara bioregion. It is considered moderately likely to occur in suitable rocky habitat within the Proposal area.

Threats to the Pilbara Barking Gecko as a result of this Proposal include loss of potential habitat as a result of clearing. 'Mesa' habitat, which represents preferred habitat for the Pilbara Barking Gecko, was not recorded within the Proposal area. 'Gorge and gully' habitat which represents potential habitat for this species is limited within the Proposal area. 'Hilltop, hillslope, ridge and cliff' habitat which also represents potential habitat for this species is the second most abundant habitat recorded (30% of the survey area). Given the extensive occurrence of suitable habitat for the Pilbara Barking Gecko throughout the Hamersley subregion (including in the conservation estate), it's unlikely that the potential habitat in the Proposal area is significant for this species. As such, the loss of potential habitat for the Pilbara Barking Gecko is not expected to adversely affect the conservation status of this species.

Threats to the Pilbara Barking Gecko as a result of this Proposal also include direct mortality of individuals, if present in the Proposal area. Given the lack of records of this species, the West Angelas region is unlikely to support a significant Pilbara Barking Gecko population and as such, any loss of individuals is not expected to adversely affect the conservation status of this species.

- **Short-tailed Mouse (*Leggadina lakedownensis*) - P4** (High likelihood of occurrence). The Short-tailed Mouse is distributed across northern Australia, but records have been sporadic.

  The Short-tailed Mouse was not found within the West Angelas region during the recent survey however, this species has been recorded within the region previously. NatureMap lists 11 records from 1997; one located within the survey area and the other 10 within 1 km of the survey area (Parks and Wildlife 2013c). Previous records of this species suggest although not recorded during the recent survey, it is considered likely to occur within the Proposal area.

  This species occupies a diverse range of habitats. The Cracking Clay habitat represents core habitat for this species within the Pilbara bioregion. If a population of this species was present in the West Angelas region at the time of surveying, it is expected that it would have been recorded from Cracking Clay habitats. Populations of this species area known to fluctuate and seasonal conditions at the time of the recent survey may explain the lack of recent records of this species despite the occurrence of core habitat.

  Threats to the Short-tailed Mouse as a result of this Proposal include loss of habitat (spinifex and tussock grassland on 'cracking clay' habitat, which represents preferred habitat for the Short-tailed Mouse) as a result of clearing. 'Cracking clay' is limited within the Proposal area, representing less than 3.5% of the 'cracking clay' habitat mapped throughout the West Angelas region. Given the extensive local occurrence of 'cracking clay' habitat throughout the West Angelas region, it's unlikely that 'cracking clay' habitat in the survey area is significant for the Short-tailed Mouse. As such, the loss of habitat for the Short-tailed Mouse is not expected to adversely affect the conservation status of this species.

Threats to the Short-tailed Mouse as a result of this Proposal also include direct mortality of individuals, if present in the Proposal area. Burrowing species are more susceptible to direct mortality. This species shelters in simple, single-chambered burrows during the day. However, any loss of individuals is not expected to adversely affect the conservation status of this species.

Given their potential to be restricted at small spatial scales, locally endemic SRE species are generally at greater risk of changes in conservation status or local population extinctions than other, more widely distributed fauna. This risk can be increased by localised threatening processes including clearing of habitat (EPA 2009).

Eight potential SRE species were also of relevance to the Proposal: two species of spider; one species of scorpion; one species of pseudoscorpion and four species of isopod.

The EPA recognises that conclusively determining the conservation significance of potential SRE species is often difficult (EPA 2016) and as such, assessment of the extent of potential habitat may be adopted for situations where surveys have been completed and potential SRE species are represented by one or few specimens recorded only from one or few locations to infer the likelihood that potential SRE species are restricted in distribution. The eight potential SRE species have been all recorded in habitats that are widespread and relatively common locally and in the Pilbara bioregion. All of the specimens were collected from within 'footslope and plain' and 'mixed Acacia woodland' habitats, which are two of the most extensive habitats recorded and occur extensively throughout the Pilbara bioregion.

Localised clearing of habitat has the potential to change the conservation status of locally endemic SRE species, however, given the broad availability of continuous 'footslope and plain' and 'mixed Acacia woodland' habitats, it is unlikely that the potential SRE species collected are restricted to the Proposal area and as such, the conservation status of the potential SRE species is unlikely to be adversely affected by the additional clearing, and removal of potential SRE habitat associated with this Proposal.

6.5 Mitigation and Predicted Outcomes

Mitigation strategies to address the above potential impacts and predicted outcomes are presented in Table 6-2.

Table 6-2: Terrestrial Fauna: Assessment of Potential Impact, Mitigation and Outcome

Potential impacts	Mitigation to address potential impacts	Predicted outcome
EPA Objective: *To protect terrestrial fauna so that biological diversity and ecological integrity is maintained.*		
Loss of potential fauna habitat as a result of clearing: Clearing will include six potential fauna habitats: 'footslope or plain'; 'hilltop, hillslope; ridge or cliff'; 'mixed Acacia woodland'; 'cracking clay'; 'major gorge and gully'; and 'major drainage'. Some of these represent habitat for conservation listed species recorded in the region.	The following key management strategies will continue to be implemented to manage the potential loss of potential fauna habitat (including habitats for conservation significant fauna species) as a result of clearing: **Avoid:** One occurrence of approximately 15.5 ha of cracking clay habitat overlies Deposit D and as such, avoidance is not possible. The Proposal has been designed to avoid disturbance to other cracking clay habitats. Deposit C intersects the floodplain of the Turee Creek East tributary and as such, avoidance of 'major drainage' habitat is not possible. **Minimise:** Backfilling of pits during operations is proposed, rather than all waste being stored in external waste dumps. The Proponent proposes that clearing be subject to a new Ministerial Statement (Appendix 3). Schedule 1 of the new Ministerial Statement shall authorise: • Clearing of no more than 12,200 ha within a 26,400 ha Mine Development Envelope.	This Proposal is expected to result in the unavoidable loss of potential fauna habitat (including habitats for conservation significant fauna species) as a result of clearing. None of the habitats recorded are restricted to the Proposal area. The six potential fauna habitats are relatively common in the West Angelas region and none of these habitats are unique to the West Angelas region. Most of these habitats are also relatively common throughout the Hamersley subregion, including within Karijini National Park. As such, the loss of habitats is not expected to adversely affect the conservation status of species (including species of elevated conservation significance) occurring or assessed as having a moderate to high likelihood of occurrence in the region. Residual impacts will be addressed via the provision of an offset in accordance with EPA requirements. Therefore, the Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	Rehabilitate: The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans.* The Closure Plan (Appendix 11) includes a Closure Objective to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the final land use. **Offset:** The Proponent also proposes the provision of an environmental offset ($750 per hectare) for the unavoidable clearing of vegetation. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA).*	
Ghost Bats (*Macroderma gigas*) have not been recorded roosting in caves within the Proposal area. However, Ghost Bats have previously been recorded roosting in five caves in the West Angelas region; four roosts; Caves A1, A2, L2 and L3 to the north of Deposit B and one cave to the north of Deposit F; Cave AA1. Rio Tinto has well established strategies for the protection of these habitat features. These strategies will continue to be implemented. Given the significance of these habitat features within the West Angelas region, contemporary conditions to protect Ghost Bat roosts are included in the proposed new Ministerial Statement (Appendix 3).	**Avoid:** Schedule 1 of the new Ministerial Statement shall ensure that there is no disturbance to the Ghost Bat roost; Cave AA1. The contemporary conditions of the new Ministerial Statement shall also require the Proponent to avoid the use of barbed wire. **Minimise:** Roosts are generally the primary focus of conservation and / or monitoring. The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement an EMP (Appendix 4) to *minimise disturbance to other Ghost Bat roosts; Caves A1, A2, L2 and L3*.	This Proposal is not expected to result in any potential impacts to Ghost Bats or significant habitat features for Ghost Bats within the West Angelas region. Therefore, the Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	The Proponent proposes to monitor direct disturbance (clearing) and indirect disturbance (blast vibration resulting in damage to roosts) to ensure that roosts are protected from permanent destruction. The Proponent also proposes to monitor the persistence of Ghost Bats (presence / absence) to ensure that disturbance does not result in permanent abandonment. Monitoring is expected to confirm, at worst, insignificant damage to roosts. The EMP proposes that disturbance within 100m of Ghost Bat roost; Cave AA1 or vibration levels exceeding threshold criteria indicate that the environmental objectives are not being met. Monitoring results are also expected to show temporary abandonment of roosts. The EMP proposes that permanent abandonment of roosts indicates that the environmental objectives are not being met. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA).*	
Loss of individuals as a result of clearing: Clearing is expected to result in the loss of some individuals of the following conservation significant fauna species: • Three Threatened fauna: the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*); Ghost Bat (*Macroderma gigas*); and Fork-tailed Swift (*Apus pacificus*) and two Priority fauna: the Pilbara Barking Gecko (*Underwoodisaurus seorsus*); and Western Pebble-mound Mouse (*Pseudomys chapmani*) recorded in the region.	The Proposal is expected to result in the unavoidable loss of some individuals (including individuals of elevated conservation significance) as a result of clearing. However, any loss of individuals is not expected to significantly adversely affect the conservation status of this species. **Minimise:** The Proponent proposes that clearing be subject to a new Ministerial Statement (Appendix 3). Schedule 1 of the new Ministerial Statement shall authorise:	Any loss of individuals is not expected to significantly adversely affect the conservation status of these species. Therefore, the Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
• Three Threatened fauna: the Northern Quoll (*Dasyurus hallucatus*), Pilbara Olive Python (*Liasis olivaceus barroni*) and Rainbow Bee-eater (*Merops ornatus*) and four Priority fauna: the Grey Falcon (*Falco hypoleucos*), Peregrine Falcon (*Falco peregrinus*), Blind Snake (*Ramphotyphlops ganei*) and Short-tailed Mouse (*Leggadina lakedownensis*) assessed as having a moderate to high likelihood of occurrence within the region. • Eight potential SRE species: two species of mygalomorph spider; one species of scorpion; one species of pseudoscorpion and four species of isopod.	• Clearing of no more than 12,200 ha within a 26,400 ha Mine Development Envelope. **Rehabilitate:** The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans.* The Closure Plan (Appendix 11) includes a Closure Objective to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the final land use. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA).*	

7. SUBTERRANEAN FAUNA

Subterranean fauna tend to be highly specialised to, and obligate dwellers of, subterranean habitats. Subterranean fauna have been recorded from Western Australia since the 1940s. They are widespread in the Pilbara region and are generally considered to comprise two main categories (Humphreys 2000a in Biota 2004):

- Troglofauna: obligate terrestrial subterranean fauna occurring in underground cavities, fissures and interstitial spaces above the water table. Troglofauna are divided into three groups based on their life histories: troglobites, which are obligate dwellers of subterranean habitats; troglophiles, which are facultative species that live and reproduce underground but that are also found in similar microhabitats on the surface; and trogloxenes, which are principally surface species that regularly inhabit underground caves and cavities for refuge (Sket 2008). A fourth group; accidentals, wander into cave systems but cannot survive there (Howarth 1983 in *ecologia* 2013b).

  A species is considered truly troglobitic if it displays morphological characteristics that appear to restrict it to subterranean habitats (Howarth 1983). These include a significant reduction or a complete loss of eyes, pigmentation and wings, as well as development of elongated appendages, slender body form and, in some species, a lower metabolism. Behavioural adaptations such as lack of a circadian rhythm (24 hour biological cycle) are also characteristic of true troglobites (*ecologia* 2013b).

- Stygofauna: obligate groundwater-dwelling, aquatic fauna that occupy the interstitial spaces, vugs and fissures in alluvial, karstic or fractured rock aquifers. This environment is devoid of light, may have restricted available space and relatively constant temperature. These species have evolved unique features such as a lack of pigmentation, elongated appendages, filiform body shape (worm like) and reduced or absent eyes (*ecologia* 2013b).

  Stygofauna, like troglofauna, are divided into three groups: stygobites which are obligate dwellers of groundwater and complete their entire life in this environment; stygophiles which inhabit both surface and subterranean aquatic environments, but are not necessarily restricted to either; and stygoxenes which are principally surface species with occasional presence in subterranean waters.

Higher levels of endemicity have been found to be characteristic of subterranean fauna (Biota 2004). It is estimated that 70% of Pilbara stygofauna species are SREs (Eberhard *et al*. 2009). The proportion of SRE troglofauna in the Pilbara is likely to be significantly higher, given that the known ranges of many troglofauna are smaller than those of stygofauna (Lamoreux 2004). The high levels of endemism that have been found to be characteristic of subterranean fauna may be due, in part, to poor dispersal capabilities. The dispersal of fauna inhabiting subterranean environs is extremely slow and limited by the geological formation in which they occur (Marmonier *et al*. 1993; Gibert *et al*. 1994 in Biota 2004).

It is unclear at present whether the occurrence of subterranean fauna as documented by recent surveys in Western Australia reflect the true distribution of the fauna or whether this is more a function of the current limitations on sampling and understanding of subterranean systems (Biota 2004). However, it is considered unlikely that the species currently known only from a few records do, in fact, have such restricted ranges. The known ranges of most 'restricted' species are thought likely to be an underestimate given that information on the range of subterranean fauna species is limited to the point where they are known to occur.

This Section describes the subterranean fauna that occur within the Proposal area and the potential subterranean fauna habitats, provides details regarding the potential impacts to those subterranean fauna from the proposed mining and dewatering that form part of this Proposal and management to ensure that the Proposal meets the EPA's objectives for subterranean fauna.

7.1 EPA Objective

The EPA applies the following objective from the *Statement of Environmental Principles, Factors and Objectives* (2016) in its assessment of proposals that may affect subterranean fauna:

> *To protect subterranean fauna so that biological diversity and ecological integrity is maintained.*

7.2 Policy and Guidance

The following EPA guidelines and guidance have been considered in the assessment of subterranean fauna with respect the above EPA objective:

- EPA *Statement of Environmental Principles, Factors and Objectives* (2016).
- EPA *Environmental Factor Guideline: Subterranean Fauna* (2016).
- EPA Technical Guidance: *Subterranean Fauna Survey* (2016).
- EPA Technical Guidance: *Sampling Methods for Subterranean Fauna* (2016).

7.3 Receiving Environment

Subterranean fauna surveys have been undertaken across the West Angelas region since 1998. Table 7-1 summarises the key subterranean fauna surveys relevant to this Proposal.

Previous surveys have also been undertaken in the region at Wonmunna and Angelo River as well as BHPBIO's Mining Area C, South Flank and Coondewanna / Mudlark (Biologic 2016b).

Table 7-1: Summary of Supporting Subterranean Fauna Studies

Report Title Author (Year)	Summary and guidance	Appendix
West Angelas Iron Ore Project Stygofauna Assessment Survey. ecologia (1998)	A baseline survey of stygofauna present in the West Angelas borefield and the then proposed Turee Creek B borefield was completed in 1998. A total of 44 bores from the West Angelas and Turee Creek B borefields were successfully sampled for stygofauna. Stygofauna were recovered from six of the bores sampled (WB32, WB41, WB51, WB54, WB58 and a pastoral bore). A review of the potential stygofauna habitat in the West Angelas and Turee Creek B borefields suggested that, while calcrete was known to be an important habitat for stygofauna (Marmonier *et al*. 1993, Eberhard 1998), the majority of the calcretes in the area were unsaturated and it was instead proposed that the stygofauna were utilising secondary habitats in other geologies. It was thought that stygofauna were utilising fractures and weathered zones in the pockets of compact, non-permeable dolerite rocks as habitat. These habitats were patchily distributed, which led to the patchy distribution of stygofauna within the area.	-
West Angelas Iron Ore Project Stygofauna Assessment Survey. ecologia (2002)	A stygofauna monitoring survey was undertaken in March 2002. A total of 12 bores (a subset of the bores from the baseline survey; ten from the West Angelas borefield and two from the Turee Creek B borefield) were successfully re-sampled for stygofauna. Stygofauna were recovered from six of the bores sampled (WOB9, WOB12, WB33, WB40, WB51, WB54). A review of the presence of stygofauna in the West Angelas and Turee Creek B borefields suggested that stygofauna were present in some bores where they had not been recorded in the 1998 survey (WOB9, WOB12, WB33 and WB40) and conversely, were absent from some bores where they had been recorded in the 1998 survey (revealing inherent difficulty in sampling stygofauna abundance and diversity). A review of the potential stygofauna habitat in the West Angelas and Turee Creek B borefields suggested that most stygofauna were recovered from the shallow Jeerinah Formation and further, that drawdown of the Jeerinah Formation could potentially isolate stygofauna populations in confined aquifers since groundwater in the this formation can only flow in fractures and fissures of impermeable Dolerite.	-
West Angelas Stygofauna Survey. Biota (2003)	A stygofauna monitoring survey was undertaken in November 2003. A total of 24 bores (a subset of the bores from the baseline survey) were successfully re-sampled for stygofauna. Stygofauna were recovered from six of the bores sampled. A review of the presence of stygofauna and potential stygofauna habitat in the West Angelas and Turee Creek B borefields suggested that, of the bores that yielded stygofauna, WB41, WB51 and WB54 in the West Angelas borefield have consistently had the most abundant and diverse collections. These three bores were of the greatest potential significance and sampled optimal stygofauna habitat; they are open to similar geology types, consisting primarily of fractured dolerites and shales, with some shallow calcretes. Other bores where stygofauna have been collected included WOB12 (cased with slotting open primarily to alluvial geology); WOB1 and WOB9 (gravelly pisolite and goethite); WOB5 (BIF and jaspilite); and WOB22 (fractured volcanics / dolerite) in the Turee Creek B borefield. Stygofauna abundance was low in these bores and it is likely that these do not intersect optimal stygofauna habitat compared to the geology intersected by WB41, WB51 and WB54.	-

Report Title Author (Year)	Summary and guidance	Appendix
West Angelas Expansion: Deposits E and F Subterranean Fauna Survey. Biota (2004)	A single phase stygofauna survey was completed in 2008 in accordance with the following: • EPA Guidance Statement No. 54 - *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (EPA 2003). A total of 20 bores; 12 bores in the Deposit E aquifer and eight bores in the Deposit F aquifer were successfully sampled for stygofauna. No stygofauna were recorded from any of the bores sampled. The geology was described as not overly prospective for stygofauna; a geological review suggested that the superficial alluvials were the only geological unit present that consistently provided habitat for stygofauna in the inland Pilbara, however, superficial alluvials in the survey area were unsaturated (given that the depth to the water table is approximately 100m below the ground level) and as such, did not provided suitable habitat for stygofauna. The deeper, saturated (below the water table) geological units (specifically, the banded iron formation) did not typically support stygal communities (Biota unpublished data, Humphreys 2000b in Biota 2004).	-
West Angelas and Deposit A Stygofauna Survey. Biota (2008)	A single phase stygofauna survey was completed in 2008 in accordance with the following: • EPA Guidance Statement No. 54 - *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (EPA 2003). A total of 15 bores in the Deposit A aquifer were successfully sampled for stygofauna. No stygofauna were recorded from any of the bores sampled. The Deposit A aquifer was described as variably permeable and is surrounded by low permeability material. The absence of stygofauna collected from this aquifer was considered consistent with the confined and disconnected nature of this aquifer.	-
West Angelas Stygofauna Survey. Biota (2012)	A single phase stygofauna survey was completed in 2012 in accordance with the following: • EPA Guidance Statement No. 54 - *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (EPA 2003); and • EPA Technical Appendix to Guidance Statement No. 54: *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (EPA 2007). A total of 12 bores; two from the Deposit A aquifer and ten from the Turee Creek B borefield were successfully sampled for stygofauna. No stygofauna were recorded from any of the bores sampled. No stygofauna have been collected from within the confined aquifer at Deposit A to date (including prior to dewatering of the deposit). The absence of stygofauna collected from this aquifer was considered consistent with the confined and disconnected nature of this aquifer. Previous sampling of the Turee Creek B borefield yielded 30 stygofauna specimens; twenty-two of those specimens were recorded from a single site during 2002 (which yielded no stygofauna during 2003). It was impossible to conclusively determine whether the absence of stygofauna from the Turee Creek B borefield in 2012 represented a natural fluctuation in stygal populations or a project-induced impact.	-

Report Title Author (Year)	Summary and guidance	Appendix
Greater West Angelas Subterranean Fauna Assessment. *ecologia* (2013)	A single phase (Phase 1) subterranean fauna (troglofauna and stygofauna) survey was completed in 2012 in accordance with the following: • EPA Guidance Statement No. 54 - *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (EPA 2003); and • EPA Technical Appendix to Guidance Statement No. 54: *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (EPA 2007). A total of 91 drill holes from across the region were successfully sampled for troglofauna. Ten troglobitic species were recorded. The majority of troglobitic species recorded were collected as singletons and doubletons, with only the Blattodea specimens (*Nocticola* sp. indet.) and Coleoptera specimens (*Anillini* sp. indet.) collected in higher numbers (13 and 26, respectively). Six of the recorded species (*Nocticola* sp. indet., *Prethopalpus* sp. indet., *Pseudodiploexochus* sp. nov., *Cormocephalus* CH1003, *Atelurinae* sp., indet., Anillini sp.indet.) were considered likely to have restricted distribution ranges and four (*Hydrobiomorpha* sp. indet., *Embioptera* sp. indet., Meenoplidae sp. indet., Trogiidae sp. indet.) were potentially restricted. Only spiders of the genus *Prethopalpus* and centipedes from the genus *Cormocephalus* had been recorded previously in the area, with the remaining eight genera/families representing new records. In addition, the spider *Prethopalpus* 'sp indet.' and the isopod *Pseudodiploexochus* 'sp. nov.' (the first ever to be recorded in the Pilbara region at the time of the survey) represented new species. The centipede *Cormocephalus* 'HCI003' was the first eyeless scolopendrid specimen recorded at the time of the survey. There was little commonality of troglofauna species across different geological units, suggesting potentially isolated species assemblages. However, this was considered likely to be an artefact of a small sample size. Stygofauna sampling was limited to four accessible bores in Deposit F, which yielded no stygofauna specimens.	**Appendix 8**
West Angelas Deposits C, D and G Subterranean Fauna Survey. Biologic Environmental Survey (2016)	Desktop review and single phase (Phase 2) subterranean fauna (troglofauna and stygofauna) survey was completed in 2016 in accordance with the following: • EPA Technical Appendix to Guidance Statement No. 54: *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (EPA 2007); and • EAG 12: *Environmental Assessment Guideline for consideration of subterranean fauna in environmental impact assessment in Western Australia* (EPA 2013b). • (EAG 12 supersedes EPA Guidance Statement No. 54: *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (2003)). The results of this survey (as amended by the *Results of DNA analysis of subterranean fauna collected at West Angelas Deposits C, D and G,* Biologic 2017) are outlined below.	**Appendix 9**

Report Title Author (Year)	Summary and guidance	Appendix
Results of DNA analysis of subterranean fauna collected at West Angelas Deposits C, D and G (Addendum to West Angelas Deposits C, D and G Subterranean Fauna Survey) Biologic Environmental Survey (2017)	Genetic identification (DNA sequencing) and comparison of subterranean fauna (troglofauna and stygofauna) taxa collected during the West *Angelas Deposits C, D and G Subterranean Fauna Survey* (Biologic 2016b).	**Appendix 9**

Over the span of the historical surveys, troglofauna were only recovered in the *ecologia* 2013 survey. The survey yielded ten potentially troglobitic species across the region. The majority of the potentially troglobitic species recorded were collected as singletons, i.e. known only from a single individual at a single location. However, the range of these 'restricted' species was considered likely to be an underestimate. Only four of the previously recorded potentially troglobitic species are associated with this Proposal (Table 7-2).

Table 7-2: Previously recorded potentially troglobitic species associated with this Proposal

Family	Species	Location	Subterranean status	SRE Status
Coleoptera	*Anillini* sp. indet.	C	Troglobite	'Likely' SRE
	Hydrobiomorpha sp. indet.	D	Potential troglobite	Potential SRE
Hemiptera	Meenoplidae sp. indet.	G, H	Potential troglobite	Potential SRE
Thysanura	Atelurinae sp. indet.	D	Potential troglobite	Potential SRE

Over the span of the historical surveys, stygofauna were recovered from the West Angelas and Turee Creek B borefields but not from the deposit aquifers. Potentially stygobitic species included: amphipods; bathynellaceans; copepods; oligochaetes; and ostracods. The majority of potentially stygobitic species were collected in low abundance. No records of potentially stygobitic species associated with the Proposal exist due to the absence of previous stygofauna sampling in the current deposits.

Biologic Environmental Survey (Biologic) most recently conducted a single phase subterranean fauna assessment in 2016, covering a survey area of approximately 9,000 ha. The current survey was conducted in accordance with EPA Technical Appendix to Guidance Statement No. 54: *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (2007) and EAG 12: *Environmental Assessment Guideline for consideration of subterranean fauna in environmental impact assessment in Western Australia* (2013) (which supersedes EPA Guidance Statement No. 54 - *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (2003)). The Biologic (2016) report is provided as Appendix 9.

Subterranean fauna were recorded from 22 out of the 100 holes sampled: nine holes within and near Deposit C; 10 holes within and near Deposit D; and three holes within and near Deposit G. The fauna comprised 28 morphospecies: 14 troglofauna species and 14 stygofauna species, including worms (four morphospecies), crustaceans (12 morphospecies), arachnids (five morphospecies), hexapods (five morphospecies), and myriapods (two morphospecies). There were also a number of higher-level indeterminate copepod specimens that could not be allocated to any of the other morphospecies based on current information.

DNA sequencing and comparisons with pre-existing regional sequences was also conducted to determine whether the species recorded represented species also recorded from elsewhere in the region. Additional species were revealed within the Amphipoda (*Kruptus* `AMP045`, Paramelitidae `AMP036`, and *Maarka* `AMP037`), Haplotaxida (Enchytraeidae `OLE026`, `OLE028` and `OLE029`), Oligochaeta (*Pristina longiseta* and Phreodrillidae `OLP012`), and Symphyla (Scutigerellidae `SYM028` and `SYM029`).

Species that were found to align genetically to previously recorded species or lineages that are known to occur widely in the Pilbara are considered to be at negligible risk of impact.

7.3.1 Conservation Significant Subterranean Fauna Species

None of the subterranean fauna species or assemblages recorded are currently listed as threatened species, TECs or PECs however, due to taxonomic uncertainty for the majority of subterranean fauna in the Pilbara region, there are thought to be many conservation significant species and communities that do not appear on threatened species lists. Recent research has suggested that relatively localised impacts (such as mining) have the potential to significantly change the conservation status of locally endemic subterranean fauna species.

Troglofauna

The following eight troglofauna species are considered to be potentially at risk from this Proposal (Table 7-3, Figure 7-1):

- Isopoda: Armadillidae sp. `ISA049` (within Deposit D);
- Symphyla: Scutigerellidae sp. `SYM028` (within Deposit C);
- Symphyla: Scutigerellidae sp. `SYM029` (within Deposit C);
- Coleoptera: Anillini `sp. indet.` (within Deposit C (ecologia 2013b)); and
- Coleoptera: *Hydrobiomorpha* `sp. indet.` (within Deposit D (ecologia 2013b)).
- Thysanura: Atelurinae `sp. indet.` (within Deposit D (*ecologia* 2013b), beyond Deposit D).
- Collembola: Cyphoderidae `sp. indet.` (within Deposit C).
- Hemiptera: Meenoplidae `sp. indet.` (within Deposits G and H (*ecologia* 2013b), within Deposits C and D (Biologic 2016b), regional).

Five of these species are known only from locations within the C, D and G deposits and are therefore considered to be at **'moderate'** risk of impact; the isopoda (Armadillidae sp. `ISA049`), Symphyla (Scutigerellidae sp. `SYM028` and `SYM029`), and Coleoptera (Anillini `sp. indet.` and *Hydrobiomorpha* `sp. indet.`). This is typical of 'restricted' troglofauna species since surveys tend to focus on mineralised iron formations of the Pilbara.

Previous sampling collected Atelurinae silverfish, within Deposit D (*ecologia* 2013b). The survey collected Atelurinae specimens that were found to align genetically to the previously recorded species just beyond Deposit D. There also remains some doubt as to whether Atelurinae 'sp. indet.' represents potentially troglobitic or epigean (soil dwelling) fauna. Atelurinae silverfish are known to inhabit soil (within ant and termite nests), although potentially troglobitic species have recently been described from deeper subterranean habitats in the Pilbara region (Smith 1998; Smith and McRae 2014 in Biologic 2016b). Based on limited taxonomic knowledge, this species is regarded as a Potential SRE (data deficient). Therefore, this species is considered to be at '**lower'** risk of impact.

There remains some doubt as to whether the springtail Cyphoderidae `sp. indet.` represents an obligate (troglobitic) subterranean fauna or a potentially facultative subterranean fauna / epigean (soil dwelling) fauna. Epigean (soil dwelling) collembola are known to occur in the Pilbara and are often caught during subterranean fauna surveys. Some troglobitic Collembola are also known to occur although the only troglobitic collembolan described from the Pilbara is from Cape Range (Greenslade 2002 in Biologic 2016b). The specimen from the current survey showed some troglomorphic characters such as elongated antennae and appendages, however, based on limited taxonomic knowledge, this species is regarded as a Potential SRE (data deficient). Therefore, this species is considered to be at '**lower'** risk of impact.

Previous sampling collected the meenoplid bug Meenoplidae, within Deposits G and H (*ecologia* 2013b). The current survey collected Meenoplidae specimens that were found to align genetically to the previously recorded species (and lineages that are known to occur widely in the Pilbara) within Deposits C and D. There also remains some doubt as to whether Meenoplidae `sp. indet.` represents an obligate (troglobitic) subterranean fauna or a potentially facultative subterranean fauna. Therefore, this species is considered to be at '**negligible'** risk of impact.

Stygofauna

The following 14 stygofauna species are considered to be potentially at risk from this Proposal (Table 7-4, Figure 7-2):

- Amphipoda: *Kruptus* sp. `AMP035`(within and near Deposits C and D);
- Amphipoda: *Maarrka* sp. `AMP037` (within Deposit D);
- Amphipoda: Paramelitidae sp. `AMP036` (within Deposit C);
- Bathynellacea: Parabathynellidae: *Atopobathynella* sp. `BAP027` (near Deposit C);
- Bathynellacea: Bathynellidae sp. `BAB018`(near Deposit C);
- Haplotaxida: Enchytraeidae sp. `OLE028` (within Deposit D)
- Haplotaxida: Enchytraeidae sp. `OLE029` (near Deposit D)
- Harpacticoida: *Australocamptus* sp. `B13` (near Deposit C).
- Cyclopoida: *Thermocyclops* sp. `WA`(near Deposit C);
- Amphipoda: Paramelitidae `sp. indet.` (near Deposit C);
- Haplotaxida: Enchytraeidae `sp. indet.` (within Deposit D and F, near Deposit C and D);
- Harpacticoida: *Parastenocaris* `sp. indet.` (near Deposit C);
- Polychaeta: Aeolosomatidae `sp. indet.` (within Deposit C); and
- Turbellaria: Turbellaria `sp. indet.` (near Deposit C).

Groundwater drawdown was conservatively assumed to extend throughout and beyond the deposits and also throughout the alluvial aquifers of the valleys and therefore, eight of these species are known only from locations within the likely drawdown extent and are considered to be at '**high'** risk of impact; the Amphipoda (*Kruptus* sp. `AMP035`, *Maarrka* sp. `AMP037` and Paramelitidae sp. `AMP036`), Bathynellacea (*Atopobathynella* sp. `BAP027` and Bathynellidae sp. `BAB018`), Haplotaxida (Enchytraeidae sp. `OLE028` and Enchytraeidae sp. `OLE029`) and Harpacticoida (*Australocamptus* sp. `B13`).

Further, sequences of the Amphipoda (*Paramelitidae*), Parabathynellidae (*Atopobathynella*) and Bathynellidae were all unique regionally, with high levels of genetic divergence between available regional material from these taxonomic groups and the samples from West Angelas and therefore, these species were considered to be at '**high'** risk of impact.

Thermocyclops sp. `WA` was considered to represent a potential new species. Few previous records of this cyclopoid copepod exist in the region, except for one record of *Thermocyclops aberrans* at South Flank (WAM database records 2016 in Biologic 2016b). *Thermocyclops* sp. `WA` was considered to be a potential SRE (data deficient), although its occurrence within near surface hyporheic groundwater habitats associated with the drainage lines suggests that it could occur further downstream within the catchment. Therefore, this species was considered to be at '**moderate'** risk of impact.

The five indeterminate species (identified as `sp. indet.`); Paramelitidae `sp. indet.`, Enchytraeidae `sp. indet.`, *Parastenocaris* `sp. indet.`, Aeolosomatidae `sp. indet.` and Turbellaria `sp. indet.` were unable to be allocated to other existing morphospecies (or genetically determined species). These species could occur more widely (some members of these groups are known regionally). Therefore, these species are considered to be at '**moderate**' risk of impact.

Three stygofauna species: the cosmopolitan naidid worm *Pristina longiseta;* the phreodrillid worm Phreodrillidae 'OLP12'; and the enchytraeid worm Enchytraeidae sp. `OLE026`, (all found near Deposit C) were found to align genetically to previously recorded species or lineages that are known to occur widely in the Pilbara and therefore, are considered to be at '**negligible'** risk of impact.

Previous surveys collected representatives of almost all stygofauna taxa (Amphipoda, Bathynellacea, Cyclopoida, Harpacticoida, Haplotaxida, Oligochaeta and Turbellaria) throughout the Central Plateau. Previous surveys also collected representatives of some groups (Amphipoda, Bathynellacea, Cyclopoida and Harpacticoida) at the Turee Creek Borefield. The majority of stygofauna collected in previous surveys have not been identified to species level likely because most of the previous surveys took place before the taxonomy was sufficiently developed to enable detailed identifications. The lack of species level identifications (or genetic data) limits the ability to compare previous and current specimens to determine species distributions across the region.

Only Polychaeta has not been collected in previous surveys. Aeolosomatids are often collected from surface aquatic habitats but are rarely collected from groundwater. However, only approximately 1.5m of groundwater was intercepted at approximately 43m bgl; the depth from surface suggests that Aeolosomatidae sp. indet., collected from Deposit C is potentially stygobitic, although to what extent they may be SRE is currently uncertain (Biologic 2016b).

Table 7-3: Potentially troglobitic species associated with this Proposal

Family	Species	Location	Status	SRE Status	Risk Assessment
Coleoptera	*Anillini* sp. indet.	C	Troglobite	Potential SRE (data deficient)	**Moderate**. Highly restricted species are known to occur. Current records (only just) within Deposit C. Species likely to occur beyond Deposit C (within Mount Newman Member).
	Hydrobiomorpha sp. indet.	D	Potential troglobite	Potential SRE (data deficient)	**Moderate**. Current records (only just) within Deposit D. Species likely to occur beyond Deposit D (within Mount Newman Member).
Collembola	Cyphoderidae sp. indet.	C	Potential troglobite	Potential SRE (data deficient)	**Low**. Current records (only just) within Deposit C. Species likely to occur beyond Deposit C (within Mount Newman Member).
Hemiptera	Meenoplidae sp. `HEM003` Genetic alignment to a widespread species previously sampled at Murrays Hill, Hardy River, and Upper South Fortescue.	C, D, Regional	Potential troglobite	Regionally widespread species	**Negligible**. Regionally widespread species. Potential to be the same as Meenoplidae sp. indet. (originally recorded by ecologia 2013b) recorded in Deposits G and H.
Isopoda	Armadillidae sp. `ISA049' Regionally distinct species of Armadillidae.	D	Troglobite	Confirmed SRE	**Moderate**. Current records (only just) within Deposit D. Species likely to occur beyond Deposit D (within Mount Newman Member).
Symphyla	Scutigerellidae sp. `SYM028` Potentially distinct species of Scutigerellidae, moderate divergence from local specimens indicates more information required to separate distinct species.	C	Potential troglobite	Confirmed SRE	**Moderate**. Current records (only just) within Deposit C. Species likely to occur beyond Deposit C (within Mount Newman Member). Moderate genetic similarities to S. SYM029.
Symphyla	Scutigerellidae sp. `SYM029` Potentially distinct species of Scutigerellidae, moderate divergence from local specimens indicates more information required to separate distinct species.	C	Potential troglobite	Confirmed SRE	**Moderate**. Current records within Deposit C. Species likely to occur beyond Deposit C (within Mount Newman Member). Moderate genetic similarities to S. SYM028.
Thysanura	Atelurinae sp. indet. Sequence failed.	D	Potential troglobite	Potential SRE	**Low.** Both troglobitic and epigean species known to occur. Species likely to occur beyond Deposit D (within the Mount Newman Member). Potential to be the same as Atelurinae sp. indet. (originally collected by ecologia 2013b) due to proximity/connected habitats.

Table 7-4: Potentially stygobitic species associated with this Proposal

Family	Species	Location	Status	SRE Status	Risk Assessment
Amphipoda (CP, TCB)	*Kruptus* sp. `AMP035` Regionally distinct species of Paramelitidae (likely *Kruptus*).	C, D	Stygobite	Confirmed SRE	**High**. Species currently known from beyond Deposits C and D (within calcrete and alluvials), but all current records known only from within likely drawdown extent.
	Maarrka sp. `AMP037` Regionally distinct species of Paramelitidae (likely *Maarka*).	D	Stygobite	Confirmed SRE	**High**. Species currently known only from single record within Deposit D, likely to occur beyond Deposit D (within Mount Newman Member), but all current records known only from within likely drawdown extent.
	Paramelitidae sp. `AMP036` Regionally distinct species of Paramelitidae (uncertain morphological ID, juvenile).	C	Stygobite	Confirmed SRE	**High**. Species currently known only from single record within Deposit C, likely to occur beyond Deposit C (within Mount Newman Member), but all current records known only from within likely drawdown extent.
	Paramelitidae sp. indet.	C	Stygobite	Potential SRE	**Moderate**. Likely to be the same as *Kruptus sp. `AMP035`*. Species currently known only from single record within Deposit C, likely to occur beyond Deposit C (within calcrete and Mount Newman Member), but all current records known only from within likely drawdown extent.
Bathynellacea (CP, TCB)	*Atopobathynella* sp. `BAP027` Regionally distinct species of Parabathynellidae (likely *Atopobathynella*).	C	Stygobite	Confirmed SRE	**High**. Unknown distribution. Species currently known only from within Deposit C. All current records also known only from within likely drawdown extent.
	Bathynellidae sp. `BAB018` Regionally distinct species of Bathynellidae	C	Stygobite	Confirmed SRE	**High**. Unknown distribution. Species currently known only from within Deposit C. All current records also known only from within likely drawdown extent.
Cyclopoida (CP, TCB)	*Thermocyclops* sp. `WA`	C	Stygobite	Potential SRE (research / expertise)	**Moderate**. Species currently known from beyond Deposit C but within likely drawdown extent.
Haplotaxida (CP)	Enchytraeidae `OLE026`	C	Stygophile/ Troglophile	Regionally widespread species	**Negligible**. Regionally widespread species

Family	Species	Location	Status	SRE Status	Risk Assessment
Haplotaxida (CP)	Enchytraeidae `OLE028` Regionally distinct species of Enchytraeidae	D		Confirmed SRE	**High**. Species currently known only from within Deposit D, likely to occur beyond Deposit D (within calcrete and Mount Newman Member), but all current records known only from within deposit and likely drawdown extent.
	Enchytraeidae `OLE029` Potentially distinct species of Enchytraeidae (moderate divergence from local specimens indicates more information required to separate distinct species). Occurs in a large species complex found across multiple catchment boundaries.	D		Potential SRE	**High**. Species currently known from beyond Deposit D (within Mount Newman Member), but all current records known only from within likely drawdown extent.
	Enchytraeidae sp. indet. Specimens cannot be allocated on current information	C, D, F	Stygophile/ Troglophile	Potential SRE	**Moderate.** Species currently known from beyond Deposits C and D (within calcrete and Mount Newman Member). Records may be within drawdown extent.
Harpacticoida (CP, TCB)	*Australocamptus* sp. `B13` Considered to represent a new species.	C	Stygobite	Potential SRE (research / expertise)	**High**. Species currently known from beyond Deposit C but within likely drawdown extent.
Harpacticoida (CP, TCB)	*Parastenocaris* sp. indet.	C	Stygobite	Potential SRE (data deficient)	**Moderate**. Unknown distribution (likely widespread). The likelihood of range-restricted harpacticoid cyclopoid species is generally considered low, as the majority of species from the Pilbara region are widespread. Nevertheless, some range-restricted species of *Parastenocaris* are known to occur. Species currently known from single record beyond Deposit C but within likely drawdown extent.
Oligochaeta (CP)	Phreodrillidae `OLP12` Genetic alignment to a species (OLP12) previously sampled widely across four catchments in the Pilbara.	D	Potential stygobite	Regionally widespread species	**Negligible**. Regionally widespread species
	Pristina longiseta Genetic alignment to a species previously sampled worldwide.	C	Potential stygobite	Worldwide	**Negligible**. Widespread species

Family	Species	Location	Status	SRE Status	Risk Assessment
Polychaeta	Aeolosomatidae sp. indet.	C	Potential stygobite	Potential SRE (data deficient)	**Moderate**. Unknown distribution (rarely collected from groundwater). Species currently known only from within Deposit C. All current records also known only from within likely drawdown extent.
Turbellaria (CP)	Turbellaria sp. indet.	C	Potential stygobite	Potential SRE (data deficient)	**Moderate**. Unknown distribution (poorly known regionally). Species currently known from beyond Deposit C but within likely drawdown extent.
CP – Central Plateau, TCB – Turee Creek B Borefield					

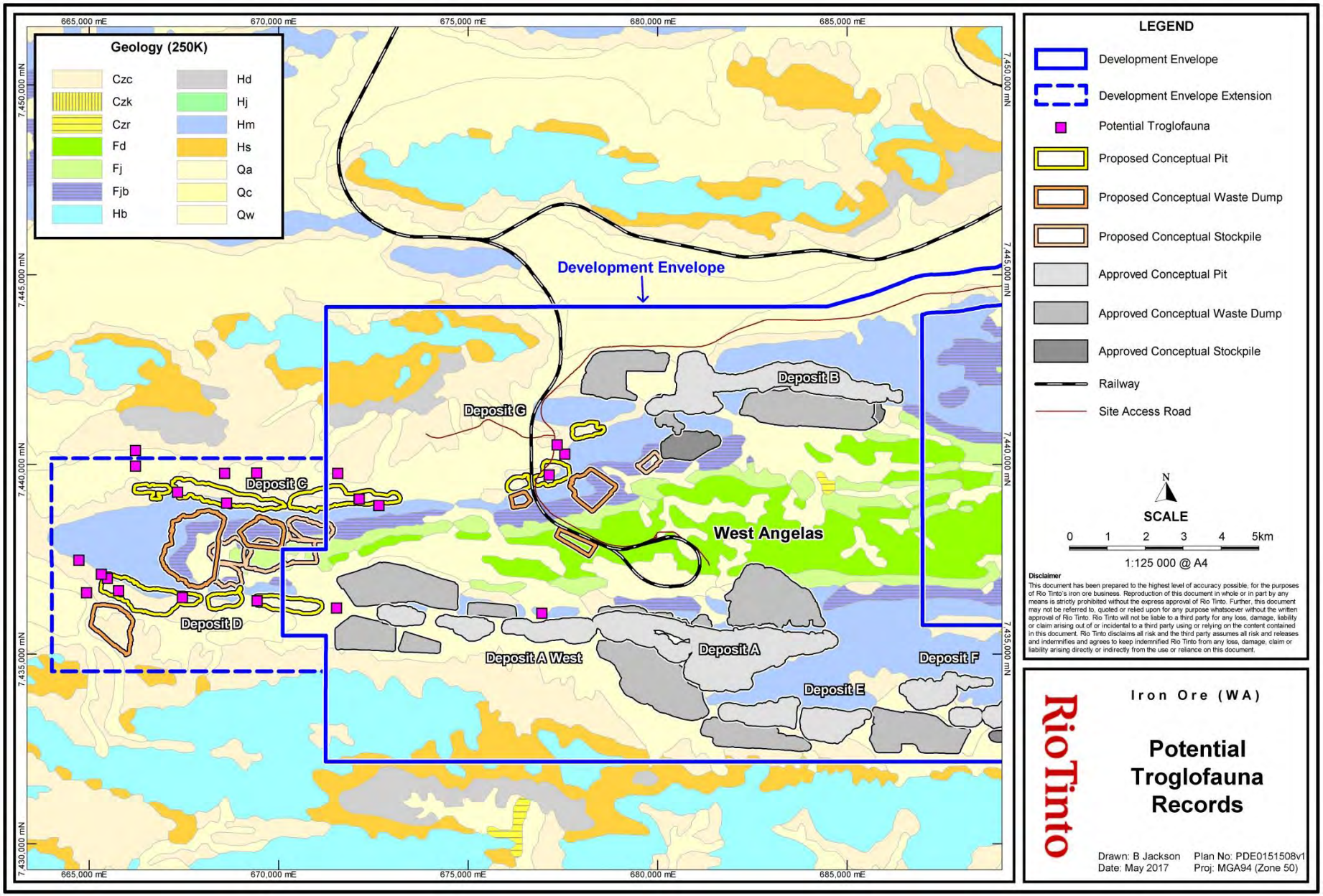

Figure 7-1: Potential Troglofauna Records

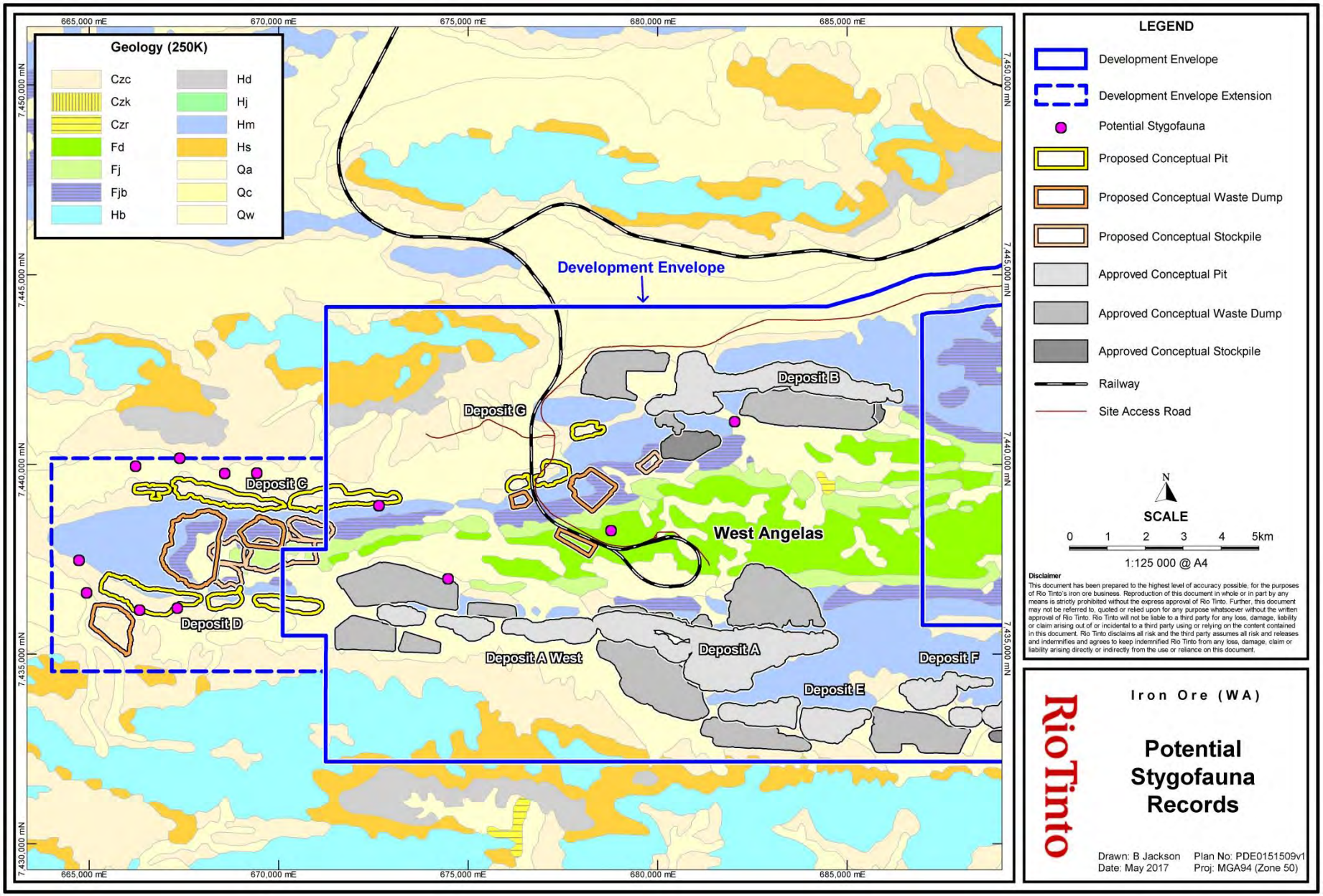

Figure 7-2: Potential Stygofauna Records

7.3.2 Subterranean Fauna Habitats

The occurrence and distribution of subterranean fauna is influenced or limited by the geological formation in which they occur. The presence of subterranean cavities (within approximately 150m of the surface) affects the pattern of occurrence, the density and distribution of subterranean fauna. Cavities for subterranean fauna are common within certain lithologies such as porous detrital deposits such as calcrete and pisolite due to high levels of secondary weathering. Where exposed near the surface and/or faulted and folded, deep weathered and fractured layers within banded iron formations may also provide suitable habitat for subterranean fauna.

Geology alone is not a precise predictor of suitable habitat. The suitability of habitat depends on the presence and interconnectedness of subterranean cavities, and on inputs of nutrients, water and oxygen from the surface (Hahn and Fuchs 2006, Howarth 1983). Vertical connectivity with the surface is important for supplying nutrients, water and oxygen to maintain populations. Nutrients, water and oxygen are generally transported into subterranean ecosystems by the infiltration of water (Howarth 1983, Humphreys 2006, Malard and Hervent 1999, Poulson and Lavoie 2000 in Biologic 2016b). The porosity (or otherwise) of the target and overlying geologies, the depth from the surface, and the presence of caves or tree roots that can provide conduits for water and nutrients are therefore important features that can influence the suitability of habitats for subterranean fauna (Hahn and Fuchs 2006, Strayer 1994). Lateral connectivity of voids is also important because it enables animals to move about underground. Geological features such as major faults can either act as barriers or conduits to below-ground dispersal of subterranean fauna. Such dispersal limitations result in extremely small, fragmented species ranges and thus high levels of endemism (EPA 2003). In order to assess the potential for subterranean fauna to occur, it is also necessary to identify likely habitats and the extent of those habitats.

Troglofauna

The suitability of a geological formation as troglofauna habitat is predominantly determined by above water table environments, with availability and interconnectivity of void/cavity space; the potential for nutrient infiltration from the surface; and the ability of the inhabited substrate to maintain a stable humidity.

The range of geological formations which troglofauna may habit has yet to be determined, however, troglofauna are most commonly associated with calcrete deposits, likely due to their karstic nature which creates habitat space in the form of cavities. More recently they have also been associated with micro-cavities of porous pisolite deposits within the Pilbara. The micro-habitats within these lithologies are yet to be characterised but it is inferred they occupy fractures, fissures and voids associated with weathering and faulting (Biologic 2016b).

Stygofauna

The presence of stygofauna in Western Australia has been well documented, especially from regions such as the Pilbara and Kimberley, and less so in the Midwest and South West regions of Western Australia (*ecologia* 2013b). Stygofauna are known to be present in the groundwater associated with a variety of geologies. These include (but are not limited to) calcrete aquifers associated with palaeochannels, pisolitic aquifers, karstic aquifers (such as calcrete and dolomite), alluvial aquifers, fractured-rock aquifers, springs and hyporheic habitats (*ecologia* 2013b). These types of aquifers provide the three known critical aquifer characteristics; porosity (sufficient interstitial spaces / micro-cavities required to support stygofauna), hydraulic conductivity and depth to water table favourable to stygofauna.

However, distribution patterns of stygofauna in aquifers are considered to be determined by hydraulic connectivity rather than associated with particular geologies. Stygofauna require adequate hydraulic connectivity to allow food and oxygen to be distributed from the surface to the groundwater. Open (porous, fractured and karstic) aquifers have abundant interstitial space and at least moderate hydraulic conductivity. There is continuous exchange with surface water for food and oxygen supply, which is why stygofauna communities are often found in this aquifer type (Hahn and Fuchs 2009). Confined and / or compact aquifers have low hydraulic conductivity and are not considered overly prospective habitat for stygofauna. These types of aquifers have minimal interstitial space and reduced food and oxygen supply, which is why these aquifer types are usually either devoid of stygofauna or have depleted taxonomic richness and abundance (Hahn and Fuchs 2009 in *ecologia* 2013b).

Depth to water table also influences the nutrients, water and oxygen that are available to maintain subterranean ecosystems which are typically almost entirely heterotrophic, with bio-production primarily dependent on the transport of these resources from the surface.

7.4 Assessment of Potential Impacts

Potential impacts to Subterranean Fauna include the following:

- Direct loss / mortality of individuals.
- Loss or degradation of potential subterranean fauna habitat as a result of mining.
- Loss or degradation of potential subterranean fauna habitat as a result of groundwater drawdown from dewatering / groundwater abstraction.
- Loss or degradation of potential subterranean fauna habitat as a result of clearing.
- Vibration effects on subterranean habitats from blasting activities.
- Contamination.

Assessment of each of these potential impacts is included below. Mitigation to address these potential impacts and predicted outcomes is presented in Table 7-5.

7.4.1 Direct loss / mortality of individuals

The subterranean fauna of the Proposal area comprised a total of 28 morphospecies: 14 stygofauna and 14 troglofauna containing worms (four morphospecies), crustaceans (12 morphospecies), arachnids (five morphospecies), hexapods (five morphospecies), and myriapods (two morphospecies). This represents a moderately rich subterranean fauna community. Eight troglofauna species were collected only from within the deposits and 14 stygofauna species were collected from within the extent of drawdown.

Many of the species that were collected were represented by single animals. The paucity of records is considered likely an artefact of the inherent difficulties in sampling rather than an indication of an extremely restricted distribution. Subterranean fauna inhabit cryptic, concealed habitats which renders them inherently difficult to sample. Much remains uncertain regarding the taxonomy and ecological status of many of the faunal groups, and for some groups, the taxonomic framework is very poorly developed or lacking entirely, which provides challenges for the interpretation of sampling results and species distributions. It is therefore, difficult to conclusively demonstrate that the likely distribution of species extends outside of recorded locations. However, the distributions of most ‘restricted’ species are thought likely to be an underestimate; it is considered probable that their distribution extends in continuous habitats outside of recorded locations and as such, the loss / mortality of individuals is not expected to significantly adversely affect the conservation status of troglofauna or stygofauna species.

The EPA acknowledges that species are unlikely to be confined to single recorded locations where there is habitat continuity and as such, endorses the use of habitat as a surrogate for species distributions at a local scale where taxa remain poorly sampled as a result of survey limitations:

> *'Where a reasonable amount of sampling is unlikely to reveal the full range of a species because of demonstrated low capture rates in the habitat sampled, surrogates can be used to estimate whether the habitat is restricted… A physical surrogate is the use of habitat, known to support a particular species, to infer the likely presence of that species in the same habitat beyond the area surveyed. A physical surrogate can be used only where continuity of the presumed habitat can be clearly demonstrated with site-specific data'* (EPA 2013b).

Deposits C, D and G are examples where sufficient sampling has occurred but subterranean fauna taxa distributions at the local scale remain poorly resolved. Thus the Proponent has assessed the potential for subterranean fauna to occur based on the presence or absence of potential geological / hydrogeological habitats and inferred the potential impact of this Proposal on subterranean fauna based on the extent of those habitats. This is addressed below in section 7.4.2.

7.4.2 Loss or degradation of potential subterranean fauna habitat as a result of mining

Mining will result in the direct removal of both above and below water table habitat for subterranean fauna.

Troglofauna

The potential geological habitats for troglofauna (occurring above the water table) that occur within Deposits C, D, and G include the following:

- **Surficial detritals (Tertiary and Quaternary alluvium / colluvium)** - Geological cross sections show that the mineralised Marra Mamba and Wittenoom Formations extend below variably porous detrital material. The majority of the detritals are clays that generally lack interconnected micro-cavities suggesting that the distribution of troglofauna is likely to be limited. However, alluvium and colluvium represent potential habitat for troglofauna where above the water table (and stygofauna below the water table).

  Surficial detritals that occur below the water table are not expected to support troglofauna communities.

- **Pisolite and calcrete deposits -** Tertiary and Quaternary detritals occasionally feature secondary deposits such as pisolite and calcrete. Pisolite and calcrete deposits occurring deeper within the detrital layers represent primary habitat for troglofauna where above the water table (and stygofauna below the water table) because of their micro-vughy textures (produced high degree of secondary weathering), and because their location near the surface enables rapid transport of nutrients and oxygen from the surface.

  Pisolite was only present above the water table at Deposit G. Calcrete was present above and below the water table at Deposits C, D and G (in minor amounts at Deposit C and G, and in greater amounts at Deposit D) and in the detrital valley north of Deposit C beneath the surficial detritals.

- **'Hydrated' material -** The mineralised Marra Mamba Iron and Wittenoom Formations are overlain by a widespread regolith of 'hydrated' material, produced by secondary weathering processes. This hydrated material is commonly intersected close to the surface both above and below the water table at Deposits C and D, and above the water table at Deposit G and is generally 20 – 50m thick.

The micro-vughy textures (produced by secondary weathering) represent primary habitat for troglofauna where above the water table (and stygofauna below the water table). Hydrated, vuggy-textured material has also previously been identified as potential troglofauna habitat elsewhere in the Pilbara.

- **Mineralised Members (Marra Mamba Iron and Wittenoom Formations) -** The Marra Mamba Iron Formation was not previously considered primary habitat for the persistence of significant populations of troglofauna. The sedimentary rocks of this Formation are generally solid and lack interconnected micro-cavities suggesting that the distribution of troglofauna is likely to be limited. However, the weathering processes related to the enrichment of iron that produced the mineralisation at West Angelas formed interconnected micro-cavities (typical of mineralised deposits of the Pilbara region) such that the mineralised Mount Newman Member of the Marra Mamba Iron Formation (and the overlying West Angela Member of the Wittenoom Formation) represents potential habitat to support troglofauna where above the water table (and stygofauna below the water table).

  Mineralisation was present both above and below the water table at Deposits C and D and above the water table at Deposit G. Mineralisation below the water table is not expected to support troglofauna communities. Mineralisation at depth is also expected to become less likely to support troglofauna communities as cavities are rarer due to pressure and depth hinders the transport of nutrients and oxygen from the surface.

- **Fractured basal Members of the Marra Mamba Iron Formation -** The mineralised Marra Mamba Iron Formation is underlain by unmineralised basal Marra Mamba Iron and Jeerinah Formations. The basal MacLeod and Nammuldi Members of the Marra Mamba Iron Formation generally lack interconnected micro-cavities suggesting that the distribution of troglofauna is likely to be limited however, local fractures represent potential secondary habitat for troglofauna, where they occur near the surface. However, fractured basal members of the Marra Mamba Iron Formation occur below the water table and as such, are not expected to support troglofauna communities.

Based on current geological information, the primary habitats for troglofauna (mineralised orebodies in the uppermost Mount Newman Member of the Marra Mamba Iron Formation, and overlying surficial detritals and hydrated material) are well-represented in the region; the proposed area affected by mining is negligible is comparison to the overall area of the formation present in the region. These geological formations extend beyond the deposits (both locally and regionally) and as such, do not represent isolated troglofauna habitat. The continuous nature of these geological formations indicates that troglofauna (if present), extend into continuous habitat throughout the region.

Given the extent of other primary habitats (nearby surficial detritals; alluvium and colluvium, pisolite and calcrete deposits) and other secondary habitats (fractured and weathered lower members of the Marra Mamba Iron Formation i.e. the MacLeod and Nammuldi Members where sufficiently fractured and above the water table), it would be reasonably expected that troglofauna, if present, would be well represented across the region.

Assumptions made on the likely wider distribution of potentially troglobitic species in a range of habitats beyond the proposed deposit boundaries are consistent with EPA guidance. As such, troglofauna are considered to be at **low** risk of impact from mining.

Stygofauna

The potential hydrogeological habitats for stygofauna (occurring below the water table) that occur within Deposits C and D include the following:

- **Surficial detritals (Tertiary and Quaternary alluvium / colluvium) -** Alluvium and colluvium and mineralised detritals (occurring within close proximity to bedded mineralisation) occurring below the water table represent potential habitat for stygofauna.

  Surficial detritals did not extend below the water table within the deposits and as such, are not expected to support stygofauna communities. However, within the valley north of Deposit C the water table is near the surface (within 2m). The alluvial gravels of surface watercourses (hyporheos) represent primary habitat for stygofauna communities.

- **Calcrete deposits -** Calcrete deposits occurring below the water table within the detrital layers represent primary habitat for stygofauna because of their micro-vughy textures (produced high degree of secondary weathering), and because their location near the surface enables rapid transport of nutrients and oxygen from the surface.

  Calcrete is present below the water table in minor amounts at Deposit C and in greater amounts at Deposit D and in the detrital valley north of Deposit C (beneath the surficial detritals).

- **'Hydrated' material -** The mineralised Marra Mamba Iron and Wittenoom Formations are overlain by a widespread regolith of 'hydrated' material, produced by secondary weathering processes. This hydrated material is commonly intersected close to the surface both above and below the water table at Deposits C and D and is generally 20 – 50m thick. The micro-vughy textures (produced by secondary weathering) represent primary habitat for stygofauna where below the water table.

- **Mineralised orebodies (Marra Mamba Iron and Wittenoom Formations) -** Stygofauna are generally known from calcrete aquifers, pisolitic aquifers, alluvial aquifers and fractured-rock aquifers. The Marra Mamba Iron Formation was not previously considered primary habitat for the persistence of significant populations of stygofauna. The sedimentary rocks of this Formation generally lack interconnected micro-cavities suggesting that the distribution of stygofauna is likely to be limited. However, the weathering processes related to the enrichment of iron that produced the mineralisation at West Angelas formed interconnected micro-cavities (typical of mineralised deposits of the Pilbara region) such that, where below the water table, the mineralised Mount Newman Member of the Marra Mamba Iron Formation (and the overlying West Angela Member of the Wittenoom Formation) represents a locally significant aquifer with potential to support stygofauna.

- **Fractured basal Members of the Marra Mamba Iron Formation -** The mineralised Marra Mamba Iron Formation are underlain by unmineralised basal Marra Mamba Iron and Jeerinah Formations. The basal MacLeod and Nammuldi Members of the Marra Mamba Iron Formation generally lack interconnected micro-cavities suggesting that the distribution of stygofauna is likely to be limited however, local fractures represent potential secondary habitat for stygofauna where below the water table. The fracture patterns are not well defined however, it is likely that local fractures extend vertically and horizontally outside of the deposits. The continuous nature of these geological formations indicates that stygofauna (if present) extend into continuous habitat in the region.

Further, these basal Members are also not as extensive or well-connected as primary habitats; the mineralised Mount Newman Member of the Marra Mamba Iron Formation (and the overlying West Angela Member of the Wittenoom Formation) or pisolite and calcrete deposits.

Based on current geological information, the primary habitats for stygofauna (mineralised orebodies in the uppermost Mount Newman Member of the Marra Mamba Iron Formation and overlying hydrated material, where below the water table) are well-represented in the region; the proposed area affected by mining is negligible is comparison to the overall area of the formation present in the region. These geological formations extend beyond the deposits (both locally and regionally) and as such, do not represent isolated stygofauna habitat. The continuous nature of these geological formations indicates that stygofauna (if present), extend into continuous habitat throughout the region (where connectivity allows for dispersal of stygofauna).

Given the extent of other primary habitats (nearby surficial detritals; alluvium and colluvium and calcrete deposits, where below the water table) and other secondary habitats (fractured and weathered lower members of the Marra Mamba Iron Formation i.e. the MacLeod and Nammuldi Members where sufficiently fractured and below the water table), it would be reasonably expected that stygofauna, if present, would be well represented across the region (where connectivity allows for dispersal of stygofauna).

Assumptions made on the likely wider distribution of potentially stygobitic species in a range of habitats beyond the proposed deposit boundaries are consistent with EPA guidance. As such, stygofauna are considered to be at **low** risk of impact from mining.

7.4.3 Loss or degradation of potential subterranean fauna habitat as a result of groundwater drawdown from dewatering / groundwater abstraction

Troglofauna

Although troglofauna cannot live below the water table, they are particularly susceptible to desiccation and require a humid atmosphere, close to 100 % saturation (Howarth 1983 in Biologic 2016b). Drawdown below troglofauna habitat may have the potential to impact subterranean humidity and therefore, the quality of troglofauna habitat. The extent to which humidity is affected by depth to the water table is unclear. However, given that pockets of residual water probably remain trapped throughout de-watered areas and keep the overlying substrate saturated with water vapour, dewatering is expected to have minimal impact on the humidity of potential troglofauna habitat. In fact, lowering of the water table may increase the amount of troglofauna habitat available. Troglofauna may be able to avoid the effects of a habitat drying out by moving deeper into the substrate if suitable connected habitat exists at depth.

Stygofauna

Groundwater drawdown has the potential to reduce habitat availability and / or hinder dispersal of stygofauna.

Based on current hydrogeological information, the primary habitats for stygofauna (mineralised orebodies in the uppermost Mount Newman Member of the Marra Mamba Iron Formation and overlying hydrated material, where below the water table) are well-represented in the region; the proposed area affected by groundwater drawdown is negligible in comparison to the overall area of the formation present in the region. These geological formations extend beyond the proposed extent of the drawdown and as such, do not represent isolated stygofauna habitat. The presence of intrusive formations such as dykes and features such as folding and faulting can produce sudden, localised geological barriers limiting the distribution of stygofauna however, these features do not appear to have affected shallow hydrogeological systems.

It is likely that stygofauna (if present) follow the alluvial gravels of surface watercourses (hyporheos), extending into hydraulically connected subterranean habitat throughout the catchment. Furthermore, shallow hydrogeological systems are expected to be recharged both directly and indirectly by seasonal rainfall and infiltration from ephemeral surface water flows, aiding stygofauna dispersal.

Given the extent of other primary habitats, (nearby surficial detritals; alluvium and colluvium and calcrete deposits, where below the water table) and other secondary habitats (fractured and weathered lower members of the Marra Mamba Iron Formation i.e. the MacLeod and Nammuldi Members where sufficiently fractured and below the water table), it would be reasonably expected that stygofauna, if present, would be well represented in continuous habitats across the region (where connectivity allows for dispersal of stygofauna).

Assumptions made on the likely wider distribution of potentially stygobitic species in a range of habitats beyond the proposed deposit boundaries are consistent with EPA guidance. As such, stygofauna are considered to be at **moderate** risk of impact from groundwater drawdown.

7.4.4 Degradation of potential subterranean fauna habitat as a result of clearing

The nutrient resources for subterranean habitats are largely allochthonous, transported from the surface into subterranean habitats by surface water infiltration, tree roots and animals (Howarth 1983 in *ecologia* 2013b).

Leaf litter is the main nutrient resource for subterranean habitats. Clearing (and potentially the placement of waste dumps) has the potential to reduce nutrient resources transported from the surface into subterranean habitats. Development may also result in localised reduction in surface water infiltration, and the associated transport of nutrients from the surface into subterranean habitats.

Reduced nutrient resources transported from the surface into subterranean habitats are considered more likely to reduce population densities than cause extinction of species. As such, the degradation of potential subterranean fauna habitat as a result of clearing is not considered a significant impacting activity.

7.4.5 Vibration effects on subterranean habitats from blasting activities

Vibration effects from blasting activities may have indirect impacts on subterranean fauna habitat; altered structure of geological formations may result in the loss of subterranean fauna habitat through collapse of voids or the creation of subterranean habitat through rock fragmentation. The effects of vibration from blasting activities on subterranean fauna habitat are poorly quantified and their ecological consequences have not been described.

Vibration dissipates with distance. Any vibration effects on subterranean fauna habitat are likely to be localised and as such blasting is not considered a significant impacting activity.

7.4.6 Contamination

Contamination of soil or groundwater has the potential to reduce the quality of subterranean fauna habitat. Rio Tinto has well established strategies for the management of wastes at its Pilbara operations to ensure that risk of contamination of soil or groundwater is minimised.

Any contamination is likely to be localised and as such, contamination is not considered a significant impacting activity.

7.5 Mitigation and Predicted Outcomes

Mitigation strategies to address the above potential impacts and predicted outcomes are presented in Table 7-5.

Table 7-5: Subterranean Fauna: Assessment of Potential Impact, Mitigation and Outcome

Potential impacts	Mitigation to address potential impacts	Predicted outcome
EPA Objective: *To protect subterranean fauna so that biological diversity and ecological integrity is maintained.*		
Loss or degradation of potential subterranean fauna habitat as a result of mining: Mining is expected to result in the direct removal of both above and below water table habitats for subterranean fauna. Potential habitats for subterranean fauna include the following: • Surficial detritals (Tertiary and Quaternary alluvium / colluvium) where above the water table for troglofauna and below the water table for stygofauna. • Pisolite deposits occurring deeper within the detrital layers above the water table for troglofauna only. • Calcrete deposits occurring deeper within the detrital layers where above the water table for troglofauna and below the water table for stygofauna. • 'Hydrated' material where above the water table for troglofauna and below the water table for stygofauna. • Mineralised Mount Newman Member of the Marra Mamba Iron Formation and the overlying West Angela Member of the Wittenoom Formation where above the water table for troglofauna and below the water table for stygofauna. • Fractured basal members of the Marra Mamba Iron Formation below the water table for stygofauna only.	The following key management strategies will continue to be implemented to manage the potential loss or degradation of potential subterranean fauna habitat as a result of mining: **Minimise:** Backfilling of pits during operations is proposed. **Rehabilitate:** The Proponent proposes that mining be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans*. The Closure Plan (Appendix 11) proposes that below water table pits will be backfilled to above recovered groundwater levels to prevent the formation of permanent pit lakes. Backfilling of pits will provide some protection to remnant subterranean fauna habitat and may potentially offer habitat given suitable cavities near or below the water table with sufficient vertical connectivity with the surface for supplying nutrients, water and oxygen to maintain subterranean fauna populations. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA)*.	The Proposal is expected to result in the unavoidable loss or degradation of potential subterranean fauna habitat as a result of mining. Geological formations which represent potential subterranean fauna habitat are well-represented in the region; the proposed area affected by mining is negligible is comparison to the overall area of the formation present in the region. These geological formations also extend beyond the proposed extent of the deposits (both locally and regionally) and as such, do not represent isolated subterranean fauna habitat. Given the continuous nature of these geological formations beyond the proposed extent of the deposits, nearby primary habitats (alluvial, pisolite and calcrete deposits) and other secondary habitats (fractured and weathered basal members of the Marra Mamba Iron Formation i.e. the MacLeod and Nammuldi Members where sufficiently fractured), it would be reasonably expected that subterranean fauna, if present, would be well represented in continuous habitats across the region. The Proponent therefore considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Loss or degradation of potential subterranean fauna habitat as a result of groundwater drawdown from dewatering / groundwater abstraction: Groundwater drawdown below troglofauna habitat is expected to have minimal impact on subterranean humidity and therefore, the quality of troglofauna habitat. In fact, lowering of the water table may increase the amount of troglofauna habitat available. Troglofauna may be able to avoid the effects of a habitat drying out by moving deeper into the substrate if suitable habitat exists at depth. Groundwater drawdown has the potential to reduce habitat availability for stygofauna and / or hinder dispersal	The following key management strategies have been and will continue to be, implemented to manage the potential loss or degradation of potential subterranean fauna habitat as a result of groundwater drawdown: **Minimise:** Hydrogeological modelling has been and will continue to be, undertaken to facilitate understanding of current and future dewatering requirements. Dewatering will be minimised to that required to access the below water table resource. Minimising groundwater drawdown will maintain viable subterranean fauna habitat. **Rehabilitate:** The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans*. The Closure Plan (Appendix 11) proposes that below water table pits will be backfilled to above recovered groundwater levels to prevent the formation of permanent pit lakes. Backfilling of pits to prevent the formation of permanent pit lakes will provide some protection to remnant subterranean fauna habitat, minimising the deterioration of groundwater quality. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA)*. Groundwater abstraction for dewatering purposes has been, and will continue to be, managed in accordance with the existing Groundwater Licence GWL98740, issued under the RIWI Act and associated Groundwater Operating Strategy, and any amendments as required.	The Proposal is expected to result in the unavoidable loss or degradation of potential subterranean fauna habitat as a result of groundwater drawdown. Geological / hydrogeological formations which represent potential subterranean fauna habitat are well-represented in the region; the proposed area affected by groundwater drawdown is negligible is comparison to the overall area of the formation present in the region. These geological formations extend beyond the proposed extent of the drawdown and as such, do not represent isolated stygofauna habitat. The presence of intrusive formations such as dykes and features such as folding and faulting can limit the distribution of stygofauna however, it is likely, that stygofauna (if present) follow the alluvial gravels of surface watercourses (hyporheos), extending into hydraulically connected subterranean habitat throughout the catchment. Given the extent of other primary habitats, (nearby surficial detritals; alluvium and colluvium and calcrete deposits, where below the water table) and other secondary habitats (fractured and weathered lower members of the Marra Mamba Iron Formation i.e. the MacLeod and Nammuldi Members where sufficiently fractured and below the water table), it would be reasonably expected that stygofauna, if present, would be well represented in continuous habitats across the region (where connectivity allows for dispersal of stygofauna). The Proponent therefore considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Degradation of potential subterranean fauna habitat as a result of clearing. Clearing has the potential to reduce nutrient resources transported from the surface into subterranean habitats.	The following key management strategies will continue to be implemented to manage the potential degradation of potential subterranean fauna habitat as a result of clearing: **Minimise:** The Proponent proposes that clearing be subject to a new Ministerial Statement (Appendix 3). Schedule 1 of the new Ministerial Statement shall authorise: • Clearing of no more than 12,200 ha within a 26,400 ha Mine Development Envelope. **Rehabilitate:** The contemporary conditions of the new Ministerial Statement shall also require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans*. The Closure Plan (Appendix 11) includes a Closure Objective to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the final land use. **Other legislation:** The Proponent will also adhere to the requirements of the *Wildlife Conservation Act 1950 (WA)*.	The Proposal is expected to result in the unavoidable loss or degradation of potential subterranean fauna habitat as a result of clearing. Reduced nutrient resources transported from the surface into subterranean habitats are considered more likely to reduce population densities than cause extinction of species. As such, the degradation of potential subterranean fauna habitat as a result of clearing is not considered a significant impacting activity. The Proponent therefore considers that this Proposal can be managed to meet the EPA's objective for this factor.
Vibration effects on subterranean habitats from blasting activities. Blasting activities could potentially alter underground structure which may result in loss of subterranean fauna habitat through collapse of voids or the creation of subterranean fauna habitat through rock fragmentation.	The Proposal is expected to result in vibration effects on subterranean habitats from blasting activities. However, any vibration effects on subterranean fauna habitat are likely to be localised and as such blasting is not considered a significant impacting activity. Specific management measures are therefore not proposed.	The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Degradation of potential subterranean fauna habitat as a result of contamination. Contamination of soil or groundwater has the potential to reduce the quality of subterranean fauna habitat.	The Proposal could potentially result in the degradation of potential subterranean fauna habitat as a result of contamination. However, any contamination is likely to be localised and as such is not considered a significant impacting activity. Rio Tinto has well established strategies for the management of contamination at its Pilbara operations. These management strategies will continue to be implemented to manage the potential degradation of potential subterranean fauna habitat as a result of contamination. **Other legislation:** Groundwater quality has been, and will continue to be, managed in accordance with the existing Groundwater Licence GWL98740, issued under the RIWI Act and associated Groundwater Operating Strategy, and any amendments as required.	The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

8. HYDROLOGICAL PROCESSES

This Section describes the hydrological and hydrogeological systems that exist within the West Angelas region, provides details regarding the potential impacts to those hydrological and hydrogeological systems from the proposed surface water diversion, groundwater dewatering and the surplus water management strategy that form part of this Proposal and management to ensure that the proposal meets the EPA's objectives for hydrological processes.

8.1 EPA Objective

The EPA applies the following objective from the *Statement of Environmental Principles, Factors and Objectives* (2016) in its assessment of proposals that may affect hydrological processes:

> *To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.*

8.2 Policy and Guidance

The following EPA guidelines and guidance have been considered in the assessment of subterranean fauna with respect the above EPA objective:

- EPA *Statement of Environmental Principles, Factors and Objectives* (2016).
- EPA *Environmental Factor Guideline: Hydrological Processes* (2016).

The following policies relevant to the protection of surface water and groundwater have also been considered:

- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) *Australian Water Quality Guidelines for Fresh and Marine Waters* (2000).
- Water and Rivers Commission *Statewide Policy No 5: Environmental water provisions policy for Western Australia* (2000).
- Department of Water *Water Quality Protection Guidelines No. 1 to 11* and *Water Quality Protection Note 22* (2008).
- *Pilbara Water in Mining Guideline* (2009).
- *Western Australian Water in Mining Guideline* (2013).
- Department of Water *Strategic policy 2.09: Use of mine dewatering surplus* (2013).

8.3 Receiving Environment

8.3.1 Hydrology

Regionally, the majority of the West Angelas deposits (Deposits A, A west, B, E and the F1 and F2 orebodies of Deposit F) are located within the upper reaches of the Turee Creek Catchment, immediately west of the regional catchment divide separating Ashburton River Catchment from the Fortescue River Catchment. The regional Turee Creek Catchment is approximately 7,400 km^2. Deposits C, D and G are also located in the upper reaches of the Turee Creek Catchment. The upper catchment has a complex drainage pattern characterised by intermittent flow and infrequent wide-spread flooding, depending on the occurrence of high intensity rainfall events.

The F3 orebody of Deposit F is located in the upper reaches of the Weeli Wolli Creek catchment, part of the regional Upper Fortescue River catchment, immediately east of the regional Ashburton River catchment.

Turee Creek, an ephemeral tributary of the Ashburton River, represents the most significant named watercourse in the region.

The east branch of Turee Creek (Turee Creek East) represents the most significant named watercourse in the West Angelas Project area. Immediately upstream of the confluence with Turee Creek, Turee Creek East has a catchment area of approximately 2,050 km^2. This catchment has been progressively reduced due to existing mining operations. The existing West Angelas Project has reduced the Turee Creek East catchment by approximately 85 km^2 (4%). This Proposal will further reduce the Turee Creek East catchment by approximately 2%.

Turee Creek East is an ephemeral watercourse which flows depending on the occurrence of high intensity rainfall events, typical of Pilbara watercourses. Turee Creek East flows generally westward across the West Angelas Project, continuing west south-westerly through the Karijini National Park, before merging with Turee Creek (Turee Creek merges with the Hardey River, which flows into the Ashburton River). A number of the West Angelas deposits (including Deposits A, B, E and F) and proposed deposits (including Deposits C, D and G) are intersected by tributaries of Turee Creek East (Figure 8-1). Existing diversions direct surface water flows from local ephemeral tributaries away from operational deposits.

Immediately downstream of Deposits C and D, Turee Creek East flows through Karijini National Park. Surface water flows along Turee Creek East are attenuated where the creek passes between two large hills that encroach into the flow channel approximately 7 km downstream of the boundary of Karijini National Park, reducing upstream flow velocity. Over time this attenuation has resulted in the deposition of sediment upstream of the topographic feature resulting in a lowering of the channel gradient. Upstream of the feature the channel gradient is 0.0022 m/m while downstream it is 0.0045 m/m. Additionally, surface water flows along Turee Creek East are naturally ponded behind the Mount McRae Shale which outcrops across the creek, resulting in the formation of surface water pools that may persist for an extended period following flow events.

Paperbark Spring on Turee Creek East is the closest permanent or semi-permanent surface water feature, located more than 60 km from West Angelas. The only local surface water features are transient, local depressions filled following rainfall events and dissipated via natural infiltration and evaporation shortly after.

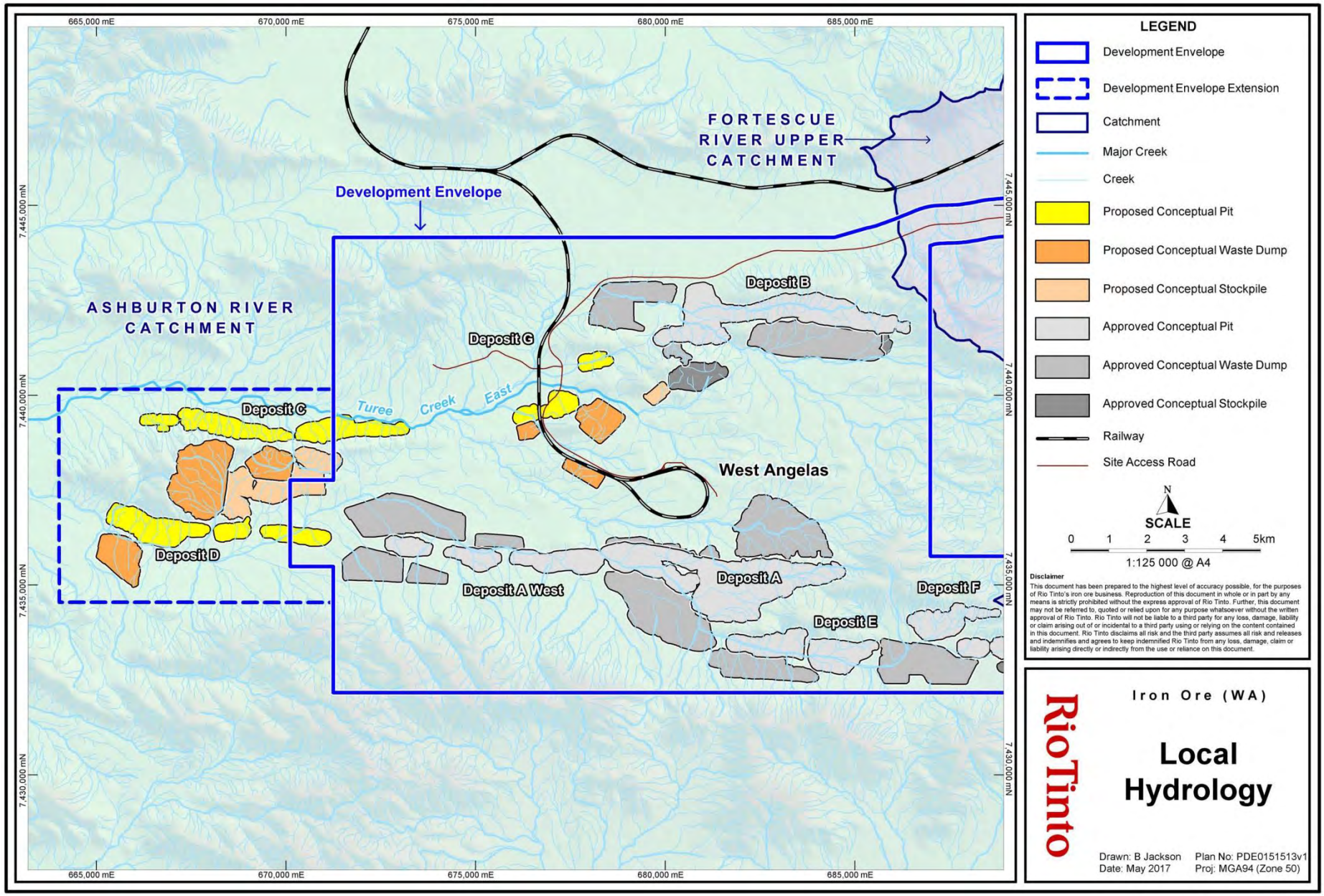

Figure 8-1: Local hydrology

Deposit C

Deposit C is located on the northern slope of a steep local ridge characterised by incised gullies. Turee Creek East is located north of Deposit C, flowing in a westerly direction. The eastern extent of Deposit C (Pit 3) intersects the 1% AEP (100 year ARI) floodplain of the Turee Creek East tributary. Several small tributaries flowing from the south into Turee Creek East are also intersected by Deposit C (eastern extent of Pit 2 and eastern extent of Pit 3) (Figure 8-2).

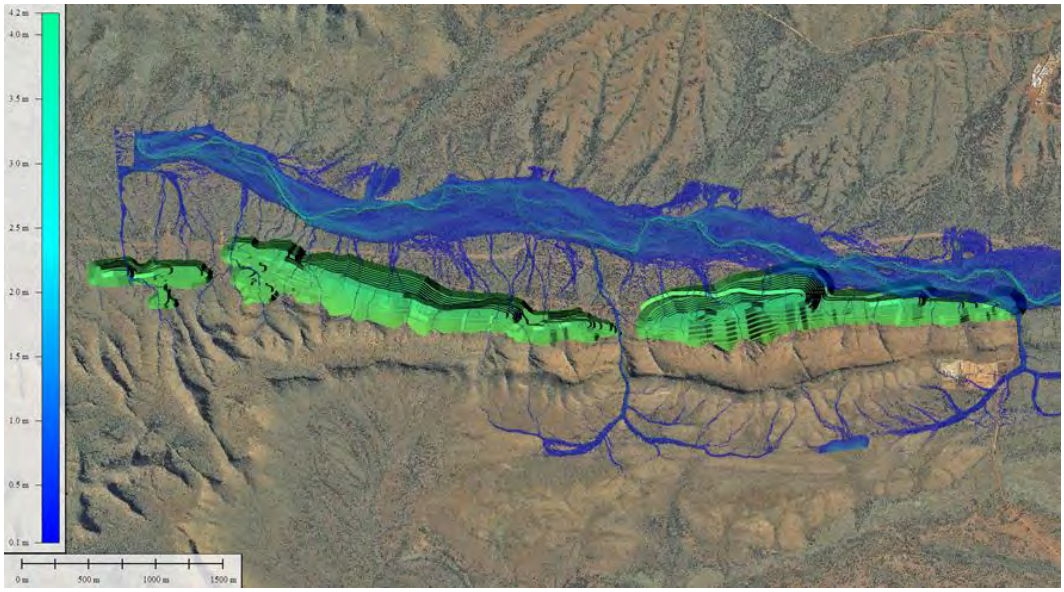

Figure 8-2: Maximum extent of 1% AEP flood event under existing conditions at Deposit C

Prior to existing operations, Turee Creek East had a contributing catchment of approximately 207 km^2 upstream of Deposit C. The existing West Angelas Project has reduced this catchment by approximately 85 km^2 (41%) such that Turee Creek East currently has a contributing catchment of approximately 122 km^2 upstream of Deposit C.

Deposit D

Deposit D is located at the base of a range of east – west oriented hills to both its north and south. The hills are characterised by steep, incised drainage channels, however, as the channels extend out from the hillside to the very flat valley floor, they transform into shallow, poorly defined drainage lines.

The southern tributary of Turee Creek East (Turee Creek East South) flows in an east – westerly direction across the valley floor and joins Turee Creek East west of Deposit D.

The eastern extent of Deposit D (Pit 3) intersects Turee Creek East South. Several small tributaries flowing from the north into Turee Creek East South are also intersected by Deposit D (eastern extent of Pit 1) (Figure 8-3).

Turee Creek East South has a contributing catchment of approximately 43 km^2 upstream of Deposit D (Pit 3) with additional contributing areas from the south until the confluence with Turee Creek East.

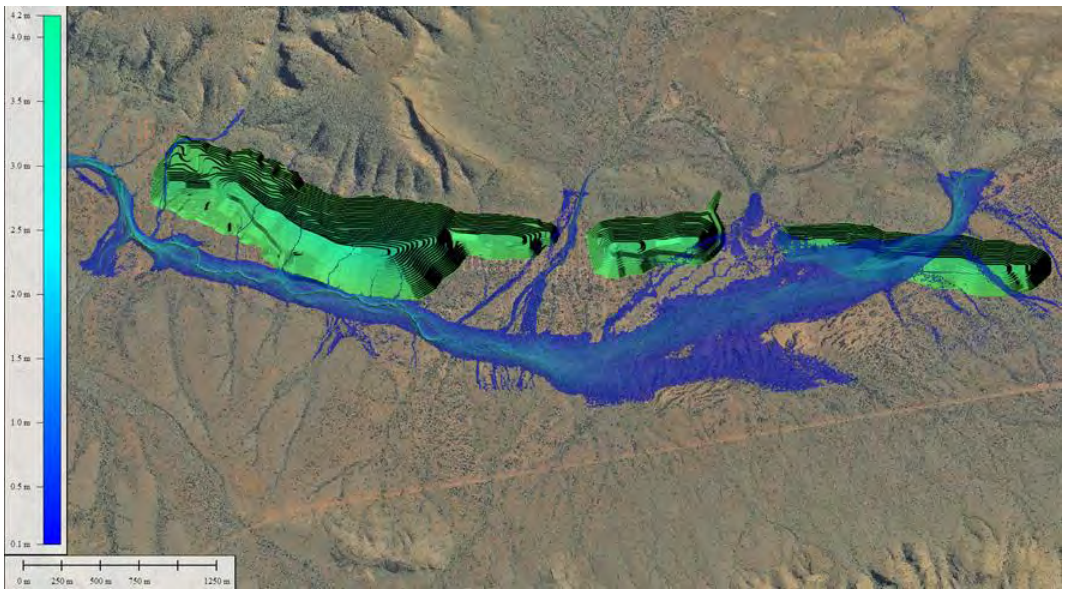

Figure 8-3: Maximum extent of 2% AEP flood event under existing conditions at Deposit D

Deposit G

Deposit G is a series of relatively small pits (Pit 1 / South, Pit 2 / Central and Pit 3 / North) located immediately west of Deposit B. Pit G1 (South) has the largest catchment contribution of approximately 3 km^2. Pit G3 (North) has a contributing catchment of approximately 1.8 km^2.

An unnamed ephemeral creek flows between Pit G2 (Central) and G3 (North). Prior to existing operations, this creek had a contributing catchment of approximately 11 km^2. However, the diversion of surface water from Padtherung Creek, south of Deposit B, has increased the catchment such that this creek currently has a contributing catchment of approximately 54 km^2.

8.3.2 Hydrogeology

The Pilbara is situated in the south-eastern comer of the Archaean Pilbara Craton. The craton is overlain overlain by the iron-ore-bearing sedimentary rocks of the Fortescue and Hamersley Basins. The Hamersley Basin is divided into three stratigraphic groups: the Turee Creek Group, Hamersley Group and Fortescue Group; the late Archean to early Proterozoic Hamersley Group (which hosts all of the banded iron formation derived iron ore deposits of the Hamersley Province) is underlain by the Archean Fortescue Group and overlain by the Proterozoic Turee Creek Group. The formations of the Hamersley Group that exist within the West Angelas region (in order of increasing age) are:

- Brockman Iron Formation.
- Mount McRae Shale.
- Mount Sylvia Formation.
- Wittenoom Formation, comprising:
    - Bee Gorge Member;
    - Paraburdoo Member; and
    - West Angela Member.
- Marra Mamba Iron Formation, comprising:

- Mount Newman Member;
- MacLeod Member; and
- Nammuldi Member.

Mineralisation at West Angelas is associated with the Mount Newman Member of the Marra Mamba Iron Formation (with some minor mineralisation present in the overlying West Angela Member of the Wittenoom Formation and the Tertiary Detritals).

The main structural feature of the West Angelas region is the regional, west plunging, east-west trending Wonmunna Anticline. The Wonmunna Anticline hosts a series of discontinuous deposits; (from west to east) Deposits C, G, B and H are located along the northern limb while Deposits D, A, E and F are located along the southern limb (Figure 8-4).

The centre of the regional anticline contains a low-lying plateau of Jeerinah Formation (Fortescue Group). Groundwater elevations in the Jeerinah Formation are relatively shallow, ranging between 10 - 20m bgl. Groundwater flow across the Jeerinah Formation is characterised by steep hydraulic gradients (except where there are local fracture systems associated with regional lineaments), indicative of relatively low permeabilities associated with this formation and lack of hydraulic connection between the central plateau and flanking valleys.

The central plateau is bounded to the north and south by valleys sub-cropped by the Marra Mamba Iron Formation and Wittenoom Formation and infilled with Tertiary Detritals (colluvium / alluvium) (Hamersley Group). Groundwater levels in the valleys are generally very deep ranging between 50 - 120m bgl. Topographic elevation falls trending westerly such that the groundwater is nearer to the surface, from 685m RL (Deposit F) to 625m RL (Deposit D).

The Marra Mamba Iron Formation is divided into three Members: the Mount Newman Member (top), MacLeod Member (middle) and Nammuldi Member (bottom). Mineralisation is associated with the Mount Newman Member of the Marra Mamba Iron Formation (with some minor mineralisation present in the overlying West Angela Member of the Wittenoom Formation and the Tertiary Detritals). Where below the water table, the mineralised Marra Mamba Iron Formation and overlying and Wittenoom Formation and Tertiary age Detritals represent a locally significant aquifer. Secondary permeability within the Marra Mamba Iron Formation (Mount Newman and MacLeod Members) and overlying Wittenoom Formation (West Angela Member) is expected to be associated with mineralisation and fractures.

Groundwater flow is generally characterised by flat hydraulic gradients, indicative of enhanced permeabilities associated with these formations, produced by processes related to the enrichment of iron and typical of mineralised deposits of the Pilbara region. Significant gradients occasionally occur from one deposit to another over relatively short distances, these anomalies are thought to be indicative of a series of discrete ‘bath-tub’ aquifers separated by intrusive formations such as dykes and features such as folding and faulting.

The Wittenoom Formation, which overlies the Marra Mamba Iron Formation, is divided into three Members: the Bee Gorge Member (top), Paraburdoo Member (middle) and West Angela Member (bottom). North of Deposit C, where the groundwater is within 2m of the surface, the Bee Gorge and Paraburdoo Members have been subject to weathering processes resulting in secondary permeability, typical of the Pilbara region, and these formations represent a locally significant aquifer. This aquifer is conceptualised to be hydraulically connected with the mineralised Marra Mamba and Wittenoom Formations.

The regional watertable, and particularly the juxtaposition of the Jeerinah Formation and the adjacent mineralised Marra Mamba and Wittenoom Formations, is relatively complex. Groundwater levels decline steeply between the Jeerinah Formation (10 - 20m bgl) and the flanking mineralised Marra Mamba Iron Formation in the valleys (50 - 120m bgl), indicative of lack of hydraulic connectivity. Any groundwater flow from the Jeerinah Formation to the valleys is thought to follow surface watercourses, where groundwater levels are higher and permeability is increased associated with unconsolidated alluvial deposits.

The mineralised Marra Mamba and Wittenoom Formations are overlain by a widespread regolith of 'hydrated' material (produced by secondary weathering processes) and detritals. Hydrated materials were commonly intersected close to the surface and were generally 20 – 50m thick. Mineralisation is also overlain by a layer of surficial detritals (Tertiary and Quaternary alluvium / colluvium). Detritals intersected were as thick as 60m (Deposit C) and 84m (Deposit D). Where below the water table, hydrated material and detritals represent a locally significant aquifer.

The mineralised Marra Mamba and Wittenoom Formations are underlain by unmineralised basal Marra Mamba and Jeerinah Formations. Groundwater is confined at depth by these formations which form effective hydraulic barriers to groundwater flow. No major regional aquifer has been encountered to date.

The valleys are bounded (furthest from the Jeerinah Formation) by high ridges of unmineralised Brockman Iron Formation, separated by bands of Mount McRae Shale / Mount Silvia Formation. Groundwater is confined by these formations which form effective hydraulic barriers to groundwater flow.

Shallow groundwater systems are expected to be recharged both directly and indirectly by seasonal rainfall and infiltration from ephemeral surface water flows. However, due to the depth to groundwater, as well as the thickness of the detritals, recharge of the groundwater is expected to be low.

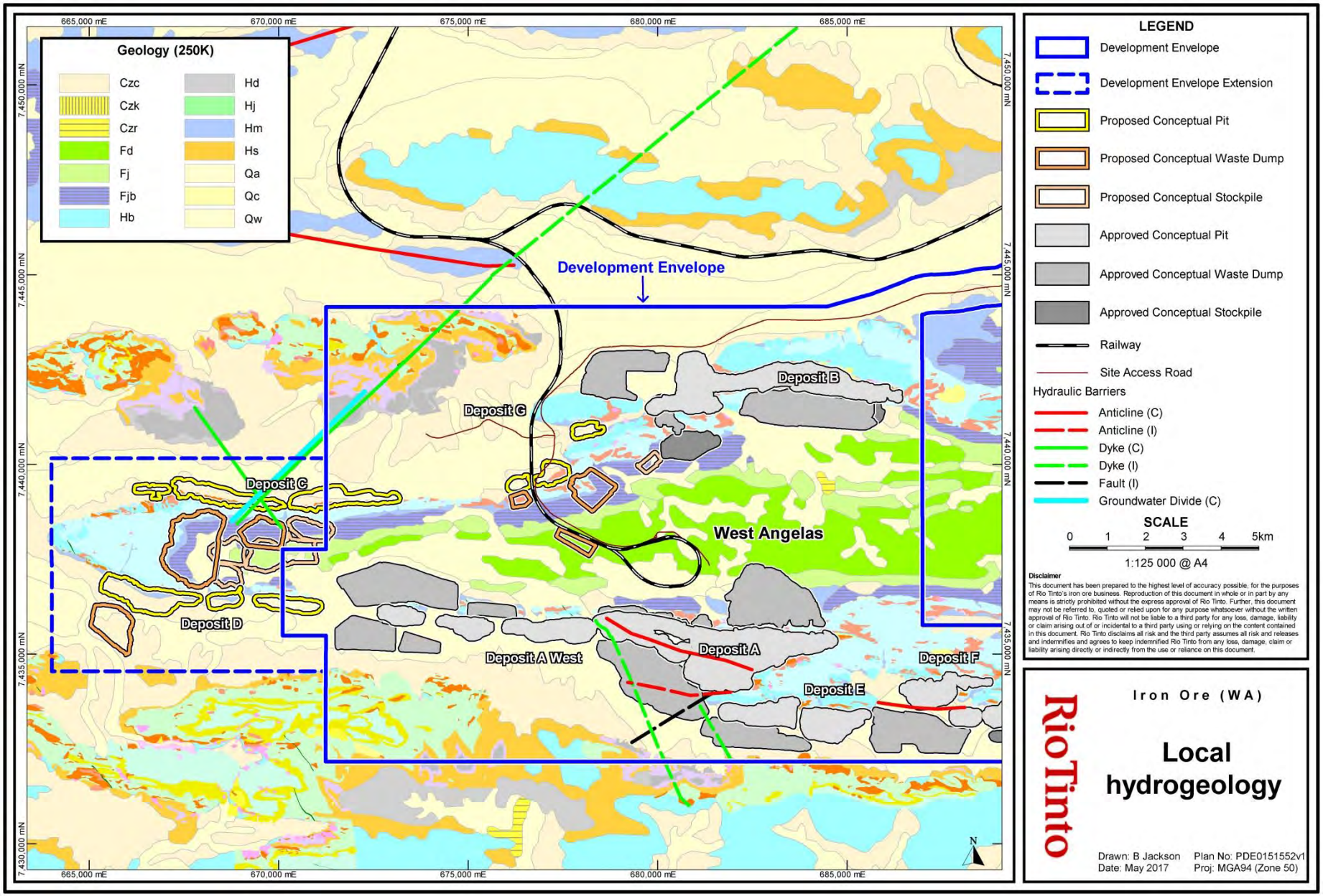

Figure 8-4: Local hydrogeology

Deposit C

Deposit C, occupying the northern limb of the west plunging, east west trending Wonmunna Anticline, is structurally relatively simple, dominated by lithology dipping gently to the north. The deposit, incorporating three pits (C1, C2 and C3), is located west of Deposit B with a strike length of approximately 8 km.

Mineralisation in Deposit C is predominately contained in the Mount Newman Member of the Marra Mamba Iron Formation. Minor mineralisation is also observed in the West Angela Member of the overlying Wittenoom Formation, and also in the underlying MacLeod Member of the Marra Mamba Iron Formation. Typical throughout the region, hydrated material and detritals cover the deposit. The detrital layer is up to 60m thick (Figure 8-5, Figure 8-6).

Observations indicate that up to approximately 30% of the Deposit C resource is below the water table. Mining is scheduled to commence in Deposit C in 2019, with subsequent below water table mining between 2023 and completion of operations in approximately 2027. Dewatering is anticipated to occur over six years (the proposed dewatering strategy requires commencement of dewatering one year in advance of below water table mining in 2022 to ensure appropriate lowering of the water table). The expected maximum depth of mining is the 568m RL, with an associated maximum depth of dewatering of up to approximately 68m in the eastern end of the deposit.

Based on the above results, and assuming pumping commences one year in advance of below water table mining, the proponent conservatively estimates that up to approximately 23 GL of groundwater will need to be pumped from Deposit C (commencing in 2022).

The mineralised Marra Mamba Iron Formation (Mount Newman Member) and the surrounding Wittenoom Formation (West Angela Member) are conceptualised to be in hydraulic connection with each other with evidence of a groundwater divide; a natural dolerite dyke through the centre of the deposit (Figure 8-7). Groundwater table elevation monitoring at Deposit C indicates the groundwater table ranges from 635m RL (approximately 55m bgl) on the eastern side of the dyke (Pit C3) to 623m RL (approximately 67m bgl) on the western side of the dyke (Pits C1 and C2). Groundwater table monitoring at the nearby Deposit B (east of Deposit C, Pit C3) indicates the groundwater table is approximately 630m RL.

Regional groundwater east of the dyke (Deposit C, Pit C3 and Deposit B) flows to the east, towards Deposit B. Regional groundwater west of the dyke (Deposit C, Pit C1 and C2, Deposit D and the western extent beyond the Deposits) flows to the west, towards Karijini National Park.

Based on observed differences in groundwater elevation (of up to 12m) on the eastern and western side of the dyke and an assumed differences in regional groundwater flow direction on the eastern and western side of the dyke, it is assumed that the presence of the dyke forms an effective hydraulic barrier to groundwater flow between the eastern and western ends of Deposit C.

Deposit C is underlain and bounded to the south by the unmineralised Marra Mamba Iron Formation (MacLeod and Nammuldi Members) and the underlying Jeerinah Formation. Consistent with experience at West Angelas and other Pilbara operations, these formations are considered to form an effective hydraulic barrier to groundwater flow (no-flow) at the basement and to the south of Deposit C. There is also an assumed hydraulic barrier to groundwater flow (no-flow) associated with the Mount McRae Shale Formation to the north of Deposit C (Figure 8-6). However, it is assumed that groundwater connectivity exists between the western end of Deposit C (west of the dyke) and the west with groundwater flow direction following this trend. Dewatering on the western side of the dyke is likely to extend west.

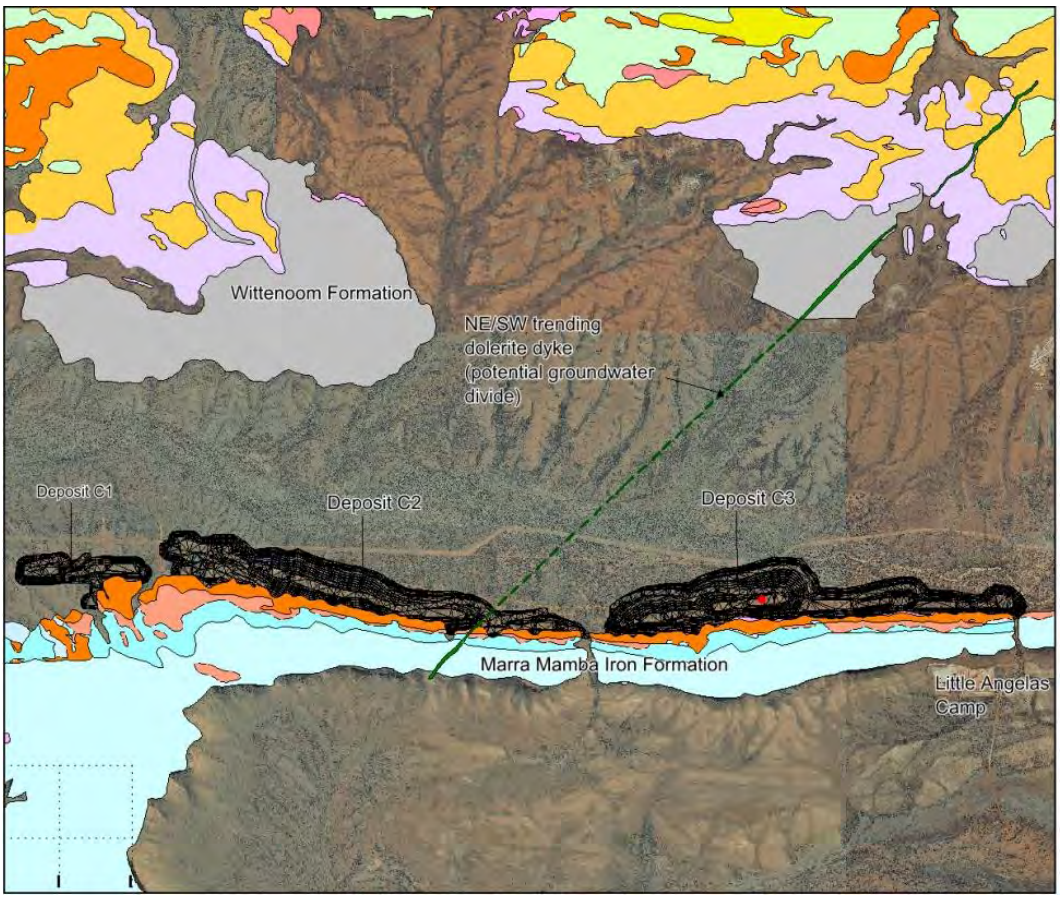

Figure 8-5: Local geology, Deposit C

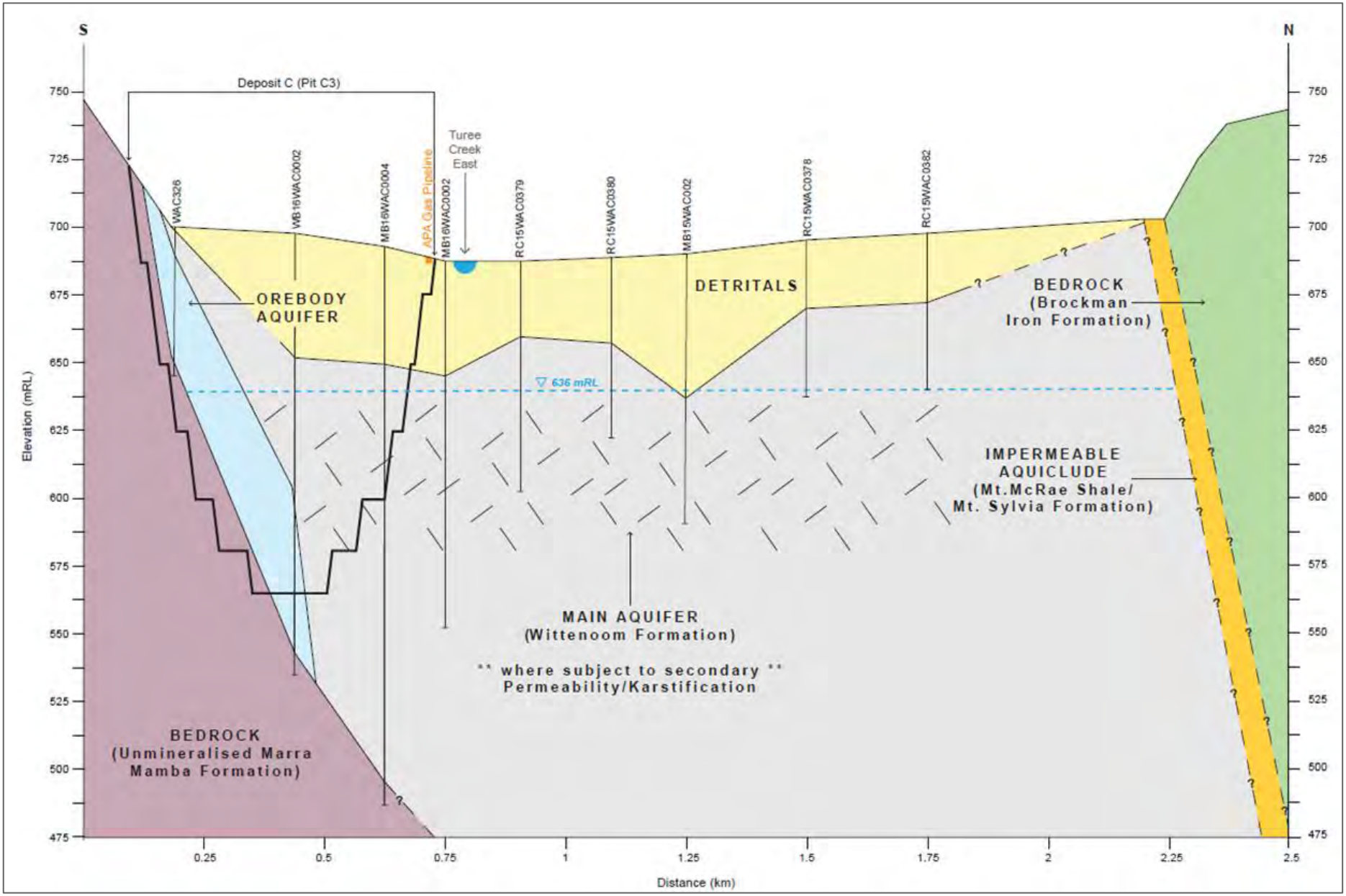

Figure 8-6: Hydrogeological conceptualisation, Deposit C cross section (north-south)

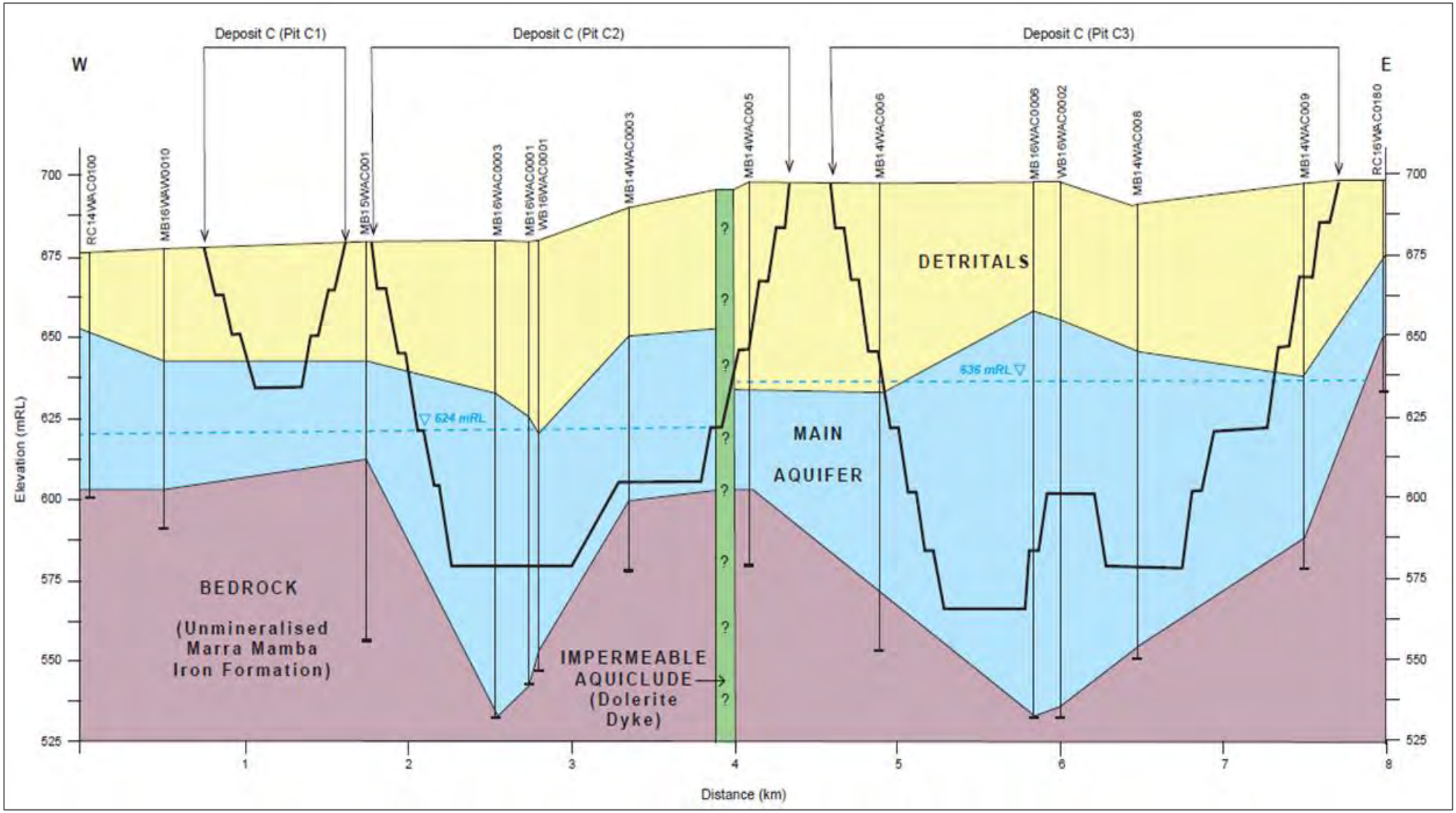

Figure 8-7: Hydrogeological conceptualisation, Deposit C cross section (east-west)

Deposit D

Deposit D, occupying the southern limb of the west plunging, east west trending Wonmunna Anticline, is structurally more complex but generally dominated by lithology dipping gently to the south. The deposit, incorporating three pits (D1, D2 and D3), is located immediately west of Deposit A west with a strike length of approximately 7 km.

Mineralisation in Deposit D is predominately contained in the Mount Newman Member. Minor mineralisation is also observed in the West Angela Member of the overlying Wittenoom Formation. Insignificant mineralisation is noted in the underlying MacLeod Member of the Marra Mamba Iron Formation. Typical throughout the region, hydrated material and detritals cover the deposit. The detrital layer is up to 84m thick (Figure 8-8).

Observations indicate that approximately 51% of the Deposit D resource is below the water table. Mining is scheduled to commence in Deposit D in 2020, with subsequent below water table mining between 2022 and 2030, and completion of operations in approximately 2031. The proposed dewatering strategy requires commencement of dewatering one year in advance of below water table mining in 2021 to ensure appropriate lowering of the water table). The expected maximum depth of dewatering is up to approximately 130m in the western end of the deposit.

Based on the above results, and assuming pumping commences one year in advance of below water table mining, the proponent conservatively estimates that up to approximately 23 GL of groundwater will need to be pumped from Deposit D (commencing in 2021).

The mineralised Marra Mamba Iron Formation (Mount Newman Member) and the surrounding Wittenoom Formation (West Angela Member) are conceptualised to be in hydraulic connection with each other. The groundwater gradient is relatively flat across the area, with the groundwater flow direction to the west. Groundwater table elevation monitoring at Deposit D indicates the groundwater table sits between 625m RL (approximately 58m bgl) in the east and 624m RL (approximately 53m bgl) in the west.

Dolerite dykes are present throughout the deposit. Evidence of a groundwater divide; a natural dolerite dyke to the east of the deposit has been observed forming an effective hydraulic barrier to groundwater flow (no-flow) between Deposits D and A.

Deposit D is underlain and bounded to the north by the unmineralised Marra Mamba Iron Formation (MacLeod and Nammuldi Members) and the underlying Jeerinah Formation. Consistent with experience at West Angelas and other Pilbara operations, these formations are considered to form an effective hydraulic barrier to groundwater flow (no-flow) at the basement and to the north of Deposit D. There is also an assumed hydraulic barrier to groundwater flow (no-flow) associated with the Mount McRae Shale Formation to the south of Deposit D (Figure 8-8). However, it is anticipated that groundwater connectivity exists between Deposit D and the west with groundwater flow direction following this trend. Dewatering of Deposit D is likely to extend west.

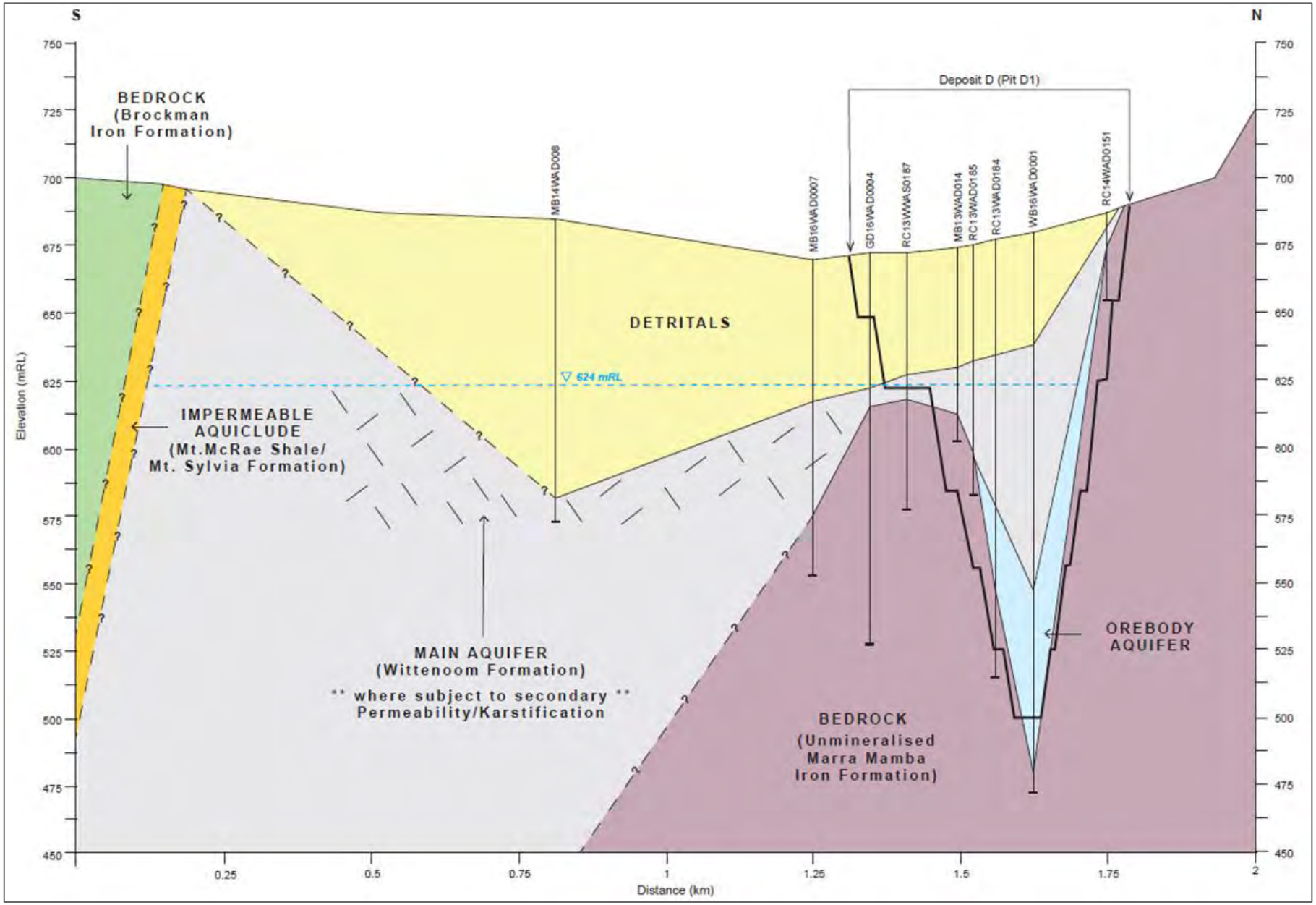

Figure 8-8: Hydrogeological conceptualisation, Deposit D cross section (north-south)

Western extent

Moving west of Deposits C and D, at the western end of the west plunging Wonmunna anticline, the bedded strata dip regionally to the west. The groundwater table west of Deposits C and D and within the south-eastern Karijini National Park occurs in the Wittenoom Formation. The Wittenoom Formation in this area is assumed to have been subjected to weathering resulting in secondary permeability.

The results of monitoring indicate a relatively flat groundwater gradient in the area, the groundwater table is approximately 623 to 624m RL (suggesting relatively slow lateral groundwater flow) with groundwater flow direction to the west. Based on the decreasing topographic elevation from east to west, the depth to groundwater decreases moving from east to west, from approximately 50m bgl to approximately 6.5m bgl in the bore located approximately 2.5 km within the boundary of Karijini National Park (WANG14).

The aquifer thickness also decreases from east to west and 'pinches' out at the Mount McRae Shale outcrop in the west (Figure 8-9 and Figure 8-10). It is assumed that the Mount McRae Shale Formation forms a hydraulic barrier to groundwater flow (no-flow) to the north and south. Due to the regional structure of the Wonmunna anticline, it is also assumed that the Mount McRae Shale Formation wraps around the western part of the valley and forms a hydraulic barrier to groundwater flow (no-flow) to the west, approximately 5 km inside the boundary of Karijini National Park.

Dewatering of the western end of Deposit C and Deposit D is predicted to extend west of the Deposits. The predicted extent of the drawdown during mining does not extend to Karijini National Park. However the drawdown is expected to continue to extend and have an unmitigated drawdown of the groundwater of between 3m and 9m beneath Karijini National Park after 2030, when mining is planned to cease.

Due to the depth to groundwater, as well as the thickness of the detritals, recharge of the groundwater is expected to be low. Given the low recharge, recovery of the groundwater elevation is conservatively assumed not to occur. As such, the drawdown of the groundwater of between 3m and 9m beneath Karijini National Park is modelled to continue to persist beyond 100 years.

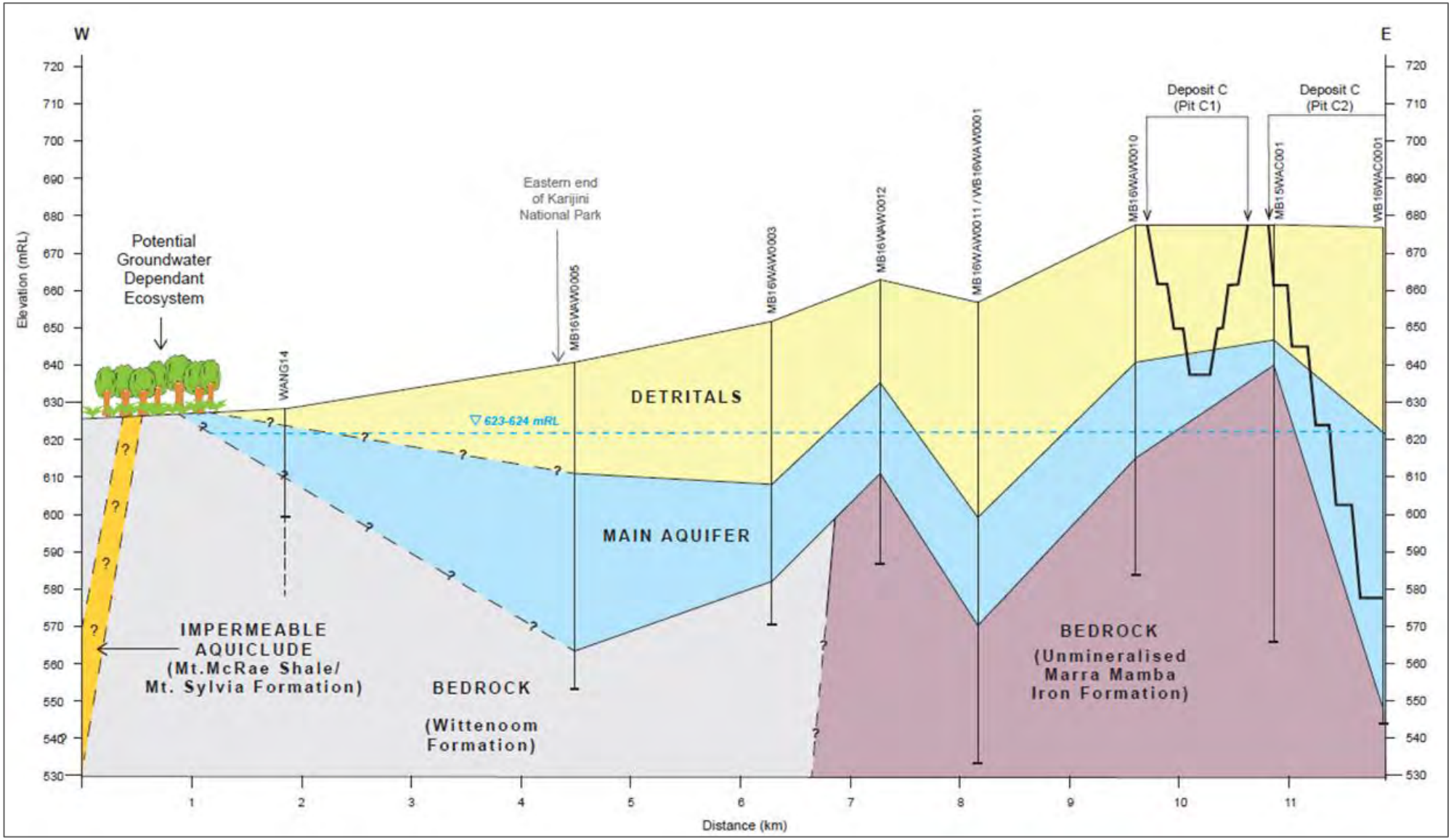

Figure 8-9: Hydrogeological conceptualisation, cross section west of Deposit C (east-west)

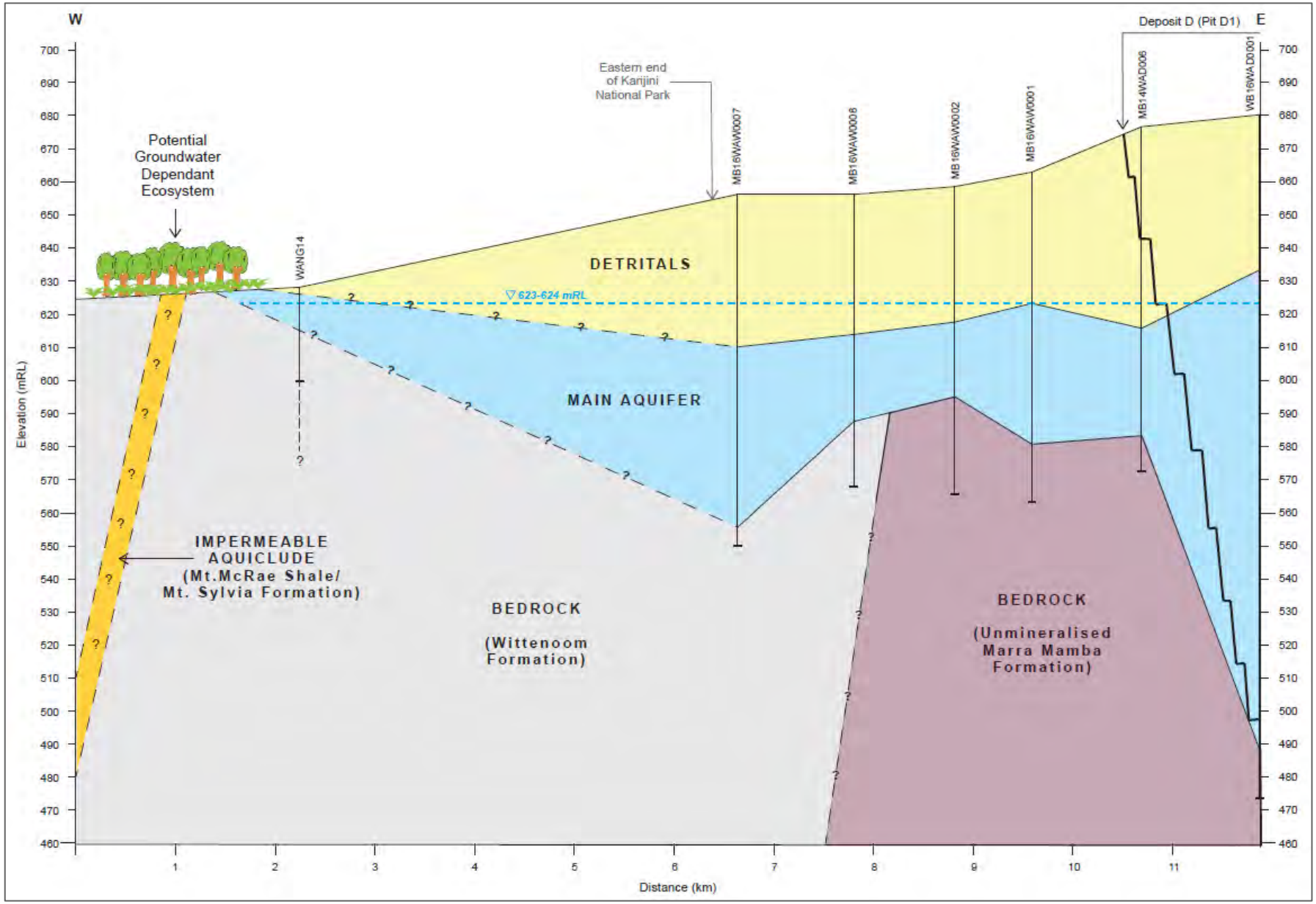

Figure 8-10: Hydrogeological conceptualisation, cross section west of Deposit D (east-west)

Deposit G

Deposit G sits on the northern limb of the west plunging, east west trending Wonmunna Anticline. The deposit, incorporating three pits (G1, G2 and G3), is located immediately west of Deposit B with a strike length of approximately 2 km.

Mineralisation in Deposit G is predominately contained in the Mount Newman Member. Minor mineralisation is also observed in the West Angela Member of the overlying Wittenoom Formation.

Groundwater table elevation monitoring at Deposit G indicates the groundwater table sits at approximately 635m RL (between approximately 85m bgl in the east and 75m bgl in the west). Only negligible below water table resource occurs at Deposit G (approximately 3%). Based on the current mining schedule, mining is scheduled to commence in Deposit G in 2022, with subsequent below water table mining commencing in 2025 (Pit G2) and 2028 (Pit G1). The expected maximum depth of mining in Pit G2 is approximately 632m RL (only 3m below the inferred water table elevation). The expected maximum depth of mining in Pit G1 is approximately 608m RL, with an associated maximum depth of dewatering of up to approximately 27m. Dewatering is anticipated to occur one year in advance of below water table mining at Pit G1 in 2027. It is assumed that these pits will be dewatered via in-pit sump pumping. Pit G3 is 100% above the water table.

Based on the above results, and assuming pumping commences one year in advance of below water table mining, the proponent conservatively estimates that up to 2.14 GL of groundwater will need to be pumped from the site (commencing in 2027).

Consistent with experience at West Angelas and other Pilbara operations, the lower, unmineralised Marra Mamba Iron Formation (MacLeod and Nammuldi Members) are considered to form an effective hydraulic barrier to groundwater flow (no-flow) to the south-southeast of Deposit G. There is also an assumed hydraulic barrier to groundwater flow (no-flow) associated with the Mount McRae Shale Formation to the north-northwest. It is assumed groundwater connectivity exists west to east with groundwater flow direction following this trend.

8.3.3 Surplus Water Management

West Angelas has historically been considered a water neutral site; whereby operational water demand is roughly equivalent to dewatering requirements. This is in contrast to most sites currently operated by Rio Tinto in the East Pilbara where dewatering volumes are much greater than demand, requiring management of significant volumes of surplus dewatering water. While the site as a whole has historically been water neutral in terms of water balance, the water management of each deposit is different with some in deficit and others in surplus. As above water table resources are depleted and below water table resources are developed, dewatering volumes are expected to exceed demand.

To ensure effective management of dewatering and operational demand volumes, water sources across West Angelas have historically been integrated. West Angelas' integrated water management strategy is aligned with the Department of Water '*Western Australian water in mining guideline'* (2013) which identifies options for use and / or release of dewatering discharge.

Currently, dewatering water is used onsite in the first instance to supply water to meet operational water demand. Any dewatering water that remains after operational requirements have been met constitutes surplus dewatering water. Currently, surplus dewatering water, exceeding the operational water demand, is discharged via an existing discharge point to the Turee Creek East tributary in accordance with existing Licence L7774/2000 issued by the Department of Environmental Regulation under Part V of the EP Act.

To ensure effective management of dewatering and operational demand volumes at future operations, this integrated water management strategy will continue to be implemented. Water balances have been developed for Deposits C, D and G to understand water supply and demand requirements and potential surplus dewatering water management.

Deposits C and D

Up to approximately 30% of the Deposit C resource and 50% of the Deposit D resource is below the water table and will therefore require dewatering to enable mining below the water table. Based on the results of modelling, it is currently estimated that up to approximately 8 GL of groundwater will need to be abstracted annually to allow below water table mining from Deposits C and D. Dewatering will be required to commence one year in advance of below water table mining, in approximately 2022, to ensure appropriate lowering of the water table, however, abstraction from dewatering bores will supply local water demands during the initial years of above-water table mining (2019-2021).

Abstraction of groundwater at West Angelas has previously been approved. Up to 5,380,000 kL (approximately 5.4 GL/a) of groundwater is licensed to be abstracted annually from the Minesite Borefield under Licence L7774/2000, issued by the Department of Environmental Regulation under Part V of the EP Act and Groundwater Licence GWL98740, issued by the Department of Water under the *Rights in Water and Irrigation Act 1914* (RIWI Act) for dewatering and water supply purposes. Groundwater abstraction will continue to be managed under the existing Groundwater Licence and the associated Groundwater Operating Strategy, and any amendments as required.

Dewatering water from Deposits C and D will be integrated with the existing West Angelas operations integrated water management strategy; dewatering water is expected to be used to supply local operational water demand (such as dust control). Operational water demand for Deposits C and D is estimated to be up to 2 GL/a. Any surplus dewatering water, exceeding the local operational water requirement will be transferred to the existing operations to supply operational water demand (such as ore processing and dust control) and / or discharged to the Turee Creek East tributary.

Local discharge of surplus dewatering water from a new discharge point at Deposits C and D was investigated. While attractive from a cost perspective, this option was not progressed in order to eliminate the potential for surface water flows as a result of surplus water discharge to reach Karijini National Park.

The Proponent has conservatively assumed that the balance of surplus dewatering water from Deposits C and D requiring management (via transfer to the existing operations) is up to approximately 6 GL/a. Turee Creek East has been subject to discharge of up to 6 GL/a of surplus dewatering water from existing operations since 2011.

However, consideration of the current and future operational water supply and demand is required to understand the cumulative impacts of discharge of surplus dewatering water to local ephemeral creeks. Deposit B is expected to contribute up to approximately 6 GL/a of surplus dewatering water requiring management. Surplus dewatering water from Deposit B will be discharged from a new discharge point at Deposit B. For discharge rates of less than 9 megalitres per day (ML/d), flow will not reach the confluence with the Turee Creek East tributary that receives flow from Deposits C and D, and as such no cumulative impacts are expected. However, for discharge rates of 12 – 16 ML/day from Deposit B, flow will extend beyond the confluence with the Turee Creek East tributary and interact with flows from Deposits C and D.

Dewatering water artificially discharged to Turee Creek East at an approximately constant rate will flow along the surface of the creek until the inflow (surplus water discharge) is balanced by outflow (infiltration and evaporative), defined as the maximum surface discharge extent. Modelling of the surface discharge extent was undertaken for a number of scenarios (Figure 8-11). The Proponent has conservatively assumed the cumulative balance of surplus dewatering water from Deposits B, C and D requiring management is up to approximately 12 GL/a (16 ML/day from Deposit B and 16 ML/day from Deposits C and D). Based on discharge of up to 12 GL/a, the maximum surface discharge extent is modelled to extend up to 22 km. The surface discharge extent will not extend as far as Karijini National Park (Figure 8-12).

Flows would be contained within the low flow channel(s), overtopping of the creek banks (in dry conditions) is not anticipated since the volume of the discharge flows would be significantly smaller than the volume of natural flows during flood events.

Discharge at West Angelas has been approved under Licence L7774/2000, issued by the Department of Environmental Regulation under Part V of the EP Act for discharge of up to 6 GL/a through the existing discharge outlet (shown on Attachment 2 of Licence L7774/2000) which flows into the Turee Creek East tributary. Existing discharge rarely exceeds 30% of the licence limit (approximately 1-2 GL/a).

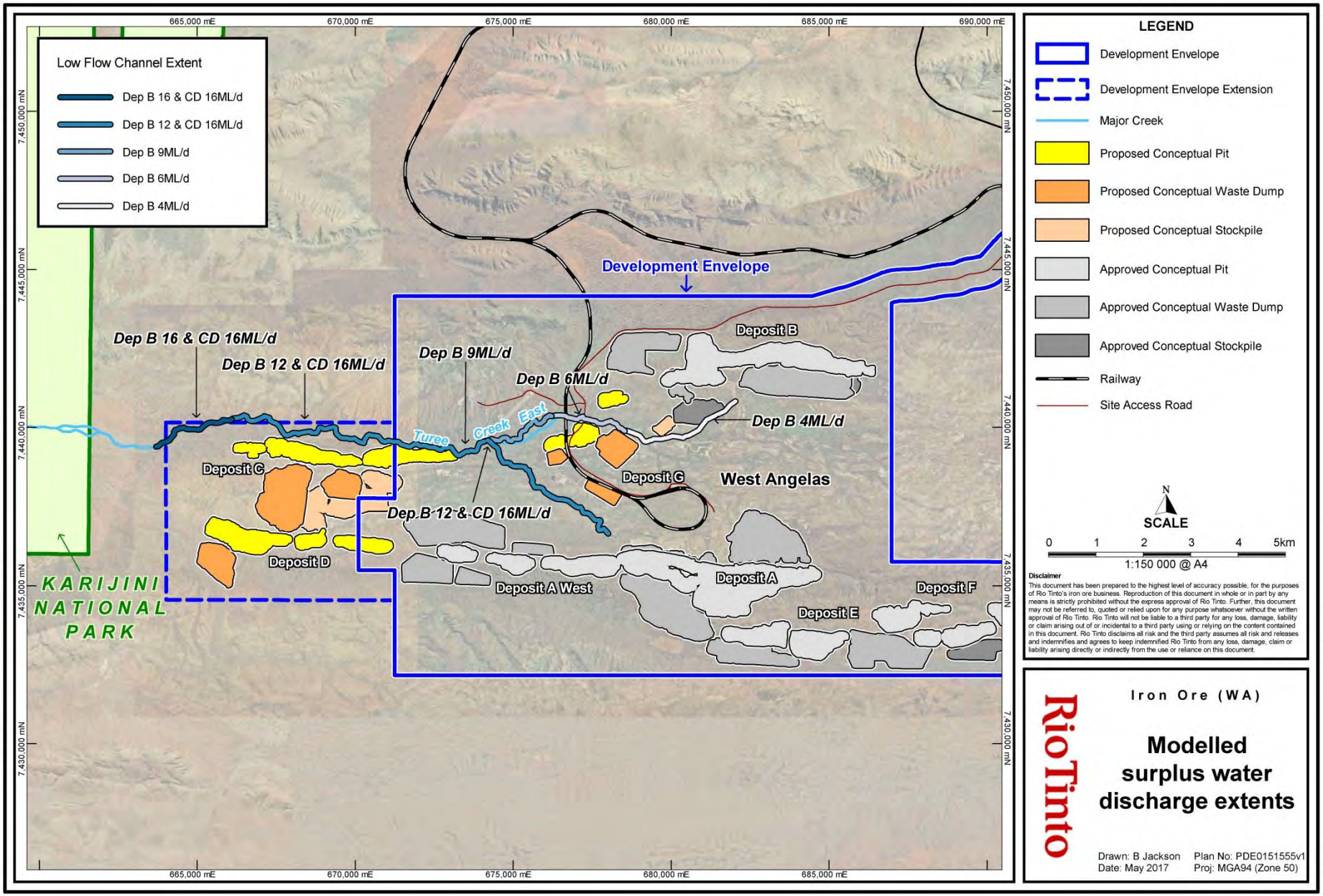

Figure 8-11: Modelled surplus water discharge extents

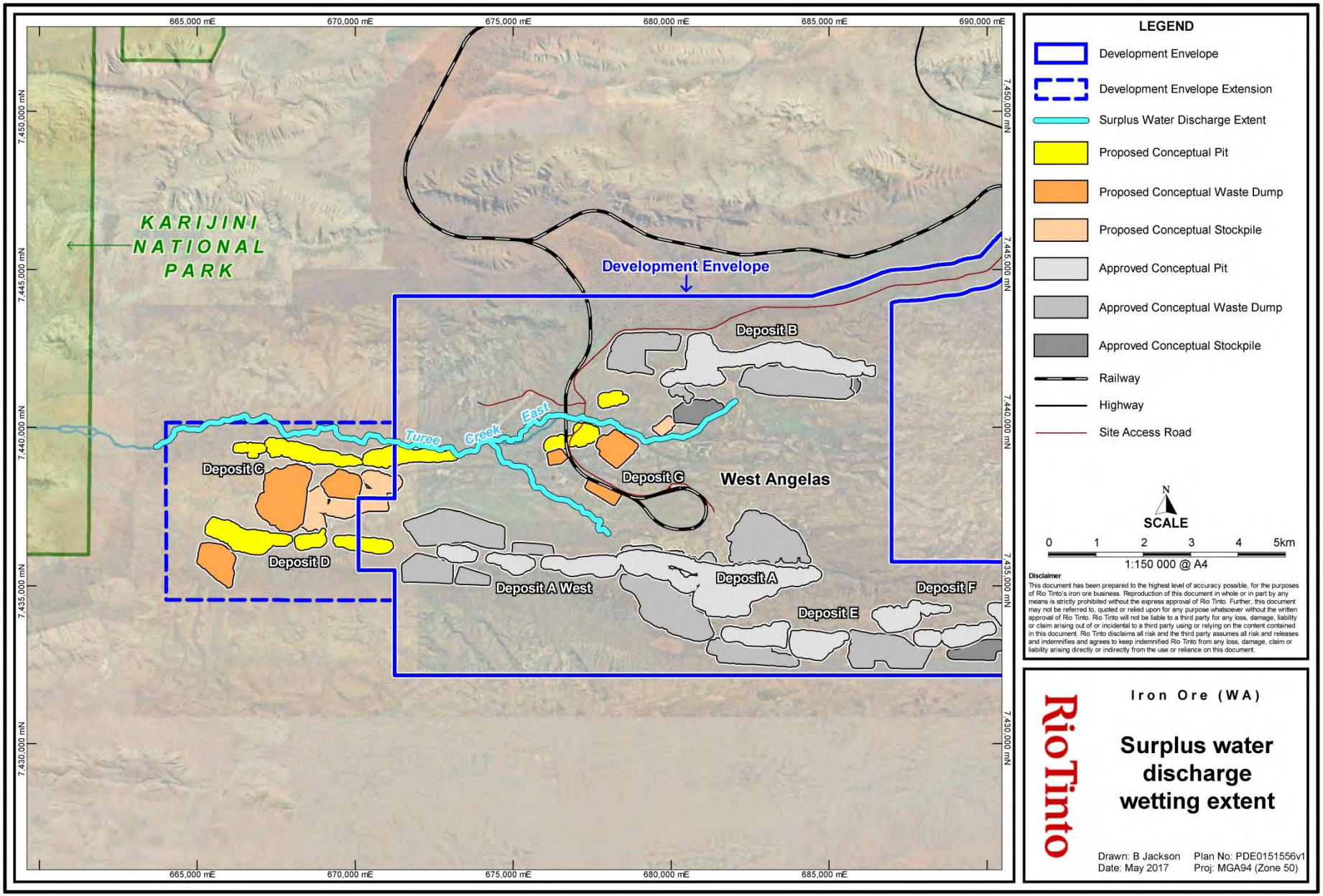

Figure 8-12: Surplus water discharge extent

Deposit G

The Deposit G resource is mostly above the water table and as such, a water deficit is predicted for Deposit G during the initial years of above-water table mining, prior to the commencement of dewatering in Pit G1 in approximately 2027. Additional water sources are likely to be required to meet the operational demand of up to 0.4 GL/a. Water is expected to be supplied from the nearby Deposit A.

Surplus dewatering at Deposit G is only anticipated to occur over the two years of below water table mining in Pit G1 (post the commencement of dewatering in approximately in 2027). Only a small amount of sump dewatering, up to approximately 3 ML/day (approximately 1.1 GL/a), is required, with a small surplus, estimated to be up to approximately 2.8 ML/day (approximately 1 GL/a), available for use elsewhere. Given the short duration and small dewatering volume, surplus dewatering water (up to approximately 1.07 GL/a) is proposed to be managed via discharge through the existing discharge outlet and in accordance with existing limits approved under Licence L7774/2000 issued under Part V of the EP Act.

Potable water supply

Up to 3,102,500 kL (approximately 3.1 GL) of potable groundwater is licensed to be abstracted annually from the Turee B Borefield under Groundwater Licence GWL103136, issued under the RIWI Act for water supply purposes. Currently, abstraction is approximately 60% of the licence allocation (approximately 1.8 GL/a). The preferential use of dewatering water to meet operational water demand reduces reliance on abstraction from the local Turee B Borefield for water supply. Potable groundwater abstraction will continue to be managed under the existing Groundwater Licence and associated Groundwater Operating Strategy, and any amendments as required.

8.4 Assessment of Potential Impacts

Potential impacts to hydrological processes include the following:

- Changes to the hydrological regime of Turee Creek East as a result of mining.
- Changes to the hydrological regime of Turee Creek East as a result of discharge of surplus dewatering water.
- Groundwater drawdown as a result of groundwater abstraction for dewatering purposes.
- Contamination.

Assessment of each of these potential impacts is included below. Mitigation to address these potential impacts and predicted outcomes is presented in Table 7-5.

8.4.1 Changes to the hydrological regime of of Turee Creek East as a result of mining

With no flood protection, water from Turee Creek East would flow into Deposit C (Pit 3). A significant reduction of flow through capture of Turee Creek East flows in Deposit C could have an unacceptable impact on the downstream Karijini National Park.

To manage surface water flows from the Turee Creek East tributary intercepted by Deposit C, a 1% AEP capacity diversion channel is proposed to the north of Deposit C (Pit 3). The 3 km diversion channel, referred to as the Turee Creek East Realignment Diversion (Figure 8-13), will be designed to redirect the surface water flows which would otherwise be captured by Deposit C northwards, to maintain the continuation of natural surface water flows in Turee Creek East.

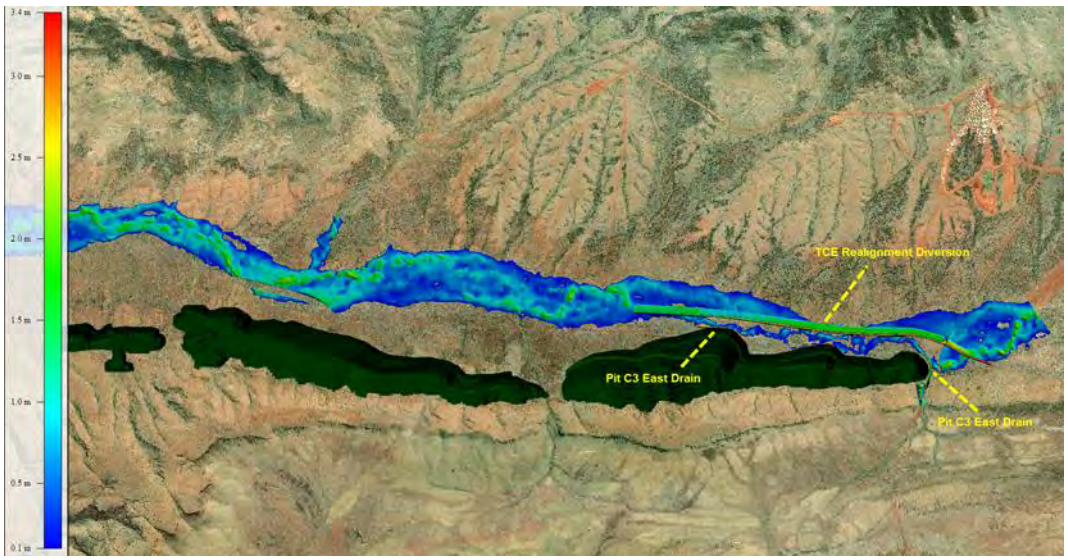

Figure 8-13: Maximum extent of 1% AEP flood event with Turee Creek East Realignment

With no flood protection, water from Turee Creek East South would flow into Deposit D (Pit 3). To manage flows from the Turee Creek East South tributary intercepted by Deposit D, a 2% AEP capacity diversion channel is also proposed to the north and west of Deposit D (Pit 3). The 2.7 km diversion channel will surface water redirect flows which would otherwise be captured by Deposit D around the north and west of Pit 3 to maintain the continuation of natural surface water flows in Turee Creek East.

Modelling indicates that flows downstream within Karijini National Park are unaffected. Hydrographs from the 50% AEP (2 year ARI) and 1 EY events (chosen as vegetation would be dependent on these more frequent flows) show the existing and post-development condition peak flows are almost identical (Figure 8-14).

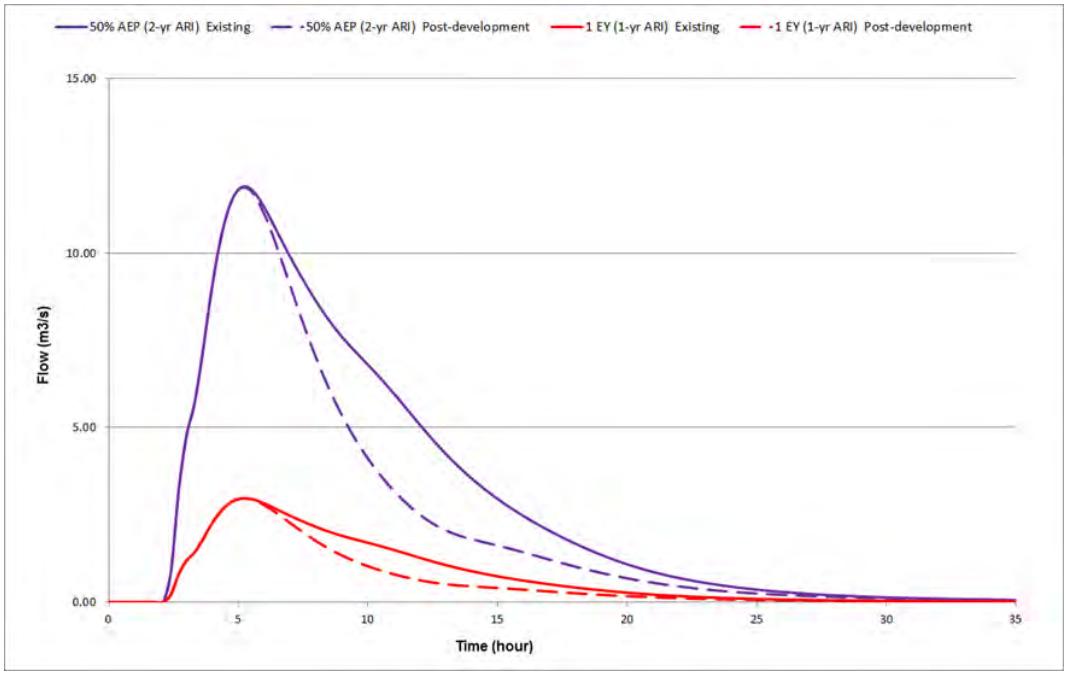

Figure 8-14: Hydrographs: existing and post-development scenarios (50% AEP and 1 EY)

Further, surface water runoff in the region is only associated with high intensity rainfall events. As is common across the Pilbara region, annual rainfall at West Angelas is episodic and highly variable, rainfall events resulting in surface water flows are uncommon. Rainfall data collected by the Australian Bureau of Meteorology are available for the period 2000 – 2016 from the West Angelas Mine Site, with average annual rainfall at the site of approximately 300mm. Based on rainfall data and flow analysis, rainfall events that result in flow are expected to occur once per year, on average.

8.4.2 Changes to the hydrological regime of Turee Creek East as a result of discharge of surplus dewatering water

Any surplus dewatering water, exceeding the operational water requirement is currently, and will continue to be discharged into the Turee Creek East tributary. The balance of surplus dewatering water from the West Angelas Project requiring management is estimated to be up to approximately 12 GL/a. Based on model results for the estimated 12 GL/a of surplus water discharge, the estimated surface discharge extent in Turee Creek East is up to approximately 22 km. The surface discharge extent will not reach Karijini National Park (Figure 8-12).

Discharge has the potential to result in the loss or degradation of riparian vegetation (discussed in Section 5.4.2).

8.4.3 Groundwater drawdown as a result of groundwater abstraction for dewatering purposes

Dewatering during mining will result in the propagation of groundwater drawdown away from the orebodies and regionally towards Karijini National Park. To address the potential impacts of dewatering on the ecohydrology of Karijini National Park, a hydrogeological conceptual model, analytical and numerical modelling have been developed based on known geology and hydrogeology (Appendix 10).

The groundwater gradient is low, approximately 0.0001 m/m, suggesting a relatively slow lateral groundwater flow. The surface gradient is an order of magnitude higher resulting in deeper groundwater (70m bgl) to the east and shallow groundwater (2m - 6.5m bgl) beneath Karijini National Park to the west.

The numerical modelling suggests dewatering of Deposits C and D will result in unmitigated drawdown of the groundwater of between 3m and 9m beneath Karijini National Park. The groundwater system bounded to the west by the Mount McRae Shale. As a result, the groundwater drawdown is not expected to extend more than 5 km beyond the boundary of Karijini National Park.

The prediction of the depth and rate of groundwater drawdown is dependent on the specific yield (Sy) values of the aquifer. An upper Sy value of 10% and lower Sy value of 1% were used to predict the depth and rate of groundwater drawdown. The results of the modelling adopting these specific yield values predict groundwater drawdown of 3m (best case, Sy 10%), 5m (base case, Sy 3%) and up to 8m (worst case, Sy 1%) beneath potentially groundwater dependant vegetation within Karijini National Park (Figure 8-15).

The base case scenario (Sy 3%) will result in unmitigated drawdown of the groundwater of 5m in 50 years beyond 2030 which will translate to a rate of groundwater drawdown of up to 10cm per year. The worst case scenario (Sy 1%) will translate to a rate of groundwater drawdown of up to 40cm per year.

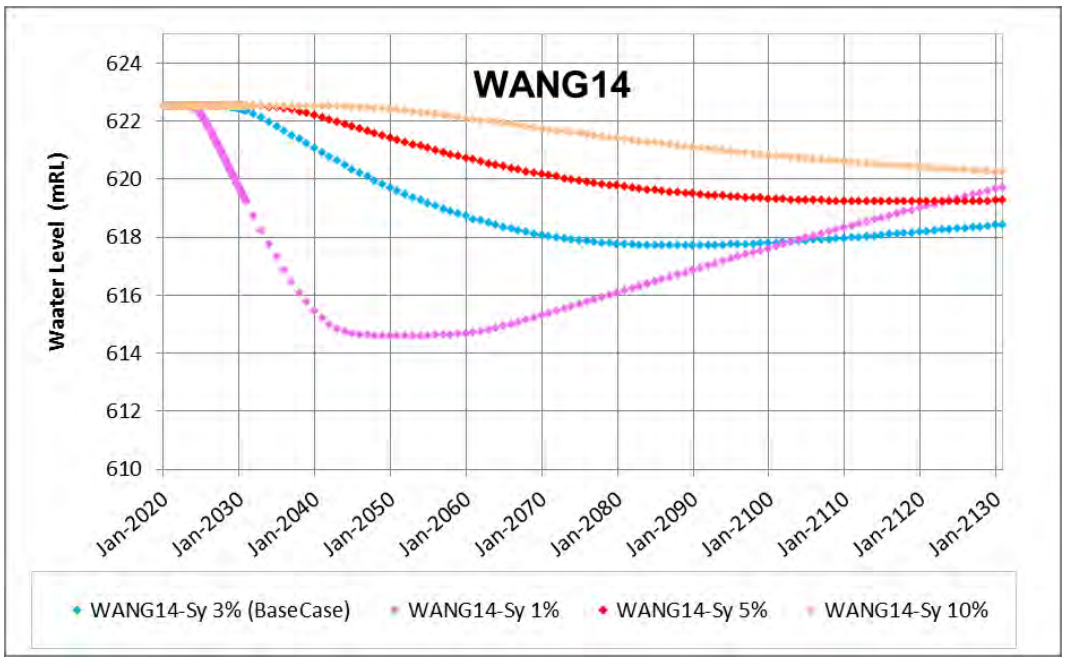

Figure 8-15: Modelled groundwater drawdown for specific yield (Sy) scenarios at bore WANG14, located approximately 2.5 km within the boundary of Karijini National Park.

Drawdown of the groundwater of up to 8m beneath potentially groundwater dependant vegetation within Karijini National Park is not expected to occur until after 2030, when mining is planned to cease. Due to the depth to groundwater, as well as the thickness of the detritals, recharge of the groundwater is expected to be low. Hydrographs show no observable response in groundwater level elevation within the deposits associated with rainfall events (Figure 8-16). Given the low recharge, recovery of the groundwater elevation is conservatively assumed not to occur. As such, the drawdown of the groundwater of up to 8m beneath potentially groundwater dependant vegetation within Karijini National Park is conservatively assumed to continue to persist beyond 100 years.

However, the numerical modelling does not take into account ephemeral surface water flows along Turee Creek East which are attenuated where the creek passes between two large hills approximately 3 km downstream of the potentially groundwater dependant vegetation within Karijini National Park. Surface water flows along Turee Creek East are also naturally ponded behind the Mount McRae Shale at the down gradient end of the potentially groundwater dependant vegetation within Karijini National Park following flow events. Ponded surface water may persist for an extended period depending on climatic conditions (evaporation rates) and the groundwater table elevation beneath the ponds. This potentially results in enhanced recharge to the already shallow water table. It is anticipated that the enhanced recharge due to ponded surface water behind the Mount McRae Shale will compensate for the annual rate of groundwater drawdown of up to 10 cm per year (base case), or up to 40cm per year (worst case), potentially mitigating the effect of the drawdown. Therefore, groundwater drawdown is not expected to have any significant impact on the ecohydrology of the Karijini National Park.

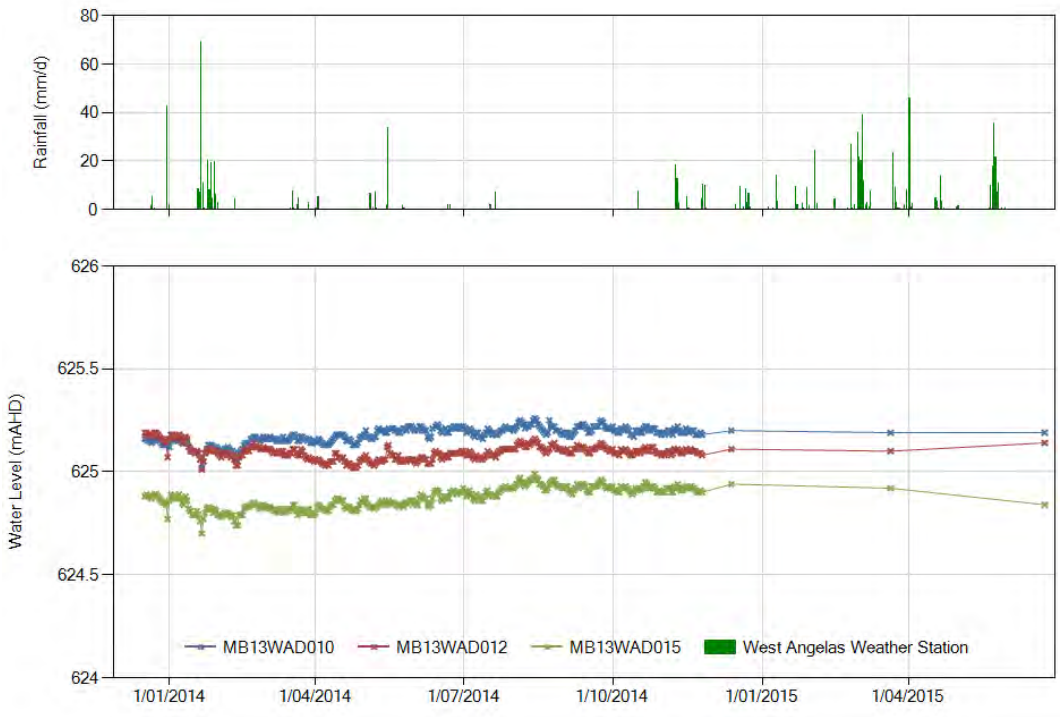

Figure 8-16: Hydrographs: groundwater level elevation within the deposits in response to rainfall data

The potential loss or degradation of potentially groundwater dependant vegetation as a result of groundwater drawdown is also discussed in Section 5.4.4.

Groundwater drawdown also has the potential to result in the loss or degradation of potential subterranean fauna habitat (discussed in Section 7.4.3).

However, groundwater drawdown is not expected to have any impact on the inherent values of the Karijini National Park. The Park is recognised for its representative ancient geologies, scenically outstanding landscape features and biological diversity (CALM 1999). Groundwater beneath Karijini National Park does not support any landscape features or biological communities of special significance in the vicinity.

8.4.4 Contamination

Contamination has the potential to reduce the quality of groundwater. Rio Tinto has well established strategies for the management of wastes at its Pilbara operations to ensure that risk of contamination of groundwater is minimised.

Any contamination is likely to be localised and as such, contamination is not considered a significant impacting activity

8.5 Mitigation and Predicted Outcomes

Mitigation strategies to address the above potential impacts and predicted outcomes are presented in Table 8-1.

Table 8-1: Hydrological Processes (Groundwater and Surface Water): Assessment of Potential Impact, Mitigation and Outcome

Potential impacts	Mitigation to address potential impacts	Predicted outcome
EPA Objective: *To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.*		
Changes to the hydrological regime of Turee Creek East as a result of mining: This Proposal is expected to contribute to alteration of the natural hydrological regime, disrupting natural surface water flows in Turee Creek East. Deposits C and D will intercept tributaries of Turee Creek East. Surface water management structures (diversions) will be required to redirect the surface water flows which would otherwise be captured by the pits, to maintain the continuation of natural surface water flows in Turee Creek East.	The following key management strategies have been, and will continue to be, implemented to manage the potential alteration of the natural hydrological regime of Turee Creek East as a result of mining: **Avoid:** Surface water management structures (diversions, including the Turee Creek East Realignment) have been designed to redirect flows which would otherwise be captured by the pits, to maintain the continuation of natural surface water flows in Turee Creek East. **Rehabilitate:** The Proponent proposes that the diversion of surface water flows be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans.* The Closure Plan will consider the closure strategy for the proposed surface water management structures once detailed designs are available however, the diversions are likely to be permanent, ensuring the continuation of natural surface water flows in Turee Creek East.	This Proposal is expected to result in alteration of the natural hydrological regime of Turee Creek East as a result of mining. However, the proposed surface water management structures will ensure the natural surface water flows are maintained in Turee Creek East. Modelling indicates that flows downstream of the Proposal, within Karijini National Park are unaffected. Further, surface water flows in the region are only associated with high intensity rainfall events. Based on rainfall data and flow analysis, rainfall events that result in flow are expected to occur once per year on average. The Proponent therefore considers that this Proposal can be managed to meet the EPA's objective for this factor.
Changes to the hydrological regime of Turee Creek East as a result of the discharge of surplus dewatering water:	The following key management strategies will continue to be implemented to manage the potential changes to the hydrological regime of Turee Creek East as a result of the discharge of surplus dewatering water: **Avoid:**	This Proposal is expected to result in the unavoidable alteration of the natural hydrological regime of Turee Creek East as a result of the discharge of surplus dewatering water in Turee Creek East. The surface discharge extent will not extend within the boundary of

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Any surplus dewatering water, exceeding the operational water requirement will be discharged into the Turee Creek East tributary. Modelling indicates the estimated surface discharge extent in Turee Creek East is up to approximately 22 km. The surface discharge extent is not expected to reach Karijini National Park. *The loss or degradation of riparian vegetation as a result of discharge is included in Table 5-4.*	The surface discharge extent in Turee Creek East (for the cumulative balance of surplus dewatering water requiring management) will not extend within the boundary of Karijini National Park. **Minimise:** Cumulative water balance modelling has been and will continue to be, undertaken to facilitate understanding of current and future operational water demands. Dewatering water will be used onsite in the first instance to supply water for operational purposes. Only surplus dewatering water exceeding the operational requirement will be discharged to a local ephemeral tributary of Turee Creek East. The Proponent proposes that the discharge of surplus dewatering water be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement an EMP (Appendix 4) to monitor the permanent surface discharge extent. Monitoring results are expected to show, at worst, surface water discharge reaches within 2.2 km of the boundary of Karijini National Park under natural conditions. **Other legislation:** The Turee Creek East tributary has been subject to discharge of surplus dewatering water from existing operations since 2011. Discharge of surplus dewatering water has been, and will continue to be, managed in accordance with the existing Operating Licence L7774/2000, issued under Part V of the EP Act, and any amendments as required.	Karijini National Park. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
Groundwater drawdown as a result of groundwater abstraction for dewatering purposes: Dewatering is predicted to have an unmitigated groundwater drawdown of between 3m and 9m beneath Karijini National Park. This drawdown is not expected to occur until after 2030, when mining is planned to cease, but is modelled to continue to persist beyond 100 years. Groundwater drawdown of between 3m and 9m beneath Karijini National Park is not expected to have any impact on the inherent values of the Park. The loss or degradation of potentially groundwater dependant vegetation as a result of groundwater drawdown is included in Table 5-4. The loss or degradation of potential subterranean fauna habitat as a result of groundwater drawdown is included in Table 7-5.	The following key management strategies will be implemented to manage the potential groundwater drawdown as a result of dewatering: **Minimise:** Hydrogeological modelling has been and will continue to be, undertaken to facilitate understanding of current and future dewatering requirements. Dewatering will be minimised to that required to access the below water table resource. At the cessation of dewatering, groundwater elevation will only be lowered by between 3m and 9m beneath Karijini National Park. **Other legislation:** Groundwater abstraction for dewatering purposes has been, and will continue to be, managed in accordance with the existing Groundwater Licence GWL98740, issued under the RIWI Act and associated Groundwater Operating Strategy, and any amendments as required.	The Proposal is expected to result in unavoidable groundwater drawdown as a result of dewatering. Modelling indicates unmitigated groundwater drawdown of between 3m and 9m beneath Karijini National Park. Groundwater drawdown of between 3m and 9m beneath Karijini National Park is not expected to have any impact on the inherent values of the Park. The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.
Contamination: Contamination has the potential to reduce the quality of groundwater.	The Proposal could potentially result in the degradation of groundwater quality as a result of contamination. However, any contamination is likely to be localised and as such; contamination is not considered a significant impacting activity. Rio Tinto has well established strategies for the management of contamination at its Pilbara operations. These management strategies have been and will continue to be, implemented to manage the potential degradation of groundwater quality as a result of contamination.	The Proponent considers that this Proposal can be managed to meet the EPA's objective for this factor.

Potential impacts	Mitigation to address potential impacts	Predicted outcome
	Other legislation: Groundwater quality has been, and will continue to be, managed in accordance with the existing Groundwater Licence GWL98740, issued under the RIWI Act and associated Groundwater Operating Strategy, and any amendments as required.	

9. CLOSURE

The existing West Angelas Closure Plan addresses closure of existing operations (Deposits A, A west, B, E and F), to meet the requirements of Condition 9 of MS 970.

The West Angelas Closure Plan has been updated to address closure of existing operations as well as Deposits C, D and G, the subject of this Proposal (Appendix 11). This Closure Plan follows the format and content requirements of the EPA / DMP *Guidelines for Preparing Mine Closure Plans* (2015) and documents the current closure knowledge base for West Angelas, outlines the objectives that need to be met at closure, the strategies to be employed to achieve them, and provides an indication of the criteria that will be used to assess closure success.

The West Angelas Closure Plan is not a static document. The Proponent will continue to revisit the Closure Plan on a regular basis to ensure that the objectives to which it is working towards remain relevant and aligned to stakeholder expectations, and to revise its strategies and plans where appropriate to achieve improved closure outcomes.

Proposed post mining land use

Aside from mining and associated infrastructure, the West Angelas region is largely undeveloped.

Inland regions are sparsely populated, with the largest inland towns (Tom Price, Paraburdoo and Newman) established to support the mining industry. The nearest town, Newman, is located approximately 130 km south-east of West Angelas.

Pastoral activity in the region has historically been limited to grazing of cattle on Juna Downs Station which is located approximately 20 km to the north and Rocklea Station which is located approximately 75 km to the west.

Options for post-mining land use are limited in the Pilbara region, with mining and pastoralism the only industries that have historically proven viable. As West Angelas is underlain by Vacant Crown Land, and is located in close proximity to Karijini National Park, the return of a native ecosystem is considered to be the most appropriate final land use. This is consistent with advice provided by the OEPA in November 2014.

Closure objectives and completion criteria

The ultimate goal of mine closure at West Angelas is to relinquish the site to the Government. This goal will be achieved once the Government and community agree that the condition of the site is compatible with an agreed post-mining land use (return of a native ecosystem). Closure objectives reflect the aspects of the Closure Plan that the government and community agree are key to evaluating the site condition.

The following revised closure objectives have been proposed for West Angelas:

Table 9-1: Revised Closure Objectives (West Angelas Closure Plan, April 2017)

Revised Closure Objectives	Justification for Change
Final landform is stable and considers ecological and hydrological issues.	This new objective covers the issues addressed by previous objectives 1 and 3 (rehabilitated landforms are stable and changes to surface water or groundwater are acceptable), and aligns with objectives for other Rio Tinto mines.
Vegetation on rehabilitated land is self-sustaining and compatible with the final land use.	Explicit recognition that rehabilitation areas need to be self-sustaining.

Revised Closure Objectives	Justification for Change
Public safety hazards have been appropriately managed.	It will not necessarily be possible to completely eliminate risk, but the company needs to demonstrate that risks have been effectively managed.
Contamination risks have been appropriately managed.	New objective to recognise this closure issue.
Infrastructure has been appropriately managed.	New objective to recognise this closure issue.

Completion criteria are the indicators used to determine whether closure objectives have been met. They are used to measure the success of closure implementation against objectives, and to facilitate relinquishment of mining tenure. Indicative completion criteria have been proposed within the updated Closure Plan (Appendix 11).

Anticipated Closure outcomes

Land: The shape of the landscape at West Angelas is still evolving, with the final mine void areas and waste dump locations and dimensions still in development across all of the deposits.

The post mining landform will include pit voids. There is no intent to reshape or rehabilitate pit voids. In general, pit walls are not designed to be stable in perpetuity. The area around the pits may be unstable, and pit walls may collapse over time.

Waste dumps will remain external to the pit voids, as well as one in pit waste dump at the western end of Deposit A that will extend above the pit crest. Waste dumps, if not designed, implemented and rehabilitated adequately could result in unstable landforms.

Rehabilitation and revegetation will be undertaken across waste dumps and other disturbance areas across the site (other than voids). To date, in areas where rehabilitation has been undertaken, the vegetation is well established, and in most cases sites compare favourably with one or more reference sites.

Surface water: Local hydrological regimes have been and will continue to be substantially altered. On closure, the landscape will be rehabilitated with consideration given to the changed topography and associated hydrological regimes that topography will generate. However, it is not intended that the original hydrological regimes be reinstated as part of the closure strategy. Surface water management structures that have been or will be built are expected to be retained on closure and the areas surrounding the diversions rehabilitated to function as a natural drainage line. The structures to be retained on closure include:

- The existing diversions that re-direct surface water flows from local ephemeral tributaries to protect operational deposits.
- The diversion (not yet constructed) that that will re-direct surface water flows from a local ephemeral tributary to the adjacent Weeli Wolli catchment to protect Deposit F.
- The proposed diversions that will re-direct surface water flows from local ephemeral tributaries to protect Deposits C and D.

Groundwater: It is expected that the groundwater levels will begin recovering after cessation of mine dewatering. However, groundwater levels are not expected to recover to pre-mining levels. The Proponent has conservatively assumed a permanent lowering of the groundwater table of between 3m and 9m beneath Karijini National Park. There will be no attempt at closure to reinstate pre-mining levels.

A backfill strategy has been adopted; below water table pits will be backfilled to prevent the formation of permanent pit lakes. It is recognised that ephemeral lakes may form at the base of the voids following rainfall events and higher than average rainfall years. It is expected that these will dissipate via natural infiltration and evaporation shortly after. Although the quality of these lakes may deteriorate, they are not expected to affect local or regional groundwater quality.

The Proponent proposes that approval of the Proposal be subject to a new Ministerial Statement (Appendix 3) including the requirement within Schedule 1 to backfill below water table pits to prevent the formation of permanent pit lakes.

The Proponent also proposes a contemporary condition requiring the Proponent to prepare and submit a consolidated Closure Plan for the West Angelas Iron Ore Mine (including this Proposal) in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans* (2015). The Closure Plan (Appendix 11) also addresses the requirement to backfill below water table pits to above recovered groundwater levels to prevent the formation of permanent pit lakes.

10. OFFSETS

10.1 Determination of Significant Residual Impact

The EPA considers that the increased amount of clearing of native vegetation in the Pilbara Bioregion, combined with the predicted future activities requiring clearing and other impacts from pastoralism and fires, and the success of rehabilitation, is likely to result in a significant residual impact on environmental values. Subsequently the EPA has determined that a proactive approach to compensating for this significant residual impact is required and have established of a strategic regional conservation initiative for the consolidation and management of offset funds for the Pilbara.

As a result, a standard offset approach has been developed by the EPA and it has been applied consistently for the clearing of native vegetation considered in Good to Excellent condition in the Pilbara since 2012. Where there is an additional level of environmental value, a higher offset has been applied to account for this greater value.

The WA Environmental Offsets Policy (Government of Western Australia 2011) and WA Environmental Offsets Guideline (Government of Western Australia 2014) provide guidance to proponents on the approach needed to determine offset requirements for proposals. The Environmental Offsets Guideline (2014) states that:

> *"In general, significant residual impacts include those that affect rare and endangered plants and animals (such as declared rare flora and threatened species that are protected by statute), areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions".*

Environmental aspects of this Proposal were assessed for potential significant residual impacts. The Proponent is proposing to contribute funding to a government-established conservation offset fund or an alternative offset arrangement providing an equivalent outcome as determined by the Minister for potential significant residual impacts.

10.2 Offset Requirement for the Proposal

An assessment of potential significant residual impacts was undertaken in accordance with the WA Environmental Offsets Guidelines (EPA 2014).

The Proponent considers that the following offset rates will apply to this Proposal:

- The majority of the vegetation communities were considered to be of low conservation significance, representing units that are likely to be widely distributed and relatively well represented in the Hamersley subregion. It is therefore expected that the standard offset rate of $750 (excluding GST) per hectare will be applied for the clearing of up to 4,269.5 ha of vegetation in 'Good to Excellent' condition within the Development Envelope.
- It is expected that a higher offset rate of $1,500 (excluding GST) per hectare will be applied to potential impacts to other vegetation communities that are considered locally significant:
  - up to 15.5 ha of the West Angelas Cracking Clay PEC; and
  - up to 25 ha of riparian vegetation along the Turee Creek East tributary.

- It is expected that the highest offset rate of $50,000 (excluding GST) per hectare will be applied to potential impacts of up to 4.2 ha of potentially groundwater dependant vegetation within the conservation estate Karijini National Park.

The Proponent considers that it is reasonable that offsets should only apply to the clearing that forms part of MS 1015 (which is already subject to an offset) and the proposed additional clearing that forms part of this Proposal. This approach is consistent with other recent Ministerial Statements.

11. OTHER ENVIRONMENTAL FACTORS

During the assessment of proposals, other factors may be identified as relevant to the proposal, but are not of significance to warrant detailed assessment or the setting of conditions by the EPA, or are impacts that can be regulated by other statutory processes to meet the EPA's objectives, outlined in the EPA's *Statement of Environmental Principles, Factors and Objectives* (2016) and the EPA's Environmental Factor Guidelines and Environmental Factor Technical Guidance. These factors are classed as 'other environmental factors'.

The other environmental factors relevant to the Proposal are:

- Landforms (Table 11-1);
- Terrestrial Environmental Quality (Table 11-2);
- Inland Waters Environmental Quality (Table 11-3);
- Air Quality (Table 11-4);
- Social Surroundings (Table 11-5); and
- Human Health (Table 11-6).

This Section describes the consideration of the 'other environmental factors' which are relevant to this Proposal and the existing management to ensure that the Proposal meets the EPA's objectives for these other environmental factors.

Table 11-1: Landforms

Potential impacts	Management to address potential impacts	Predicted outcome
EPA Objective: *To maintain the variety and integrity of physical landforms so that environmental values are protected.*		
Land systems Land systems comprise a series of 'land units' that are classified by the recurring patterns of geological and ecological features across regional landscapes. Land systems have been mapped across most of Western Australia's rangeland pastoral leases as part of rangeland inventory and condition surveys. The survey described and mapped the condition of natural resources (landforms, ecosystems, vegetation, habitats and declared plants and animals) of the region's pastoral land to assist with the planning and implementation of land management practices. The West Angelas region crosses the northern boundary of the area surveyed by Payne et al (1982) in the *Regional Inventory of the Ashburton Rangelands* and into the area surveyed by Van Vreeswyk et al. (2004) in the *Regional Inventory of the Pilbara Rangelands*. Of the one hundred and seven Land Systems that have been identified, seven occur within the West Angelas region: Boolgeeda; Egerton; Elimunna; Newman; Platform; Rocklea; and Wannamunna, with the Boolgeeda and Newman land systems being the most extensive. These land systems are not unique on a local or regional scale. **Landforms** Local topography is characterised by steep ridges rising over relatively flat valleys. The development of additional pits and waste dumps will result in permanent changes to local landforms. These landforms are not of elevated conservation significance or other special interest and are not unique to the West Angelas region. Waste dumps will remain as permanent landforms in the post-closure landscape. These permanent landforms will potentially be higher than the surrounding ridges however, these are not considered to be particularly prominent in the regional landscape given the proximity to the existing operations. Backfilling and rehabilitation of the waste dumps will also potentially reduce the extent of these permanent landforms in the post-closure landscape.		
Land systems The development of additional pits and waste dumps will intersect Boolgeeda; Elimunna; Newman; Platform; and Rocklea land systems. However, these land systems are not unique on a local or regional scale. As such, the diversity and representation of the land systems in the region will not be significantly altered as a result of this Proposal.	The following key management measures will continue to be, implemented to manage potential impacts to landforms as a result of mining: **Minimise:** Waste dumps will be designed in accordance with the internal standards described in the Iron Ore (WA) Landform Design Guidelines. Backfilling of pits during operations is proposed, rather than all waste being stored in external waste dumps.	The potential for impacts to land systems and landforms can be appropriately managed via existing management strategies (the continued implementation of the West Angelas Closure Plan (Appendix 11)). Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

Potential impacts	Management to address potential impacts	Predicted outcome
Landforms The development of additional pits and waste dumps will result in permanent changes to local landforms. These landforms are not of elevated conservation significance or other special interest and are not unique to the West Angelas region.	**Rehabilitate:** The Proponent proposes that mining be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a Closure Plan in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans.* The Closure Plan (Appendix 11) includes a Closure Objective to ensure that the final landform is stable and considers ecological and hydrological issues. **Other legislation:** DMP / EPA *Guidelines for Preparing Mine Closure Plans*.	

Table 11-2: Terrestrial Environmental Quality

Potential impacts	Management to address potential impacts	Predicted outcome
EPA Objective: *To maintain the quality of land and soils so that environment values are protected.*		
Wastes generated by the proposal will include: • inert and putrescible domestic and industrial wastes; • liquid wastes including ablution effluent; and • hazardous waste including hydrocarbons, chemicals, used oils and greases. Inert and putrescible domestic and industrial wastes associated with the Proposal will continue to be disposed of to the existing onsite landfill facility. Ablution effluent will continue to be disposed of to the existing onsite wastewater treatment plant (WWTP). Bulk quantities of fuel required for operations will continue to be stored in on-site bulk fuel storage facilities. Fuel storage and handling will be in accordance with Australian Standard (AS) 1940 *The storage and handling of flammable and combustible liquids* and/or the *Dangerous Goods Safety (Explosives) Regulations 2007* and their updates. Waste generation is not expected to be significantly different to existing operations. Wastes will continue to be handled, stored, treated and / or disposed of in a manner that minimises the risk to both ecological and social values.		
Wastes, including general domestic waste; industrial wastes; and hazardous wastes, if inappropriately managed, have the potential to contaminate soils.	Wastes are primarily regulated under Part V of the EP Act, unless the environmental impact is significant and warrants EIA by the EPA under Part IV of the Act (EPA 2012). Wastes will continue to be managed using existing facilities, in accordance with relevant approvals and legislation. Operating licence L7774/2000, issued under Part V of the EP Act, contains specific requirements for the management of wastes within the West Angelas prescribed premise boundary. Rio Tinto has well established management strategies for the management of waste materials at its Pilbara operations. The following key management strategies (in accordance with the waste management hierarchy of elimination, reduction, reuse, recycling, treatment and disposal) have been, and will continue to be, implemented to manage wastes:	The potential for impacts to terrestrial environmental quality can be appropriately managed via existing legislation (wastes have been, and will continue to be, managed using existing facilities, in accordance with the existing Operating licence L7774/2000, issued under Part V of the EP Act) and existing management strategies. Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

Potential impacts	Management to address potential impacts	Predicted outcome

	• An inventory of wastes generated, handled and disposed of onsite and off-site will be developed and maintained.
	• Assessment of the environmental risks associated with wastes generated and disposed of on-site will be developed and maintained.
	• On-site waste storage, treatment and disposal facilities will be inspected on a regular basis to ensure compliance.
	Domestic and Industrial Waste
	• The following will be disposed of at landfill facilities, which will be managed in accordance with licences and appropriate landfill guidelines:
	  ○ putrescibles (food scraps);
	  ○ biodegradables (e.g. paper, cardboard);
	  ○ inert materials (e.g. concrete, steel, wood); and
	  ○ other general rubbish (e.g. plastics).
	• The landfill will be fenced and backfilled on a regular basis to prevent wind-blown litter and feral animal foraging.
	Ablution effluent
	• Ablution effluent will be managed via appropriately licenced wastewater treatment facilities.
	• Wastewater treatment facilities will be routinely maintained.
	• Effluent from wastewater treatment facilities will be discharged within designated irrigation area.	

Potential impacts	Management to address potential impacts	Predicted outcome
	Hazardous Waste • An inventory of hazardous waste on-site will be maintained. • Hazardous waste will be segregated from the general waste stream. • Hazardous waste will be collected as required by appropriately licenced controlled waste contractors for offsite disposal. • Appropriate spill response equipment will be located nearby to work areas where hazardous materials are frequently used, such that it is available for immediate use. **Hydrocarbons** • Hydrocarbons will be handled, stored and disposed of in accordance with all legal requirements. • Hydrocarbon storage facilities and all associated connections will be within appropriately bunded areas. • Hydrocarbon storage facilities and bunds will be inspected on a regular basis to identify any leaks or maintenance requirements. • Any hydrocarbon contaminated soil will be remediated and/or disposed of as appropriate. • Hydrocarbon waste materials not suitable for onsite disposal will be collected as required by appropriately licenced controlled waste contractors for offsite disposal or recycling.	

Table 11-3: Inland Waters Environmental Quality

Potential impacts	Management to address potential impacts	Predicted outcome
EPA Objective: *To maintain the quality of groundwater and surface water so that environmental values are protected.*		

• Rio Tinto Iron Ore (WA) has undertaken an extensive program of geochemical testing, over several years, to understand the potential for acidification and / or metal enrichment to occur as a result of the various material types common to mining operations in the Pilbara.
• The most significant geochemical risk is associated with sulfides, such as pyrite (FeS_2), which can form sulfuric acid when exposed to oxygen and water.
• The current risks associated with acid and metalliferous drainage (AMD) in the West Angelas area have been assessed. The purpose of this assessment was to identify and document the AMD risks associated with lithologies that have been, and will be, mined at West Angelas. This assessment includes analysis of:
  • Background information and the surrounding environment;
  • Total sulfur concentrations within rock types of the general mining area (based on drillhole data);
  • Total sulfur concentrations within rock types in the individual pit shells;
  • Acid base accounting data including the measured acid neutralising capacity of waste rock types;
  • Lithology chemistry including sulfur distribution and chemical enrichment; and
  • Estimated tonnes and exposure of elevated-sulfur material (where available).
• The likelihood of encountering PAF materials (e.g. black shale or lignitic material) is considered low for all deposits.
• **Observed pyrite -** Three samples from Deposit D had pyrite visually identified. The pyrite samples were from the MacLeod and Nammuldi Members. Only one sample from Deposit G had pyrite visually identified. The pyrite sample was from the Newman Member. Although pyrite has been visually identified in samples, no pyrite samples are located within the current proposed pit shells.
• **Sulfur analysis -** Rio Tinto Iron Ore (WA) has undertaken static acid base accounting (ABA) and geochemical characterisation on different lithologies to identify the potential for these rock types to generate acidity. For lithologies such as banded iron formation and detrital rock types, a value of 0.3% total sulfur concentration has been adopted as the boundary value to denote potentially acid forming (PAF) material from inert/non-acid forming (NAF) material.
• A total of 158 samples from the Greater West Angelas deposits have been submitted for ABA. Approximately 11% of samples analysed were classified as either PAF or PAF in a low capacity (PAF-LC). PAF samples were restricted to the Mount Newman Member (NEW). PAF-LC samples were from the following groups; Pisolite (PI) ore, Detrital (DET) ore, MacLeod Member (MAC) waste and ore, and Nammuldi Member waste and ore (NAM). PAF-LC samples were not associated with sulfides. Approximately 82% of samples analysed were classified as NAF. The remaining approximately seven percent of the samples assayed classified as Uncertain and were expected to be NAF.		

Potential impacts	Management to address potential impacts	Predicted outcome

- **Deposit C is expected to pose a low AMD risk based on the current pit designs**. Approximately 0.94% of all in-pit samples (including waste samples) have sulfur levels greater than 0.1%, with approximately 0.13% with sulfur levels greater than 0.3%. Groups with elevated-sulfur samples located in-pit include MAC waste and MAC ore. Elevated-sulfur samples are located within 25m of the surface and above the pre-mining water table. It is therefore likely that the sulfur is present as sulfates rather than sulfide minerals. Given the limited number and limited distribution of elevated-sulfur samples located above the pre-mining water table, MAC waste and MAC ore pose a low acid drainage risk.

  Although NAM waste was assessed as posing a low-moderate AMD risk, no elevated sulfur NAM waste samples are located within the proposed pit design and hence, are not expected to be mined.

- **Deposit D is expected to pose a low AMD risk based on the current pit designs**. Approximately 1.3% of all in-pit samples (including waste samples) have sulfur levels greater than 0.1%, with approximately 0.26% with sulfur levels greater than 0.3%. Groups with a significant number of elevated-sulfur samples located in-pit include MAC waste, MAC ore, DET ore and PI ore. No elevated sulfur NAM waste samples are located within the proposed pit design. Elevated-sulfur samples are located within 40m of the surface and most are located above the pre-mining water table (a total of five elevated-sulfur samples were located below the water table). It is therefore likely that the sulfur is present as sulfates rather than sulfide minerals. Given the limited number and limited distribution of elevated-sulfur samples located above the pre-mining water table, MAC waste, MAC ore, DET ore and PI ore pose a low acid drainage risk.

- **Deposit G is expected to pose a low AMD risk based on the current pit designs**. Approximately 0.83% of all in-pit samples (including waste samples) have sulfur levels greater than 0.1%, with approximately 0.07% with sulfur levels greater than 0.3%. PI ore is the only group with a significant number of elevated-sulfur samples (3.5% of in-pit PI ore samples have sulfur greater than 0.1% with only one sample with sulfur greater than 0.3%). Elevated sulfur samples are located within 26m of the surface and above the pre-mining water table. It is therefore likely that the sulfur is present as sulfates rather than sulfide minerals. Given the limited number and limited distribution of elevated-sulfur samples located above the pre-mining water table, PI ore poses a low acid drainage risk.

- **Metals -** The following elements have been identified as being enriched in the West Angelas deposits: Iron, Arsenic and Tin (Fe, As and Sn) as well as (Cobalt, Chromium, Copper, Manganese, Nickle, Lead and Zinc (Co, Cr, Cu, Mn, Ni, Pb and Zn).
- It is recognised that sulfur-related AMD includes acid drainage (elevated concentrations of contaminants (metals and metalloids) at low-pH) and neutral drainage (elevated concentrations of contaminants at near-neutral pH) (INAP 2010; DITR 2007).
- Analysis of total sulfur in rock types has been undertaken to identify those with the propensity to generate acidity and lead to poor quality drainage characterised at both low-pH and near neutral pH conditions. Poor quality drainage may also result from contaminants soluble at neutral pH (and not related to sulfur). Many minerals are unstable when exposed to the atmosphere; elevated concentrations of dissolved minor and trace elements in surface water runoff may result from the dissolution of readily soluble salts (being a source of such elements).For those rock types associated with sulfides and some sulfate minerals, it is understood that metalliferous drainage requires, at a minimum, low-pH conditions on a microscopic scale as a mechanism to initially solubilise contaminants. If there is sufficient neutralising capacity in the acid-generating rock then any acid generated at the microscopic scale is subsequently neutralised; however, as a result, concentrations of some contaminants (e.g. and (Zn, As, Ni and Cadmium (Cd)) which do not precipitate at circumneutral pH, may remain in solution and result in poor-quality drainage (DITR, 2007). For this reason, the analysis of total sulfur in rock types will identify those with the propensity to generate acidity and lead to poor quality drainage characterised at both low-pH and circumneutral pH conditions.

Potential impacts	Management to address potential impacts	Predicted outcome
Deionised water leach tests have been undertaken on a range of waste rock types. The results have indicated that, other than the main constituents of Sodium, Calcium, Magnesium, Potassium, Chloride and Sulfate (Na, Ca, Mg, K, Cl and SO_4), concentrations are generally at or below the detection limits for the test methods employed. It is expected that the material will behave in a similar manner to other below water table iron ore deposits in the Pilbara.		
Mining could expose PAF materials, causing AMD, impacting groundwater quality. Further, dewatering could expose PAF material in previously saturated layers to oxygen, causing AMD, impacting groundwater quality. However, based on less than 1% of below water table samples having sulfur values greater than 0.1%, and relatively low sulfur values associated with the elevated-sulfur rock types, the likelihood of encountering PAF material is considered low. The risk of generating AMD is also considered low.	Rio Tinto has well established management strategies for the management of PAF materials at its Pilbara operations. While the likelihood of encountering PAF material is considered low, if PAF materials are encountered then existing management strategies within the Rio Tinto Iron Ore (WA) Mineral Waste Management Plan, and the Spontaneous Combustion and ARD (SCARD) Management Plan have been, and will continue to be implemented to ensure waste material is adequately geochemically characterised, and PAF material that poses an AMD risk is appropriately managed. **Other legislation:** Compliance with the requirements of the *Contaminated Sites Act 2003* if contamination occurs.	The potential for impacts to inland waters environmental quality can be appropriately managed via existing legislation (in particular the *Contaminated Sites Act 2003*) and existing management strategies. Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

Table 11-4: Air quality

Potential impacts	Management to address potential impacts	Predicted outcome
EPA Objective: *To maintain air quality and minimise emissions so that environmental values are protected.*		
Air emissions of both dust and greenhouse gases can affect both environmental receptors and human health. **DUST** Air quality has the potential to be impacted by dust emissions created by the Proposal. Dust emissions have been, and will continue to be will be generated by: • construction activities (including clearing); • vehicle movements (including both heavy and light vehicles on unsealed surfaces); • mining and processing (including blasting, loading, hauling, crushing, conveying, screening and stockpiling material and transport), although the likelihood of dust-related impacts associated with mining and processing is likely to be limited given the below watertable nature of the ore; and • wind erosion from cleared areas in dry, windy conditions. Dust emissions created by the Proposal are likely to be associated with nuisance rather than human health problems. The Proposal is remote from dust-sensitive receptors, with other mining operations being the nearest premises and as such, impacts on communities from nuisance dust are expected to be limited (there have never been any complaints received in regard to nuisance dust emissions from the existing West Angelas operations). However, dust emissions are an occupational health and safety risk for employees at the West Angelas Operations. The West Angelas accommodation village (the village) is located approximately 1.4 km from Deposit C and 2.4 km from Deposit G. Envall Environmental Alliances (Envall) was engaged to model dust emissions in association with mining of current and future deposits at West Angelas (Deposits A, B, E, A West and F, C, D and G) in 2016 (Appendix 12). The modelling suggests that predicted dust levels are reasonably high at the village. The peak predicted dust levels occur in 2022, corresponding with the highest predicted material movement at the adjacent Deposit C. Monitoring and mitigation strategies have been implemented for the purpose of managing potential nuisance dust impacts at the village from the existing West Angelas operations and will continue to be implemented for this Proposal. These strategies provide for continuously identifying and rectifying the causes of circumstances that lead to excessive dust levels. The Pilbara environment is naturally dusty; hence native vegetation is expected to be reasonably tolerant to dust deposition. Internal studies undertaken for Rio Tinto (Butler 2009) suggest that the potential for adverse dust deposition impacts on plants is seasonally related. The Butler (2009) study failed to identify any significant loss of plant function for exposures of Pilbara species to deposited crustal dust loadings on plant leaves of up to a very high level of 7,500 g/m² (Butler 2009). For this study, 7 g/m²/month was used as an indicative criterion for potential impacts on vegetation, however the Butler (2009) work shows that this is probably very conservative. For this reason, the potential impact of dust on native vegetation is not discussed further in this document.		

Potential impacts	Management to address potential impacts	Predicted outcome
GREENHOUSE GAS EMISSIONS Greenhouse gases have been, and will continue to be emitted (primarily carbon dioxide (CO_2) generated by diesel consumption), however, West Angelas is seen as a relatively small emitter of greenhouse gases. Greenhouse gases were considered in the original ERMP (1998). Schedule 1 of Ministerial Statement 514 included a greenhouse gas emission limit (of approximately 0.140 Mt/a) and the EPA recommended in its Report and Recommendations (1999) that the Proponent's commitment, to prepare a Greenhouse Gas Emissions Management Plan, should be made an enforceable condition. Subsequently, Condition 4 of Ministerial Statement 514 required the Proponent to prepare and implement an Environmental Management Program that included a Greenhouse Gas Emissions Management Plan. Condition 9 of Ministerial Statement 514 outlined the requirements of the Greenhouse Gas Emissions Management Plan. The Greenhouse Gas Emissions Management Plan was prepared, approved by the CEO of the Department of Environment and Conservation (formerly the Department of Environmental Protection) in December 1999 and implemented in 2000. References to greenhouse gases were removed from the Ministerial Statement on advice from the EPA (2013); *'in order to be consistent with EPA's previous decisions and the Minister's position on greenhouse gas conditions, ensure that conditions are complementary to the carbon pricing scheme and for the reason that West Angelas Project is a relatively small emitter, any references to greenhouse gas emissions throughout the Ministerial Statement should be removed'.* Greenhouse gas emissions have not been considered a key environmental factor in any subsequent environmental impact assessment since greenhouse gas emissions generated by subsequent Proposals are considered to be similar to those of existing operations, will continue to be mitigated as far as reasonable practicable and will be managed in to meet environmental greenhouse gas emission standards, in accordance with relevant legislation and national and state strategies.		
This Proposal is expected to generate dust and greenhouse gas emissions. However, this Proposal is to sustain current production from West Angelas and so the dust and greenhouse gas emissions associated with additional deposits are not expected to be significantly different to the emissions from existing operations.	Emissions are primarily regulated under Part V of the EP Act, unless the environmental impact is significant and warrants EIA by the EPA under Part IV of the Act (EPA 2012). **DUST** Rio Tinto has well established strategies for the management of dust emissions at its Pilbara operations. These strategies will continue to be implemented to manage dust emissions. Strategies to manage dust emissions include: • Minimising exposed surfaces by minimising clearing and rehabilitating disturbed areas no longer in use. • Applying water (or other dust suppressants) to roads, working surfaces and stockpiles as required.	The potential for impacts to air quality can be appropriately managed via existing legislation (emissions have been, and will continue to be, managed in accordance with the existing Operating licence L7774/2000, issued under Part V of the EP Act) and existing management strategies. Greenhouse gas emissions have been, and will continue to be managed under the *Clean Energy Act 2011* (Cwth) and reported under the *National Greenhouse and Energy Reporting Act 2007* (Cwth). Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

Potential impacts	Management to address potential impacts	Predicted outcome
	• Restricting vehicle access to designated roads and tracks and implementing speed limits to minimise dust generation from roads. Potential emissions from existing processing facilities that will also be utilised for processing of ore from this Proposal may also be subject to controls imposed through an environmental licence required for such prescribed premises, in accordance with Part V of the EP Act. Monitoring will enable dust management performance to be continually assessed and strategies to manage dust emissions refined where necessary. **GREENHOUSE GAS EMISSIONS** Management of greenhouse gas emissions will continue to be, in accordance with relevant legislation and national and state strategies relating to greenhouse gas emissions. Rio Tinto has well established procedures for the reporting of greenhouse gas emissions at its Pilbara operations. In accordance with the *National Greenhouse and Energy Reporting Act 2007* the proponent reports annually on: • energy production; • energy consumption; • emissions; and • updates on energy management projects. Rio Tinto is committed to an ongoing program of reporting and review to identify opportunities to further reduce energy consumption and reduce greenhouse gas emissions.	

Table 11-5: Social Surroundings

Potential impacts	Management to address potential impacts	Predicted outcome
EPA Objective: *To ensure that social surroundings are not materially affected.*		
VISUAL AMENITY The location of West Angelas is very remote. The visual landscape of the region is predominantly natural in appearance, with localised areas of highly modified landscapes due to mining. The Proponents knowledge of current and potential mining projects in the region, in addition to this Proposal, is limited to the following: • BHPBIO's Mining Area C is located approximately 35 km north-north east of West Angelas; • Rio Tinto's Hope Downs is located approximately 45 km north east of West Angelas; • BHPBIO's Yandi (Marillana Creek) is located approximately 60 km north-north east of West Angelas; • Rio Tinto's Yandicoogina is located approximately 65 km north east of West Angelas; • Rio Tinto's Hope Downs 4 is located approximately 85 km east of West Angelas; • Rio Tinto's Marandoo is located approximately 90 km north west of West Angelas; and • BHPBIO's Mount Whaleback is located approximately 95 km north east south-east of West Angelas. The nearest town, Newman, is located approximately 130 km south-east of West Angelas. It is expected that impacts on visual amenity from this Proposal will be similar to the existing West Angelas operations. **HERITAGE** This Proposal is located within the traditional lands of the Yinhawangka People. Ethnographic and archaeological surveys within the West Angelas area have identified a rich and diverse region of heritage sites of ethnographic and / or archaeological significance. Two sites of ethnographic significance have been identified in the region; 'Guburingu' located approximately 7 km to the north west of Deposit C within the Karijini National Park and 'Garjiringu' located approximately 150m to the west of Deposit D. Although the nature of 'Guburingu' is currently unknown, given its distance from Deposits C and D, and the presence of Mount McRae Shale (assumed hydraulic boundary) limiting the extent of drawdown, it is currently considered unlikely that potential environmental impacts (which warrant assessment under the EP Act) will affect this site. However, given its proximity to Deposit D and potential environmental impacts which warrant assessment under the EP Act, ecological, hydrological and hydrogeological assessments of 'Garjiringu' have been undertaken. The vegetation is described as low open woodland of *Eucalyptus victrix* over *Acacia citrinoviridis* and *Grevillea wickhamii* high open shrubland over *Acacia pyrifolia* scattered shrubs over *Gossypium robinsonii* and *Ptilotus obovatus* scattered low shrubs over *Themeda triandra* open tussock grassland over *Triodia epactia* very open hummock grasses. The vegetation is considered to be consistent with that of other minor drainage lines within the West Angelas region and more broadly the Hamersley subregion. *Eucalyptus victrix* was the only potentially groundwater dependent species recorded, however, this species is unable to access the groundwater in this area; previous studies in the Pilbara have confirmed *Eucalyptus victrix* roots to a depth of 21m bgl (Department of Water 2010), groundwater elevation at 'Garjiringu' is approximately 625m RL (approximately 40m bgl).		

Potential impacts	Management to address potential impacts	Predicted outcome
As such, *Eucalyptus victrix* is considered to be vadophytic; less reliant on groundwater resources and more reliant on available soil water. Soil water is considered to be recharged by surface water flows (with two major tributaries converging immediately upstream of the area), depending on the occurrence of high intensity rainfall events**.** Maintaining surface water flows is therefore, important for maintaining the vegetation association at 'Garjiringu', the Proponent is proposing to redirect flows which would otherwise be captured by Deposit D to maintain continuity of flow downstream (Section 8.4.1). A change to groundwater elevation (as a result of drawdown) is considered unlikely to impact the vegetation at the site. A draft management plan for this location and its ongoing management is in review with the Yinhawangka Traditional Owners. Numerous archaeological sites of have also been recorded in the Proposal area; artefact scatters, rockshelters, scarred trees and rock art sites have. Some of these heritage places contain heritage features that are under-represented in the East Pilbara archaeological record and are considered to be of high archaeological significance to Traditional Owners. These include some walled features within rockshelters, grinding patches and engraving / rock art sites It is currently considered unlikely that potential environmental impacts (which warrant assessment under the EP Act) will affect these sites. The Proponent is committed to avoiding sites wherever possible and will continue to work in close consultation with the Yinhawangka Traditional Owners. However, some sites are likely to be disturbed by this Proposal. The Proponent will request approval under section 18 of the *Aboriginal Heritage Act 1972* where disturbance to sites cannot be avoided. Cultural material contained within those sites which cannot be avoided will be mitigated in accordance with the approval conditions set by the Minister of Aboriginal Affairs and in consultation with the Yinhawangka Traditional Owners.		
VISUAL AMENITY The development of additional deposits and waste dumps will result in permanent changes to local landforms. Waste dumps will be higher than the surrounding landscape. However, visual impacts associated with permanent changes to local landforms are not expected to be particularly prominent in the regional landscape given the proximity to the existing operations The Proposal is also remote from communities or other sensitive receptors (such as scenic outlooks).	Rio Tinto has well established strategies for the management of visual amenity at its Pilbara operations. These strategies have been, and will continue to be implemented to manage visual amenity. Strategies include: • The design (height and slope) of mineral waste dumps will consider: minimisation of dump height to blend with the surrounding natural topography whenever possible; construction to meet the requirements of the final rehabilitation design; and drainage and erosion management features. • Backfilling will be implemented wherever possible. • Rehabilitation with local native vegetation has been, and will continue to be, undertaken wherever possible. During mine closure, the maintenance of aesthetic values for cultural and amenity purposes are an important consideration. The following closure objectives will ensure that impacts to visual amenity are minimised at closure:	There will be some permanent changes to the general landscape of the Proposal area. However, the potential for impacts to social surroundings are relatively low, particularly given that the Proposal is remote from communities or other sensitive receptors, and can be appropriately managed via existing management strategies. Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

Potential impacts	Management to address potential impacts	Predicted outcome
	• Final landform is stable and considers ecological and hydrological issues; and • Vegetation on rehabilitated land is self-sustaining and compatible with the final land use.	
HERITAGE Sites of ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners could potentially be disturbed by proposed activities including clearing, dewatering and surplus water discharge. The Proponent will also ensure that the Proposal does not affect the accessibility of sites of ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners and the ability of the Traditional Owners to use the area for cultural purposes.	Rio Tinto has well established procedures for the management of Aboriginal heritage at its Pilbara operations. The identification and management of all cultural heritage within the West Angelas Project is in accordance with the principles and practices outlined within the following heritage management procedures: • Rio Tinto's Communities and Social Performance Guidelines; • Rio Tinto's Cultural Heritage Group Procedure; • the heritage protocol within the Yinhawangka People Claim Wide Participation Agreement (CWPA); and • Rio Tinto's Heritage Drill and Blast Management Plan. A management plan for 'Garjiringu' has also been drafted and is in review with the Yinhawangka Traditional Owners. These heritage management procedures have been, and will continue to be implemented to manage sites of ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners. Ongoing engagement with the Yinhawangka Aboriginal Corporation and the Yinhawangka Traditional Owners through survey work and formal consultation such as Local Implementation (LIC) and Heritage Sub Committee (HSC) meetings provide opportunities for ongoing communication and collaboration.	Some sites of archaeological significance are likely to be disturbed by this Proposal however, any disturbance will be in accordance with approval under section 18 of the *Aboriginal Heritage Act 1972* and will have the support of the Yinhawangka Traditional Owners. Ongoing engagement with the Yinhawangka Traditional Owners is managed through engagement frameworks established through our agreements. Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

Potential impacts	Management to address potential impacts	Predicted outcome
	In line with statutory requirements and the above internal heritage management standards, ethnographic and archaeological surveys have been completed. Rio Tinto is committed to avoid heritage sites, wherever practicable. Sites will be protected from inadvertent impacts by appropriate fencing / signposting or alternative suitable approaches agreed with Traditional Owners. Approval under section 18 of the *Aboriginal Heritage Act 1972* will be required for disturbance of those sites which cannot be avoided.	

Table 11-6: Human Health

Potential impacts	Management to address potential impacts	Predicted outcome
EPA Objective: *To ensure that human health is not materially affected.*		

NOISE

The nearest noise sensitive receptors to the West Angelas operations is the village, located approximately 1.4 km from Deposit C and 2.4 km from Deposit G. The village is a Rio Tinto owned premise located within the mine operation premises and therefore, are not legally required to comply with the 'assigned levels' for occupied premises under the *Environmental Protection (Noise) Regulations 1997*. However, Rio Tinto implements internal criteria to ensure noise levels associated with the mining of current deposits at West Angelas are within an acceptable range to protect the health and amenity of occupants at the village. The Proposal is remote from communities or other noise sensitive receptors, with other mining operations being the nearest premises.

Herring Storer Acoustics was engaged to model cumulative noise levels associated with the mining of current and future deposits at West Angelas (Deposits A, B, E, A West and F, C, D and G) in 2016. The recommended noise assessment criteria for the identified noise sensitive receptors and the highest predicted noise levels under 'worst case' meteorological conditions are summarised below:

DEPOSIT	NOISE	
	VILLAGE	AERODROME
Assessment Criteria	115 L_{Zpeak}	125 L_{Zpeak}
C	**127**	122
D	110	110
G	**120**	**127**

Noise levels exceeding the assessment criteria are predicted for the village; noise levels up to 127 dB L_{Zpeak} are expected from blasting in the eastern portion of Deposit C, nearest the village and noise levels up to 120 dB L_{Zpeak} are expected from Deposit G. However, these noise levels assume worst-case meteorological conditions. Modelling assumed westerly winds (towards the village) however, the West Angelas operations are generally subject to prevailing easterly winds (winds from any other direction occurs for only around 10% of the year). Under easterly winds the noise from blasting in Deposit C is reduced to acceptable levels. Noise levels exceeding the assessment criteria may also be acceptable if blasts occur during non-sleep periods (for both day and night shifts).

The Proponent will continue to manage cumulative noise levels associated with the mining of current and future deposits at West Angelas in line with the requirements of the *Environmental Protection (Noise) Regulations 1997* to protect the health and amenity of occupants at the village.

Potential impacts	Management to address potential impacts	Predicted outcome
Cumulative noise levels associated with the mining of current and future deposits at West Angelas are expected to occasionally exceed assessment criteria however, are not expected to result in any significant impacts to human health at the nearest noise sensitive receptor; the village, located within the mine operation premises. Due to the remote location of West Angelas from other noise sensitive receptors, noise levels exceeding assessment criteria are not expected to result in any significant impacts to human health within the surrounds.	Potential noise impacts will continue to be managed in line with the *Environmental Protection (Noise) Regulations 1997*	There will be some noise levels exceeding assessment criteria. However, the potential for impacts to human health can be appropriately managed via existing legislation (in particular *Environmental Protection (Noise) Regulations 1997*) and existing management strategies. Therefore the Proponent considers that the Proposal meets the EPA's objective for this factor.

12. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The Commonwealth EPBC Act provides for the referral and assessment of Proposals which, if implemented, may have a significant impact on threatened species, ecological communities or heritage places listed as MNES.

Threatened fauna species are categorised under the categories endangered, critically endangered, conservation dependant, vulnerable, extinct in the wild and extinct.

12.1 Existing environmental values

Previous biological surveys conducted throughout the region since 1979 have not recorded threatened species and / or communities and as such, the West Angelas Project has not warranted referral to the DoEE under the requirements of the EPBC Act to date.

Recent biological surveys have recorded the following three Threatened species in the West Angelas region:

- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) – EPBC Vulnerable;
- Ghost Bat (*Macroderma gigas*) – EPBC Vulnerable; and
- Fork-tailed Swift (*Apus pacificus*) – EPBC Migratory.

In addition, the following three Threatened species have been assessed as having a moderate to high likelihood of occurrence in the region:

- Northern Quoll (*Dasyurus hallucatus*) – EPBC Endangered (moderate likelihood of occurrence);
- Pilbara Olive Python (*Liasis olivaceus barroni*) – EPBC Vulnerable (moderate likelihood of occurrence);
- Rainbow Bee-eater (*Merops ornatus*) – EPBC Migratory (high likelihood of occurrence).

12.2 Assessment of potential impacts on MNES

Potential impacts to threatened species include the following:

- Loss or degradation of potential habitat for Threatened species as a result of clearing; and
- Loss of individuals of Threatened species (if present) as a result of clearing.

Assessment of potential impacts to Threatened species recorded or assessed as having a moderate to high likelihood of occurrence is included in Section 6 (Fauna). The Proponent considers that this Proposal is unlikely to result in a significant impact on Threatened species recorded or assessed as having a moderate to high likelihood of occurrence and as such, the Proponent has determined that this Proposal does not warrant referral to the DoEE under the requirements of the EPBC Act.

13. HOLISTIC IMPACT ASSESSMENT

This ER document provides detailed assessment of the potential environmental impacts and proposed environmental management strategies for environmental factors to support the formal referral of the West Angelas Deposits C, D and G Proposal to the EPA under section 38 of the EP Act.

Preliminary key and other environmental factors have been identified and considered against EPA objectives, as defined in the EPA's *Statement of Environmental Principles, Factors and Objectives* (2016). The Proponent considers that the preliminary key environmental factors relevant to this Proposal are: *Flora and Vegetation*; *Terrestrial Fauna; Subterranean Fauna*; and *Hydrological Processes.* In addition, Closure and Offsets are considered relevant to this Proposal.

The Proponent has applied the mitigation hierarchy in the *Western Australian Environmental Offsets Guidelines* (Government of Western Australia, 2014) and the EPA's bulletin *Environmental Protection Bulletin No.1: Environmental Offsets* (EPA, 2014a):

- **Avoidance:** Avoidance is the preferred strategy for managing potentially significant impacts to the environment. This Proposal has been designed to avoid potentially significant impacts to the environment. Specifically;
    - The proponent shall ensure that there is no disturbance to the West Angelas Cracking Clay Priority Ecological Community (PEC-2015-5)
    - The surface discharge extent will not extend as far as Karijini National Park.

    This Proposal has also been designed to avoid sites of high ethnographic and / or archaeological significance to the Yinhawangka Traditional Owners.
- **Minimise:** After avoidance strategies have been considered (and implemented where practical), mitigation measures to minimise the remaining significant impacts (if any) are investigated and implemented to reduce remaining significant impacts to an acceptable level. This Proposal has been designed to minimise the remaining potentially significant impacts to the environment. Specifically;
    - The proponent shall minimise disturbance to other representations of the West Angelas Cracking Clay PEC.
    - The proponent shall ensure that there is no irreversible impact to groundwater dependant vegetation within Karijini National Park as a result of dewatering.
    - The proponent shall ensure that there is no irreversible impact to the health of riparian vegetation of Turee Creek East as a result of the discharge of excess water.
- **Rehabilitate:** After practicable avoid and minimise measures have been considered or implemented, rehabilitation will be applied to further reduce remaining impacts.

    The Proponent proposes that mining be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to manage the implementation of this Proposal to meet the following environmental objective:

    (1) '*ensure that the Proposal is rehabilitated and decommissioned in an ecologically sustainable manner*'.

The contemporary conditions of the new Ministerial Statement shall also require the Proponent to implement a Closure Plan (Appendix 11) in accordance with the DMP / EPA *Guidelines for Preparing Mine Closure Plans*.

- **Offset:** If, after the previous steps of the mitigation hierarchy have been considered (and implemented where practical), residual significant impacts to the environment are expected, then offsets will be applied.

  The Proponent proposes the provision of offsets for residual residual significant impacts to the environment as a result of this Proposal. Three offset rates are proposed: the standard offset rate of $750 per hectare is proposed for vegetation in 'Good to Excellent' condition cleared within the Development Envelope, a higher offset rate of $1,500 per hectare is proposed for vegetation communities that are considered locally significant (West Angelas Cracking Clay PEC and riparian vegetation along the Turee Creek East tributary) and the highest offset rate of $50,000 per hectare is proposed for potentially groundwater dependant vegetation within Karijini National Park.

In addition to the above mitigation strategies, the Proponent proposes that this Proposal be subject to a new Ministerial Statement (Appendix 3). The contemporary conditions of the new Ministerial Statement shall require the Proponent to implement a condition Environmental Management Plan (EMP, Appendix 4) to demonstrate that the environmental outcomes for key environmental factors (hydrological processes, flora and vegetation and terrestrial fauna) are met.

Based on the mitigation strategies proposed and the continued implementation of existing and proposed management strategies, the Proponent considers that, for all environmental factors, the EPA objective can be met and the potential residual impacts to the environment are not significant.

13.1 Environmental Management

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

The key components of the environmental management approach that have been implemented include:

- The Rio Tinto Iron Ore Group Health, Safety, Environment, Communities and Quality Policy (HSECQ Policy). The HSECQ Policy is the guiding document for environmental management and provides context and direction for continuous improvement.
- Rio Tinto Iron Ore (WA) operates under an Environmental Management System (EMS), contained within the HSEQ Management System. The HSEQ Management System is a continuous improvement model covering:
  - systematic assessment of environmental risk and legal requirements; systems for training, operational control, communication, emergency response and corrective actions;
  - the development of objectives and targets for improvements; and
  - audits and review.
- Conditions of the relevant Ministerial Statement (Appendix 3).

The existing West Angelas Project operates under the existing Ministerial Statements (MS 970 and MS 1015, Appendix 2). Subject to approval of this Proposal, the Proponent requests that a new Ministerial Statement is published to supersede these existing Ministerial Statements. A Proponent drafted Ministerial Statement is provided as Appendix 3 for the OEPA's consideration.

- Management strategies of the relevant Environmental Management Plan (Appendix 4).

  The Proponent currently operates under the existing, approved West Angelas Operations Environmental Management Plan (dated November 2013). An updated Condition Environmental Management Plan is proposed to demonstrate that the environmental outcomes for key environmental factors (hydrological processes, flora and vegetation and terrestrial fauna) are met. This EMP will be implemented subject to approval by the EPA and will supersede the existing approved Environmental Management Plan.

- Closure strategies of the relevant Closure Plan (Appendix 11). The Rio Tinto closure approach will continue to guide closure planning for this Proposal. This approach governs:

  - commencement of planning for closure prior to project implementation;
  - the development of closure plans;
  - stakeholder consultation regarding closure;
  - financial provisioning for closure; and
  - the ongoing review of closure plans, which will become increasingly detailed as the site approaches closure.

- Existing licences issued under Part V of the EP Act and the RIWI Act, and any amendments as required:

  - Licence L7774/2000, issued under Part V of the EP Act for processing of ore, dewatering (discharge), screening, power generation, sewage facility, landfill and bulk storage of chemicals;
  - Groundwater Licence GWL98740, issued under the RIWI Act for abstraction of 5,380,000 kL from the mine for dewatering and water supply purposes; and
  - Groundwater Licence GWL103136, issued under the RIWI Act for abstraction of 3,102,500 kL from the Turee B Borefield for water supply purposes.

The Proponent will continue to implement key components of the environmental management approach in accordance with the existing Project's approved practices.

14. RATIONALISATION OF WEST ANGELAS STATEMENTS

This Proposal provides an opportunity to rationalise the West Angelas Proposal description, implementation conditions and Schedule 1 from the two existing Ministerial Statements and this Proposal into one new Ministerial Statement, pursuant to section 46 of the EP Act. The Proponent proposes that, subject to approval, the new Ministerial Statement supersedes MS 970 and MS 1015.

The intent of this rationalisation is as follows:

- To reflect the proposed changes to the West Angelas Project.
- To facilitate integrated management under a single set of conditions.

14.1 Proposal Description

The current description of the West Angelas Iron Ore Project, the subject of MS 970 and MS 1015, includes the following:

> *The development and operation of an open-cut iron ore mine and associated infrastructure at the West Angelas, located 130 kilometres west of Newman in the Pilbara region of Western Australia. Iron Ore is to be mined from above and below the water table in Deposits A, A west, B, E and F.*
>
> *The mining operations are supplied with water from the mine dewatering bores and water from the Turee Creek B Borefield, located approximately 30 kilometres west of the minesite.*
>
> *Railway infrastructure transports ore from West Angelas to the port facilities at Cape Lambert.*

The Proponent proposes that, subject to approval of this Proposal, a new MS will consolidate the two existing Ministerial Statements and this Proposal and that the description of the West Angelas Project in the new Ministerial Statement will read as follows:

> *The Proposal is located approximately 130 kilometres west of Newman in the Pilbara region of Western Australia. The Proposal involves above and below water table, open-cut iron ore mining and the construction and operation of associated infrastructure including but not limited to the following: a 413 km rail network from West Angelas to port facilities located at Cape Lambert with a spur loop at West Angelas and sidings (including but not limited to Juna Downs, Rosella, Bellbird, Brockman Refuge and Emu); dewatering and surplus water management infrastructure; surface water management infrastructure; linear infrastructure; processing and support facilities*.
>
> *The Turee Creek B Borefield, located approximately 30 km west of the mine site supplies potable water to mine and camp facilities and, when required, for operational purposes. Mine dewatering, which dewaters the ore bodies to allow below water table mining, supplies water for operational purposes. Surplus dewatering water, exceeding the operational requirement, is discharged to the environment.*
>
> *The mine and associated infrastructure described above will be contained within the West Angelas Mine and Linear Infrastructure Development Envelopes.*

14.2 Ministerial Conditions

The existing West Angelas Project, the subject of MS 970 and MS 1015, is managed via 10 existing Ministerial conditions:

1. Proposal Implementation
2. Contact Details
3. Compliance Reporting
4. Public Availability of Data
5. Environmental Management Program
6. Groundwater
7. Surface Water
8. Conservation Significant Communities and Species
9. Rehabilitation and Closure
10. Offsets

The Proponent has undertaken a review of these existing Ministerial conditions and proposes that, subject to approval, these Ministerial conditions be amended as follows:

- Conditions shall be updated to reflect contemporary wording and format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.
- Development of conditions which reflect the requirement for Condition Environmental Management Plans to meet environmental outcomes for key environmental factors (hydrological processes, flora and vegetation and terrestrial fauna) consistent with the EP Act, EPA guidance (*Statement of Environmental Principles, Factors and Objectives*, 2016) and other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.
- Removal of redundant conditions, or conditions that are managed under other processes and as such, do not require regulation under Part IV the EP Act where this can be justified.

The proposed Ministerial conditions of the revised West Angelas Project include the following:

1. Proposal Implementation
2. Contact Details
3. Compliance Reporting
4. Public Availability of Data
5. Condition Environmental Management Plan
6. Hydrological Processes and Flora and Vegetation - Dewatering, discharge and riparian vegetation communities
7. Flora and Vegetation - Conservation significant vegetation communities; West Angelas Cracking Clay Priority Ecological Communities
8. Terrestrial Fauna - Conservation significant fauna species; Ghost bat (*Macroderma gigas*)
9. Closure
10. Offsets.

Table 14-1 provides the proponents rationalisation for these proposed changes.

These proposed Ministerial conditions are closely aligned to the existing Ministerial conditions and will maintain the overall level of protection of environmental values and the required standard of management of key environmental factors. The Proponent proposes that these conditions be adopted for the new Ministerial Statement that, subject to approval, will supersede the existing MS 970 and MS 1015. A Proponent drafted Ministerial Statement is provided as Appendix 3 for the OEPA's consideration.

Table 14-1: Rationalisation of Conditions of MS 970 and MS 1015

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
1	**Proposal Implementation**		**1**	**Proposal Implementation**
1-1	When implementing the proposal, the proponent shall not exceed the authorised extent of the proposal as defined in Column 3 of Table 2 in Schedule 1, unless amendments to the proposal and the authorised extent of the proposal have been approved under the *Environmental Protection Act 1986*.	This Condition is still relevant and should be retained; however, it has been updated to reflect contemporary wording and format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	1-1	When implementing the proposal, the proponent shall not exceed the authorised extent of the proposal as defined in Table 2 in Schedule 1 of this Statement, unless amendments to the proposal and the authorised extent of the proposal have been approved under the *Environmental Protection Act 1986*.
2	**Proponent Nomination and Contact Details**		**2**	**Contact Details**
2-1	The proponent shall notify the Chief Executive Officer (CEO) of any change of its name, physical address or postal address for the serving of notices or other correspondence within 28 days of such change. Where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State.	This Condition is still relevant and should be retained.	2-1	The proponent shall notify the Chief Executive Officer (CEO) of any change of its name, physical address or postal address for the serving of notices or other correspondence within twenty eight (28) days of such change. Where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State.
3	**Compliance Reporting**		**3**	**Compliance Reporting**
3-1	The proponent shall prepare and maintain a Compliance Assessment Plan to the satisfaction of the CEO.	This Condition is still relevant and should be retained; however, it has been updated to reflect contemporary wording and format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	3-1	The proponent shall prepare, submit and maintain a Compliance Assessment Plan to the satisfaction of the CEO prior to the first Compliance Assessment Report required by condition 3-6, or as agreed in writing by the CEO.
3-2	The proponent shall submit to the CEO the Compliance Assessment Plan required by condition 3-1 prior to the first Compliance Assessment Report required by condition 3-6. The compliance assessment plan shall indicate:		3-2	The Compliance Assessment Plan shall indicate: 1. the frequency of compliance reporting; 2. the approach and timing of compliance assessments; 3. the retention of compliance assessments;

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
	1. the frequency of compliance reporting; 2. the approach and timing of compliance assessments; 3. the retention of compliance assessments; 4. the method of reporting of potential non-compliances and corrective actions to take; 5. the table of contents of Compliance Assessment Reports; and 6. public availability of Compliance Assessment Reports.			4. the method of reporting of potential non-compliances and corrective actions taken; 5. the table of contents of Compliance Assessment Reports; and 6. public availability of Compliance Assessment Reports.
3-3	The proponent shall assess compliance with conditions in accordance with the Compliance Assessment Plan required by condition 3-1.		3-3	After receiving notice in writing from the CEO that the Compliance Assessment Plan satisfies the requirements of condition 3-2, the proponent shall assess compliance with conditions in accordance with the Compliance Assessment Plan required by condition 3-1.
3-4	The proponent shall retain reports of all compliance assessments described in the Compliance Assessment Plan required by condition 3-1 and shall make those reports available when requested by the CEO.		3-4	The proponent shall retain reports of all compliance assessments described in the Compliance Assessment Plan required by condition 3-1 and shall make those reports available when requested by the CEO.
3-5	The proponent shall advise the CEO of any potential non-compliance within seven days of that non-compliance being known.		3-5	The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that non-compliance being known.
3-6	The proponent shall submit to the CEO Compliance Assessment Reports addressing compliance in the previous calendar year. Compliance Assessment Reports shall be submitted by the submission date defined in the Compliance Assessment Plan required by condition 3-1. The compliance assessment report shall: 1. be endorsed by the proponent's Managing Director/ General Manager/ Chief Executive Officer or a person delegated to sign on the Managing Director's/ General Manager's/ Chief Executive Officer's behalf;		3-6	The proponent shall submit to the CEO the first Compliance Assessment Report by 30 April each year addressing compliance in the previous calendar year, or as agreed in writing by the CEO. The first Compliance Assessment Report shall be submitted by 30 April 2019 addressing the compliance for the period from the date of issue of this Statement, notwithstanding that the first reporting period may be less than 12 months. The Compliance Assessment Report shall: 1. be endorsed by the proponent's Chief Executive Officer or a person delegated to sign on the Chief Executive Officer's behalf;

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
	2. include a statement as to whether the proponent has complied with the conditions; 3. identify all potential non-compliances and describe corrective and preventative actions taken; 4. be made publicly available in accordance with the approved Compliance Assessment Plan; and 5. indicate any proposed changes to the Compliance Assessment Plan required by condition 3-1.			2. include a statement as to whether the proponent has complied with the conditions; 3. identify all potential non-compliances and describe corrective and preventative actions taken; 4. be made publicly available in accordance with the approved Compliance Assessment Plan; and 5. indicate any proposed changes to the compliance assessment plan required by condition 3-1.
4	**Public Availability of Data**		**4**	**Public Availability of Data**
4-1	Subject to condition 4-2, within a reasonable time period, approved by the CEO, of the issue of this statement and for the remainder of the life of the proposal, the proponent shall make publicly available, in a manner approved by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products (e.g. maps)) relevant to the assessment of this proposal and implementation of this statement	This Condition is still relevant and should be retained; however, it has been updated to reflect contemporary wording and format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	4-1	Subject to condition 4-2, within a reasonable time period approved in writing by the CEO of the issue of this Statement and for the remainder of the life of the Proposal, the proponent shall make publicly available, in a manner approved in writing by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products e.g. maps) required under this Statement.
4-2	If any data referred to in condition 4-1 contains particulars of: 1. a secret formula or process; or 2. confidential commercially sensitive information; the proponent may submit a request for approval from the CEO to not make this data publicly available. In making such a request, the proponent shall provide the CEO with an explanation and reasons why the data should not be made publicly available.		4-2	If any data referred to in condition 4-1 contains particulars of: 1. a secret formula or process; or 2. confidential commercially sensitive information; the proponent may submit a request for approval from the CEO to not make this data publicly available. In making such a request the proponent shall provide the CEO with an explanation and reasons why the data should not be made publicly available.

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
5	**Environmental Management Program**		**5**	**Condition Environmental Management Plans**
5-1	The proponent shall implement the proposal in accordance with the "*Environmental Management Program*", dated November 2013, or subsequent revisions approved by the CEO. The Environmental Management Program consists of the following Management Plans: (1) Groundwater Management Plan; (2) Surface Water Management Plan; (3) Vegetation and Flora Management Plan; (4) Fauna Management Plan; (5) Dust Management Plan; (6) Waste Management Plan; and (7) Rail Management Plan. Each Management Plan includes: i. the specific environmental objectives and targets for each environmental factor; ii. the management measures to be applied to avoid and minimise the environmental impact of the proposal; iii. monitoring measures to measure the performance of management against targets; and iv. contingency measures to mitigate impacts	This Condition is still relevant and shall be retained; however, it has been updated to reflect the requirement for Environmental Management Plans to meet environmental outcomes, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations. The requirement for a dust and waste management plan shall be removed, emissions have been, and will continue to be, managed under the existing Operating Licence issued under Part V of the EP Act. The licensee will consult the DER if additional approvals are required.	5-1	Within 6 months of the issue of this Statement, the proponent shall prepare and implement a Condition Environmental Management Plan to the satisfaction of the CEO. This plan shall demonstrate that the environmental outcomes specified in in condition 6-1, condition 7-1 and condition 8-1 will be met

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
			5-2	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.
5-2	The proponent shall make the Environmental Management Program required by condition 5.1 publicly available, in a manner approved by the CEO.		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; 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.

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
			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 as required by condition 5-6(1). 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 the investigations required by condition 5-5(3) and 5-5(4); d. measures to prevent the threshold criteria being exceeded in the future;

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
			5-4	e. measures to prevent, control or abate the environmental harm which may have occurred; f. justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes would continue to be met.
			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.
6	**Groundwater**		**6**	**Hydrological Processes and Flora and Vegetation – Dewatering, discharge and riparian vegetation**
6-1	The proponent shall manage groundwater abstraction and dewatering activities to ensure minimal adverse impacts on the availability and quality of groundwater resources and the dependent ecology.	This Condition is still relevant and should be retained; however, it has been updated to reflect the requirement to meet environmental outcomes, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	6-1	The proponent shall manage the implementation of the proposal to meet the following environmental outcomes: 1. The proponent shall ensure that there is no irreversible impact, as a result of the proponent's dewatering activities, to groundwater dependant vegetation within Karijini National Park, as delineated in Figure 6 of Schedule 1 and defined by the geographic coordinates in Schedule 2. 2. The proponent shall ensure that there is no irreversible impact, as a result of the proponent's discharge of excess water, to the health of riparian vegetation of Turee Creek East.
6-2	To verify that the requirements of condition 6-1 are met the proponent shall undertake monitoring of groundwater level elevations and quality as outlined in the Groundwater Management Plan approved as part of Environmental Management Program required by condition 5.			
6-3	In the event that the monitoring required by condition 6-2 indicates that the requirements of condition 6-1 are not met, the proponent shall implement contingency actions as outlined in the Groundwater Management Plan.			
6-4	The proponent shall submit annually the results of monitoring required by condition 6-2 to the CEO of the Office of the Environmental Protection Authority as part of the compliance assessment reports required by condition 3-6.			

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
7	**Surface Water**			
7-1	The proponent shall manage surface water drainage and discharge to ensure minimal adverse impacts on existing surface water drainage patterns or the water dependent ecosystems.	This Condition is still relevant and should be retained; however, it has been updated to reflect the requirement to meet environmental outcomes, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.		As per proposed Condition 6-1 (above).
7-2	To verify that the requirements of condition 7-1 are met, the proponent shall undertake monitoring of the quality and quantity of water discharge as outlined in the Surface Water Management Plan approved as part of the Environmental Management Program required by condition 5.			
7-3	In the event that the monitoring required by condition 7-2 indicates that the requirements of condition 7-1 are not met, the proponent shall implement contingency actions as outlined in the Surface Water Management Plan.			
7-4	The proponent shall submit annually the results of monitoring required by condition 7-2 to the CEO as part of the Compliance Assessment Reports required by condition 3-6.			
8	**Conservation Significant Communities and Species**		**7**	**Flora and Vegetation – Conservation significant vegetation communities; West Angelas Cracking Clay Priority Ecological Communities**
8-1	The proponent shall manage clearing activities to ensure minimal adverse impacts on conservation significant communities and species	This Condition is still relevant and shall be retained; however, it has been updated to reflect the requirement to meet environmental outcomes, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	7-1	The proponent shall manage the implementation of the Proposal to meet the following environmental outcomes: 1. The proponent shall ensure that there is no disturbance to the West Angelas Cracking Clay Priority Ecological Community (PEC-2015-5) as delineated in Figure 4 of Schedule 1 and defined by the geographic coordinates in Schedule 2.
8-2	To verify that the requirements of condition 8-1 are met, the proponent shall implement the proposal in accordance with the Vegetation and Flora Management Plan and Fauna Management Plan approved as part of the Environmental Management Program required by condition 5.			

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
8-3	In the event that monitoring required by the Management Plans detailed in condition 8-2 indicates that the specific environmental objectives and targets, identified for each environmental factor, have been exceeded, the proponent shall: 1. within 7 days of becoming aware of the exceedance, implement contingency measures as outlined in the management plans and continue implementation until environmental objectives and targets are being met, or as otherwise agreed by the CEO; and 2. within 14 days of becoming aware of the exceedance, submit details of contingency measures implemented to the CEO.			2. The proponent shall ensure no more than 20 ha of disturbance to other representations of the West Angelas Cracking Clay Priority Ecological Community that are not authorised to be cleared in Schedule 1.
			8	**Terrestrial Fauna – Conservation significant fauna species; Ghost Bat (*Macroderma gigas*)**
			8-1	The proponent shall manage the implementation of the Proposal to meet the following environmental outcomes: 1. The proponent shall ensure that there is no disturbance to the Ghost Bat roost; Cave AA1 as delineated in Figure 5 of Schedule 1 and defined by the geographic coordinates in Schedule 2. 2. The proponent shall minimise disturbance to other roosts; Caves A1, A2, L2 and L3 as delineated in Figure 5 of Schedule 1 and defined by the geographic coordinates in Schedule 2.
			8-2	The proponent shall avoid the use of barbed wire in the Proposal area except where there is a statutory requirement to do so, and where avoidance is not possible, minimise the impact of barbed wire on Ghost Bats

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
9	**Rehabilitation and closure**		**9**	**Rehabilitation and Decommissioning**
9-1	The proponent shall ensure that the mine is closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State of Western Australia.	This Condition is still relevant and should be retained; however, it has been updated to reflect contemporary wording and format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	9-1	The proponent shall manage the implementation of the Proposal to meet the following environmental objective: 1. The proponent shall ensure that the Proposal is rehabilitated and decommissioned in an ecologically sustainable manner.
9-2	The proponent shall prepare a Mine Closure Plan for the West Angelas Iron Ore Project.		9-2	Within 12 months of the issue of this Statement the proponent shall prepare and submit a Mine Closure Plan in accordance with the *Guidelines for Preparing Mine Closure Plans*, May 2015, (or any subsequent revisions of the guidelines), to the requirements of the CEO, on advice of the Department of Mines and Petroleum.
9-3	The Mine Closure Plan required by condition 9-2 shall: 1. when implemented, manage the implementation of the proposal to meet the requirements of condition 9-1; 2. be prepared in accordance with the *Guidelines for Preparing Mine Closure Plans*, *June 2011* (Department of Mines and Petroleum and Environmental Protection Authority) or its revisions; and 3. be to the requirements of the CEO on advice of the Department of Mines and Petroleum.		9-3	The proponent shall review and revise the Mine Closure Plan required by condition 9-2 at intervals not exceeding three years, or as otherwise specified by the CEO, and submit the plan to the CEO at the agreed interval.
9-4	Within 12 months of commissioning of additional mine pits or as otherwise agreed by the CEO the proponent shall implement the approved Mine Closure Plan and continue implementation until otherwise agreed by the CEO.		9-4	The proponent shall implement the latest revision of the Mine Closure Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 9-2.
9-5	Revisions to the Mine Closure Plan may be approved by the CEO on the advice of the Department of Mines and Petroleum.			

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
9-6	The proponent shall implement revisions of the Mine Closure Plan required by condition 9-5.			
10	**Offsets**		**10**	**Offsets**
10-1	In view of the significant residual impacts and risks as a result of implementation of the proposal, the proponent shall contribute funds to offset clearing of 'good to excellent' condition native vegetation, including the loss of habitat for conservation significant species, in the Hamersley IBRA subregion, and calculated pursuant to condition 10-2. This funding shall be provided to a government-established conservation offset fund or an alternative offset arrangement providing an equivalent outcome as determined by the Minister.	This Condition is still relevant and should be retained; however, it has been updated to reflect contemporary wording and format, consistent with other recent Ministerial Statements for Rio Tinto's Pilbara iron ore operations.	10-1	In view of the residual impacts and risks as a result of implementation of the Proposal, the proponent shall contribute funds to offset clearing of 'good to excellent' condition native vegetation, including the loss of habitat for conservation significant species, in the Hamersley IBRA subregion, and calculated pursuant to condition 10-2. This funding shall be provided to a government-established conservation offset fund or an alternative offset arrangement providing an equivalent outcome as determined by the Minister.
10-2	The proponent's contribution to the initiative identified in condition 10-1 shall be paid biennially, the first payment due two years after commencement of the additional ground disturbance defined in Table 2 of Schedule 1. The amount of funding will be $750 AUD (excluding GST) per hectare of 'good to excellent' condition native vegetation cleared within the development envelope (delineated in Figure 1 and defined by the geographic coordinates in Schedule 2, within the Hamersley IBRA subregion.		10-2	The 4,667 ha of clearing of native vegetation previously approved under Ministerial Statement 970 is exempt from the requirement to offset under condition 10-1.
10-3	The 4,667 ha of clearing of native vegetation previously approved under Ministerial Statement 970 is exempt from the requirement to offset under condition 10-1.		10-3	The proponent's contribution to the initiative identified in condition 10-1 shall be paid biennially, the first payment due two years after commencement of the additional ground disturbance defined in Table 2 of Schedule 1. The amount of funding will be made on the following basis and in accordance with the approved Impact Reconciliation Procedure required by condition 10-5:

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
				1. $750 AUD (excluding GST) per hectare of 'Good to Excellent' condition native vegetation cleared within the Mine Development Envelope (delineated in Figure 2 and defined by the geographic coordinates in Schedule 2) within the Hamersley IBRA subregion; 2. $1500 AUD (excluding GST) per hectare of conservation significant vegetation; West Angelas Cracking Clay Priority Ecological Community cleared within the Mine Development Envelope (delineated in Figure 5 and defined by the geographic coordinates in Schedule 2) within the Hamersley IBRA subregion. 3. $1500 AUD (excluding GST) per hectare of conservation significant vegetation; riparian vegetation communities within Turee Creek East affected by discharge (delineated in Figure 5 and defined by the geographic coordinates in Schedule 2) 4. $50,000 AUD (excluding GST) per hectare of potentially groundwater dependant vegetation within Karijini National Park affected by dewatering (delineated in Figure 5 and defined by the geographic coordinates in Schedule 2).
10-4	The proponent shall prepare and submit an Impact Reconciliation Procedure to the satisfaction of the CEO within six months of the date of this Statement, or as approved by the CEO.		10-4	The proponent shall prepare and submit an Impact Reconciliation Procedure to the satisfaction of the CEO within six months of the date of this Statement, or as approved by the CEO.
10-5	The Impact Reconciliation Procedure required pursuant to condition 10-4 shall: 1. include a methodology to identify clearing of 'good to excellent' condition native vegetation in the Hamersley IBRA subregion.		10-5	The Impact Reconciliation Procedure required pursuant to condition 10-4 shall: 1. include a methodology to identify clearing of the areas subject to offsets as defined in condition 10-3; 2. require the proponent to submit spatial data identifying areas subject to offsets as defined in condition 10-3;

Ministerial Conditions of MS 970 (as amended by MS 1015)		Proposed Change / Rationale	Proposed New Ministerial Conditions	
	2. require the proponent to submit spatial data identifying areas of 'good to excellent' condition native vegetation that has been cleared; 3. include a methodology for calculating the amount of clearing undertaken during each biennial time period; and 4. state dates for the commencement of the biennial time period and for the submission of results of the Impact Reconciliation Procedure, to the satisfaction of the CEO.			3. include a methodology for calculating the amount of clearing undertaken during each biennial time period; and 4. state dates for the commencement of the biennial time period and for the submission of results of the Impact Reconciliation Procedure, to the satisfaction of the CEO.
10-6	The real value of contributions described in condition 10-2 will be maintained through indexation to the Perth Consumer Price Index (CPI), with the first adjustment to be applied to the first contribution.		10-6	The real value of contributions described in condition 10-2 will be maintained through indexation to the Perth Consumer Price Index (CPI), with the first adjustment to be applied to the first contribution.

14.3 Schedule 1

The Proponent proposes that, subject to approval, the summary of the Proposal and the location and authorised extent of operational elements of Schedule 1 will be amended to consolidate the two existing Ministerial Statements and this Proposal, to read as follows:

Table 1: Summary of the Proposal

Proposal title	West Angelas Iron Ore Project
Short description	The Proposal is located approximately 130 kilometres west of Newman in the Pilbara region of Western Australia (Figure 1). The Proposal involves above and below water table, open-cut iron ore mining and the construction and operation of associated infrastructure including but not limited to the following: a 413 km railway network from West Angelas to port facilities located at Cape Lambert with a spur loop at West Angelas and sidings (including but not limited to Juna Downs, Rosella, Bellbird, Brockman Refuge and Emu); dewatering and excess water management infrastructure; surface water management infrastructure; linear infrastructure; processing and support facilities. The Turee Creek B Borefield, located approximately 30 km west of the mine site supplies potable water to mine and camp facilities and, when required, for operational purposes. Mine dewatering, which dewaters the ore bodies to allow below water table mining, supplies water for operational purposes. Surplus dewatering water, exceeding the operational requirement, is discharged to the environment. The mine and associated infrastructure described above will be contained within the West Angelas Mine and Linear Infrastructure Development Envelopes (Figure 2 and Figure 3). Disturbance within the Development Envelopes will not exceed those values indicated in Table 2.

Table 2: Location and authorised extent of physical and operational elements of the Proposal

Element	Location	Authorised Extent
Mine and associated infrastructure	Figure 2, Figure 4, Figure 5 and geographic coordinates in Schedule 2	Clearing of no more than 12,200 hectares (ha) within a 26,400 ha Mine Development Envelope, including: • No clearing within the Ghost Bat Cave AA1 Exclusion Zone. • No clearing within the West Angelas Cracking Clay Priority Ecological Community, PEC-2015-5. • No more than 20 ha of other representations of the West Angelas Cracking Clay Priority Ecological Community. Below water table pits are to be backfilled to a level to prevent the formation of permanent pit lakes.

Element	Location	Authorised Extent
Linear infrastructure	Figure 3	A 413 km rail network transports processed ore from West Angelas to port facilities located at Cape Lambert. Clearing no more than 1,500 ha within a 19,400 ha Linear Infrastructure Development Envelope, including: • Five existing sidings; Spoonbill, Bellbird, Rosella, Brockman Refuge and Emu and potential additional sidings to support the rail network. • Turee Creek B borefield, pipeline, powerline, access roads and other associated infrastructure.
Surplus water management	Figure 6 and geographic coordinates in Schedule 2	Dewatering water will be used onsite in the first instance to supply water for operational purposes. Excess dewatering water, exceeding the operational requirement is discharged to a local ephemeral tributary of Turee Creek East. The surface discharge extent will not extend within the boundary of Karijini National Park.

15. REFERENCES

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16. APPENDICES

Appendix 1: **Section 38 Referral Form**

Appendix 2: **Ministerial Statement 970 and 1015**

http://edit.epa.wa.gov.au/EPADocLib/Statement%20No.%201000.pdf

Appendix 3: **Draft Ministerial Statement**

Appendix 4: **Environmental Management Plan**

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

Appendix 5: **Vegetation and Flora Assessment (ecologia 2013)**

Appendix 6: **Groundwater Dependant Vegetation Assessment (Rio Tinto 2017)**

Appendix 7: **Terrestrial Fauna Assessment (ecologia 2014)**

Appendix 8: **Subterranean Fauna Assessment – Phase 1 (ecologia 2013)**

Appendix 9: **Subterranean Fauna Assessment – Phase 2 (Biologic 2016)**

Appendix 10: **Hydrogeological Modelling Report (Rio Tinto 2017)**

Appendix 11: **West Angelas Closure Plan (Rio Tinto 2017)**

Appendix 12: **West Angelas Dust Dispersion Modelling (Envall 2016)**

GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

EPA Referral Form

Form for the referral of a proposal to the Environmental Protection Authority under Section 38 of the *Environmental Protection Act 1986*

Referrer information			
Who is referring this proposal?		☒ Proponent ☐ Decision-making authority ☐ Community member/third party	
Name (print) Paul Shannon		**Signature**	
Position	Director	Organisation	Robe River Mining Co. Pty. Ltd.
Email			
Address	152-158	St Georges Terrace	
	Perth	WA	6000
Date	11 July 2017		
Does the referrer request that the EPA treat any part of the proposal information in the referral as confidential? *Provide confidential information in a separate attachment.*		☐ Yes ☒ No	
Referral declaration for organisations, proponents and decision-making authorities: I, Paul Shannon, declare that I am authorised to refer this proposal on behalf of Robe River Mining Co. Pty. Ltd. and further declare that the information contained in this form is true and not misleading.			

Part A: Proponent and proposal description

Proponent information

Name of the proponent/s (including Trading Name if relevant)	The Proponent for the Proposal is Robe River Mining Co. Pty. Ltd. Robe River Mining Co. Pty. Ltd. (a wholly owned subsidiary of the Rio Tinto) is the authorised management company for the Robe River Iron Associates joint venture which is an unincorporated joint venture in which the Rio Tinto Group (53%), Mitsui (33%), Nippon Steel (10.5%) and Sumitomo Metal Industries (3.5%) retain interests.
Australian Company Number(s) ☒ **OR** Australian Business Number(s) ☐	71 008 694 246

Contact for the proposal (if different from the referrer) *Please include: name; physical address; phone; and email.*	The contact person in relation to the environmental approvals process for this Proposal is Carly Nixon (Environmental Approvals Specialist) A: 152-158 St Georges Terrace Perth, WA 6000 T: +61 (08) 6213 1297 E: carly.nixon@riotinto.com
Does the proponent have the legal access required for the implementation of all aspects of the proposal? *If yes, provide details of legal access authorisations / agreements / tenure.* *If no, what authorisations / agreements / tenure is required and from whom?*	☒ Yes ☐ No The West Angelas Project is located on Mineral Lease 248SA which was granted in 1976 under the *Iron Ore (Robe River) Agreement Act 1964* (WA). The infrastructure at West Angelas that is located outside of ML248SA is supported by the following other tenure (General Purpose Leases and Miscellaneous Licences) that have been granted under the *Mining Act 1978* (WA): • General purpose leases 47/1235 and 47/1236; • Miscellaneous Licence L47/50 for the rail; • Miscellaneous Licence L47/409 for the gas pipeline; and • Miscellaneous Licence L47/53 for the pipeline and powerline to the Turee B Borefield and L47/41 for the Turee B Borefield. Refer to Section 1.4 of the Environmental Review document.
Proposal type	
What type of proposal is being referred? For a change to an approved proposal please state the Ministerial Statement number/s (MS No./s) of the approved proposal	☒ significant – new proposal ☐ significant – change to approved proposal (MS No./s: _____) ☐ proposal under an assessed planning scheme ☐ strategic ☐ derived (Strategic MS No.: _____)
For a significant proposal: • Why do you consider the proposal may have a significant effect on the environment and warrant referral to the EPA?	Refer to Section 4.2 of the Environmental Review document.
For a proposal under an assessed planning scheme, provide the following details: • Scheme name and number For the Responsible Authority: • What new environmental issues are raised by the proposal that were not assessed during the assessment of the planning scheme? • How does the proposal not comply with the assessed scheme and/or the environmental conditions in the assessed planning scheme?	N/A

Proposal description	
Title of the proposal	West Angelas Iron Ore Project Deposit C, D and G Proposal
Name of the Local Government Authority in which the proposal is located.	The Proposal is located in the Shire of East Pilbara.
Location: a) street address, lot number, suburb, and nearest road intersection; or b) if remote the nearest town and distance and direction from that town to the proposal site.	The West Angelas Iron Ore Mine is located approximately 130 km northwest of Newman in the Pilbara region of Western Australia.
Proposal description – including the key characteristics of the proposal	Refer to Section 2.2 of the Environmental Review document.
Have you provided electronic spatial data, maps and figure in the appropriate format?	☒ Yes ☐ No
What is the current land use on the property, and the extent (area in hectares) of the property?	Existing land uses in the region are limited to mining activities. This Proposal is located adjacent to the existing West Angelas Iron Ore Mine. Clearing of up to 7,890 ha within the 22,600 ha West Angelas development envelope has been approved under existing Ministerial Statements 970 and 1015.
Have you had pre-referral discussions with the OEPA? If so, quote the reference number and/or the OEPA contact.	Pre-referral discussions were held with the OEPA on 1 November and 22 November 2017. The Proponent has, and will continue to, consult with the OEPA and other relevant stakeholders during the environmental approval process. Refer to Section 3 of the Environmental Review document.

Part B: Environmental impacts

Environmental factors

What are the likely significant environmental factors for this proposal?	☐ Benthic Communities and Habitat ☐ Coastal Processes ☐ Marine Environmental Quality ☐ Marine Fauna ☒ Flora and Vegetation ☐ Landforms ☒ Subterranean Fauna ☐ Terrestrial Environmental Quality ☒ Terrestrial Fauna ☒ Hydrological Processes ☐ Inland Waters Environmental Quality ☐ Air Quality ☐ Social Surroundings ☐ Human Health

For the environmental factors identified above, complete the following table, or provide the information in a supplementary report. Please be sure to complete a separate table per factor identified above.

Potential environmental impacts		
1	***EPA Factor***	The Proponent considers that the preliminary key environmental factors relevant to this Proposal are: *Flora and Vegetation* (refer to Section 5 of the Environmental Review document); *Terrestrial Fauna* (refer to Section 6 of the Environmental Review document)*; Subterranean Fauna* (refer to Section 7 of the Environmental Review document); and *Hydrological Processes* (refer to Section 8 of the Environmental Review document). In addition, Closure and Offsets are considered relevant to this Proposal (refer to Sections 9 and 10 of the Environmental Review document).
2	***EPA policy and guidance*** - What have you considered and how have you applied them in relation to this factor?	Refer to the following Sections of the Environmental Review document: Flora and Vegetation - Section 5.2 ; Fauna - Section 6.2; Subterranean Fauna - Section 7.2; and Hydrological Processes - Section 8.2.
3	***Consultation*** – Outline the outcomes of consultation in relation to the potential environmental impacts	Refer to Section 3 of the Environmental Review document.
4	***Receiving environment*** **-** Describe the current condition of the receiving environment in relation to this factor.	Refer to the following Sections of the Environmental Review document: Flora and Vegetation - Section 5.3 ; Fauna - Section 6.3; Subterranean Fauna - Section 7.3; and Hydrological Processes - Section 8.3.
5	***Proposal activities*** – Describe the proposal activities that have the potential to impact the environment	Refer to Section 2.2 of the Environmental Review document.
7	***Impacts*** - Assess the impacts of the proposal and review the residual impacts against the EPA objective.	Refer to the following Sections of the Environmental Review document: Flora and Vegetation - Section 5.4 ; Fauna - Section 6.4; Subterranean Fauna - Section 7.4; and Hydrological Processes - Section 8.4.
6	***Mitigation*** **-** Describe the measures proposed to manage and mitigate the potential environmental impacts.	Refer to the following Sections of the Environmental Review document: Flora and Vegetation - Section 5.5 ; Fauna - Section 6.5; Subterranean Fauna - Section 7.5; and Hydrological Processes - Section 8.5.
8	***Assumptions*** - Describe any assumptions critical to your assessment *e.g. particular mitigation measures or regulatory conditions.*	As above.

Part C: Other approvals and regulation

State and Local Government approvals

Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.	☐ Yes ☒ No
If this proposal has been referred by a decision-making authority, what approval(s) are required from you?	N/A

Proposal activities	Land tenure/access	Type of approval / Legislation regulating the activity
Clearing	*Iron Ore (Robe River) Agreement Act 1964* General purpose leases and Miscellaneous Licences granted under the *Mining Act 1978.*	Clearing is subject to approval under Part IV of the *Environmental Protection Act 1986.* Mining Proposals may be required for work on General Purpose Leases under the *Mining Act 1978.*
Mining	*Iron Ore (Robe River) Agreement Act 1964*	State Agreement approval is required under the *Iron Ore (Robe River) Agreement Act 1964* for the proposed additional Deposits C, D and G and new associated infrastructure (including but not limited to transport routes, power and water supply, accommodation).
Processing	*Iron Ore (Robe River) Agreement Act 1964*	A Works Approval may be required under Part V of the Environmental Protection Act 1986 for new infrastructure considered a prescribed activity (i.e. processing facilities). An amendment to the existing existing Operating Licence, L7774/2000, issued under Part V of the *Environmental Protection Act 1986* is potentially required if a Works Approval has been issued in order to operate a new facility or for changes to existing facilities within the existing prescribed premise.
Diversions	*Iron Ore (Robe River) Agreement Act 1964*	A Permit to Obstruct or Interfere with Bed / Banks may be required under the *Rights in Water and Irrigation Act 1914* for the proposed diversion of Turee Creek East.
Dewatering	*Iron Ore (Robe River) Agreement Act 1964*	A Licence to Construct Wells is required under section 26D of the *Rights in Water and Irrigation Act 1914* for new bores. An amendment to the existing Groundwater Licence GWL98740 is required under section 5C of the *Rights in Water and Irrigation Act 1914* for groundwater abstraction from new water supply / dewatering bores or an increase in abstraction from existing water supply / dewatering bores.

		The existing Groundwater Operating Strategy must also be updated prior to groundwater abstraction commencing.
Discharge	*Iron Ore (Robe River) Agreement Act 1964* and unallocated crown land	An amendment to the existing existing Operating Licence, L7774/2000, issued under Part V of the *Environmental Protection Act 1986* is potentially required when changing the volume of discharge.
Closure	*Iron Ore (Robe River) Agreement Act 1964*	A Closure Plan which meets the requirements of the requirements of the EPA / DMP *Guidelines for Preparing Mine Closure Plans* (2015) is required under the *Environmental Protection Act 1986.*
Commonwealth Government approvals		
Does the proposal involve an action that may be or is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)?		☐ Yes ☒ No Refer to Section 12 of the Environmental Review document.
Has the proposed action been referred? If yes, when was it referred and what is the reference number (EPBC No.)?		☐ Yes ☒ No Date: _____ EPBC No.: _____
If referred, has a decision been made on whether the proposed action is a controlled action? If 'yes', check the appropriate box and provide the decision in an attachment.		☐ Yes ☐ No ☐ Decision – controlled action ☐ Decision – not a controlled action
Do you request that this proposal be assessed under the bilateral agreement or as an accredited assessment?		☐ Yes - Bilateral ☐ No ☐ Yes - Accredited
Is approval required from other Commonwealth Government/s for any part of the proposal? *If yes, describe.*		☐ Yes ☐ No Approval:

Published on: 21 August 2015 Statement No. 1015

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED
(Environmental Protection Act 1986)

WEST ANGELAS - DEPOSIT A WEST AND DEPOSIT F – REVISED PROPOSAL

Proposal: West Angelas Deposit A west and Deposit F – Revised Proposal – a proposal to amend the West Angelas Iron Ore Project, the subject of Statement No. 970 dated 12 June 2014

Proponent: Robe River Mining Co. Pty. Ltd.
Australian Company Number 008 694 246

Proponent Address: Robe River Mining Co. Pty Ltd.
Central Park 152-158 St Georges Terrace
PERTH WA 6000

Assessment Number: 2046

Report of the Environmental Protection Authority: 1551

Previous Assessment Number: 1914

Previous Report of the Environmental Protection Authority: 1508

Previous Statement Number: 970

Pursuant to section 45 of the *Environmental Protection Act 1986* (EP Act) it has been agreed that the Proposal described and documented in Table 1 of Schedule 1 may be implemented and that, pursuant to section 45B of EP Act, the implementation of the Proposal is subject to the implementation conditions in Ministerial Statement No. 970 dated 12 June 2014, and as further amended as follows.

Insert the following additional condition into Ministerial Statement No. 970:

10 Offsets

10-1 In view of the significant residual impacts and risks as a result of implementation of the proposal, the proponent shall contribute funds to offset clearing of 'good to excellent' condition native vegetation, including the loss of habitat for conservation significant species, in the Hamersley IBRA subregion, and calculated pursuant to condition 10-2. This funding shall be provided to a government-established conservation offset fund or an alternative offset arrangement providing an equivalent outcome as determined by the Minister.

10-2 The proponent's contribution to the initiative identified in condition 10-1 shall be paid biennially, the first payment due two years after commencement of the additional ground disturbance defined in Table 2 of Schedule 1. The amount of funding will be $750 AUD (excluding GST) per hectare of 'good to excellent' condition native vegetation cleared within the development envelope (delineated in Figure 1 and defined by the geographic coordinates in Schedule 2, within the Hamersley IBRA subregion.

10-3 The 4,667 ha of clearing of native vegetation previously approved under Ministerial Statement 970 is exempt from the requirement to offset under condition 10-1.

10-4 The proponent shall prepare and submit an Impact Reconciliation Procedure to the satisfaction of the CEO within six months of the date of this Statement, or as approved by the CEO.

10-5 The Impact Reconciliation Procedure required pursuant to condition 10-4 shall:

(1) include a methodology to identify clearing of 'good to excellent' condition native vegetation in the Hamersley IBRA subregion.

(2) require the proponent to submit spatial data identifying areas of 'good to excellent' condition native vegetation that has been cleared;

(3) include a methodology for calculating the amount of clearing undertaken during each biennial time period; and

(4) state dates for the commencement of the biennial time period and for the submission of results of the Impact Reconciliation Procedure, to the satisfaction of the CEO.

10-6 The real value of contributions described in condition 10-2 will be maintained through indexation to the Perth Consumer Price Index (CPI), with the first adjustment to be applied to the first contribution.

[Signed 21 August 2015]

Albert Jacob MLA
MINISTER FOR ENVIRONMENT; HERITAGE

Schedule 1

Table 1: Summary of the Proposal

Proposal Title	West Angelas Deposit A west and Deposit F - Revised Proposal
Short Description	Revision of the approved West Angelas Iron Ore Project located approximately 130 kilometres (km) northwest of Newman in the Pilbara Region of Western Australia. In addition to the proposal approved under Ministerial Statement 970, the revised proposal includes the development of the Deposits A west and F, and additional infrastructure such as waste rock dumps, access roads, accommodation and other supporting infrastructure.

Table 2: Location and authorised extent of physical and operational elements

Column 1	Column 2	Column 3
Element	**Location**	**Authorised Extent**
Additional Mining Areas (Deposits A west and F)	Figure 1 and geographic coordinates in Schedule 2	Clearing no more than 920 hectares (ha) of native vegetation within 19,853 ha Development Envelope for Mining Activities in Ministerial Statement 970 and the 2,747 ha Additional Development Envelope.
Additional Waste Dumps	Figure 1 and geographic coordinates in Schedule 2	Clearing of no more than 1,853 ha within the 19,853 ha Development Envelope for Mining Activities in Ministerial Statement 970 and the 2,747 ha Additional Development Envelope.
Additional associated infrastructure, access and accommodation	Figure 1 and geographic coordinates in Schedule 2	Clearing of no more than 450 ha within the 19,853 ha Development Envelope for Mining Activities in Ministerial Statement 970 and the 2,747 ha Additional Development Envelope.

Table 3: Abbreviations and Definitions

Acronym or Abbreviation	Definition or Term
CPI	Consumer Price Index
ha	Hectares
km	kilometre
GL/a	gigalitre per annum
CEO	The Chief Executive Officer of the Department of the Public Service of the State responsible for the administration of section 48 of the *Environmental Protection Act 1986*, or his delegate.
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*

Figures (attached)

Figure 1 Additional Development Envelope (This figure is a representation of the coordinates in Schedule 2)

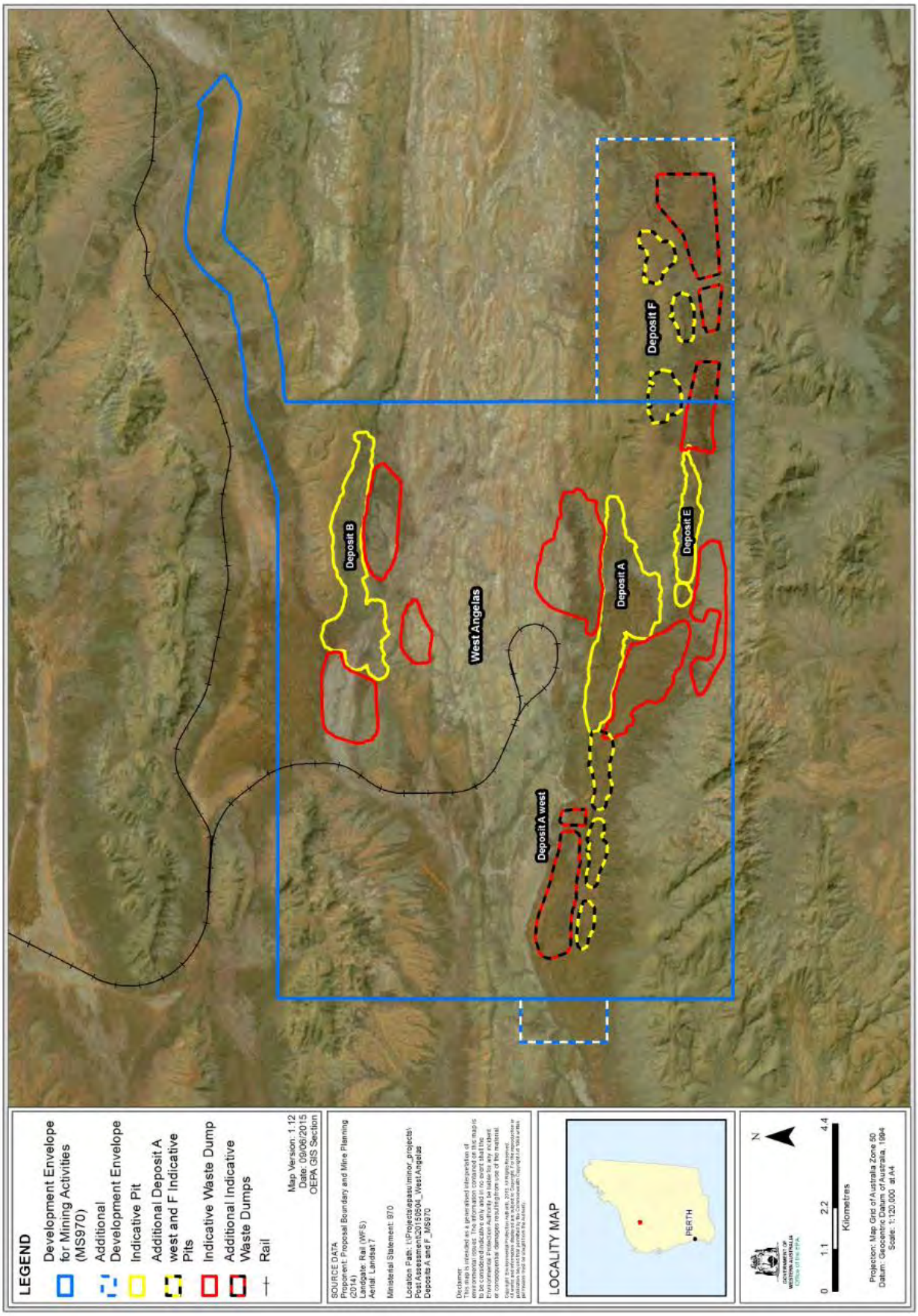

Figure 1 Additional Development Envelope

Schedule 2

Geographic spatial data coordinates

Coordinates defining the Additional Development Envelope are held by the Office of the Environmental Protection Authority, Document Reference Number 2015-0001166811, dated 12 June 2015.

Appendix 3

Proponent's API Environmental Review documentation

Provided on CD in hardcopies of this report and on the EPA's website at www.epa.wa.gov.au

Published on: 12 June 2014 Statement No: 970

STATEMENT TO AMEND CONDITIONS APPLYING TO A PROPOSAL (PURSUANT TO THE PROVISIONS OF SECTION 46 OF THE *ENVIRONMENTAL PROTECTION ACT 1986*)

West Angelas Iron Ore Project

Proposal: The development of iron ore mines at Deposits 'A', 'B', and 'E', waste dumps, ore processing operation and associated infrastructure at West Angelas, 130 kilometres west of Newman, and rail infrastructure, as documented in Schedule 1 of this Ministerial Statement.

Proponent: Robe River Mining Co. Pty. Ltd.

Proponent Address: 152-158 St Georges Terrace
PERTH WA 6000
GPO Box A42, PERTH WA 6001

Assessment Number: 1914

Previous Assessment Number: 1144

Report of the Environmental Protection Authority: 1508

Previous Report of the Environmental Protection Authority: 924

Previous Ministerial Statement Number: 514

The implementation of the proposal to which the above report of the Environmental Protection Authority relates is subject to the following conditions and procedures, which replace and supersede all previous conditions of Ministerial Statement 514.

1 Proposal Implementation

1-1 When implementing the proposal, the proponent shall not exceed the authorised extent of the proposal as defined in Column 3 of Table 2 in Schedule 1, unless amendments to the proposal and the authorised extent of the proposal have been approved under the *Environmental Protection Act 1986*.

2 Contact Details

2-1 The proponent shall notify the Chief Executive Officer (CEO) of any change of its name, physical address or postal address for the serving of notices or other correspondence within 28 days of such change. Where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State.

3 Compliance Reporting

3-1 The proponent shall prepare and maintain a Compliance Assessment Plan to the satisfaction of the CEO.

3-2 The proponent shall submit to the CEO the Compliance Assessment Plan required by condition 3-1 prior to the first Compliance Assessment Report required by condition 3-6.

The Compliance Assessment Plan shall indicate:

(1) the frequency of compliance reporting;

(2) the approach and timing of compliance assessments;

(3) the retention of compliance assessments;

(4) the method of reporting of potential non-compliance and corrective actions to take;

(5) the table of contents of Compliance Assessment Reports; and

(6) public availability of Compliance Assessment Reports.

3-3 The proponent shall assess compliance with conditions in accordance with the Compliance Assessment Plan required by condition 3-1.

3-4 The proponent shall retain reports of all compliance assessments described in the Compliance Assessment Plan required by condition 3-1 and shall make those reports available when requested by the CEO.

3-5 The proponent shall advise the CEO of any potential non-compliance within seven days of that non-compliance being known.

3-6 The proponent shall submit to the CEO Compliance Assessment Reports addressing compliance in the previous calendar year. Compliance Assessment Reports shall be submitted by the submission date defined in the Compliance Assessment Plan required by condition 3-1.

The Compliance Assessment Report shall:

(1) be endorsed by the proponent's Managing Director/ General Manager/ Chief Executive Officer or a person delegated to sign on the Managing Director's/ General Manager's/ Chief Executive Officer's behalf;

(2) include a statement as to whether the proponent has complied with the conditions;

(3) identify all potential non-compliances and describe corrective and preventive actions taken;

(4) be made publicly available in accordance with the approved Compliance Assessment Plan; and

(5) indicate any proposed changes to the Compliance Assessment Plan required by condition 3-1.

4 Public Availability of Data

4-1 Subject to condition 4-2, within a reasonable time period, approved by the CEO, of the issue of this statement and for the remainder of the life of the proposal, the proponent shall make publicly available, in a manner approved by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products (e.g. maps)) relevant to the assessment of this proposal and implementation of this statement.

4-2 If any data referred to in condition 4-1 contains particulars of:

(1) a secret formula or process; or

(2) confidential commercially sensitive information;

the proponent may submit a request for approval from the CEO to not make this data publicly available. In making such a request, the proponent shall provide the CEO with an explanation and reasons why the data should not be made publicly available.

5 Environmental Management Program

5-1 The proponent shall implement the proposal in accordance with the "*Environmental Management Program*", dated November 2013, or subsequent revisions approved by the CEO.

The Environmental Management Program consists of the following Management Plans:

(1) Groundwater Management Plan;

(2) Surface Water Management Plan;

(3) Vegetation and Flora Management Plan;

(4) Fauna Management Plan;

(5) Dust Management Plan;

(6) Waste Management Plan; and

(7) Rail Management Plan.

Each Management Plan includes:

i. the specific environmental objectives and targets for each environmental factor;

ii. the management measures to be applied to avoid and minimise the environmental impact of the proposal;

iii. monitoring measures to measure the performance of management against targets; and

iv. contingency measures to mitigate impacts.

5-2 The proponent shall make the Environmental Management Program required by condition 5.1 publicly available, in a manner approved by the CEO.

6 Groundwater

6-1 The proponent shall manage groundwater abstraction and dewatering activities to ensure minimal adverse impacts on the availability and quality of groundwater resources and the dependent ecology.

6-2 To verify that the requirements of condition 6-1 are met the proponent shall undertake monitoring of groundwater level elevations and quality as outlined in the Groundwater Management Plan approved as part of Environmental Management Program required by condition 5.

6-3 In the event that the monitoring required by condition 6-2 indicates that the requirements of condition 6-1 are not met, the proponent shall implement contingency actions as outlined in the Groundwater Management Plan.

6-4 The proponent shall submit annually the results of monitoring required by condition 6-2 to the CEO of the Office of the Environmental Protection Authority as part of the compliance assessment reports required by condition 3-6.

7 Surface Water Drainage

7-1 The proponent shall manage surface water drainage and discharge to ensure minimal adverse impacts on existing surface water drainage patterns or the water dependent ecosystems.

7-2 To verify that the requirements of condition 7-1 are met, the proponent shall undertake monitoring of the quality and quantity of water discharge as outlined in the Surface Water Management Plan approved as part of the Environmental Management Program required by condition 5.

7-3 In the event that the monitoring required by condition 7-2 indicates that the requirements of condition 7-1 are not met, the proponent shall implement contingency actions as outlined in the Surface Water Management Plan.

7-4 The proponent shall submit annually the results of monitoring required by condition 7-2 to the CEO as part of the Compliance Assessment Reports required by condition 3-6.

8 Conservation Significant Communities and Species

8-1 The proponent shall manage clearing activities to ensure minimal adverse impacts on conservation significant communities and species.

8-2 To verify that the requirements of condition 8-1 are met, the proponent shall implement the proposal in accordance with the Vegetation and Flora Management Plan and Fauna Management Plan approved as part of the Environmental Management Program required by condition 5.

8-3 In the event that monitoring required by the Management Plans detailed in condition 8-2 indicates that the specific environmental objectives and targets, identified for each environmental factor, have been exceeded, the proponent shall:

(1) within 7 days of becoming aware of the exceedance, implement contingency measures as outlined in the management plans and continue implementation until environmental objectives and targets are being met, or as otherwise agreed by the CEO; and

(2) within 14 days of becoming aware of the exceedance, submit details of contingency measures implemented to the CEO.

9 Rehabilitation and closure

9-1 The proponent shall ensure that the mine is closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State of Western Australia.

9-2 The proponent shall prepare a Mine Closure Plan for the West Angelas Iron Ore Project.

9-3 The Mine Closure Plan required by condition 9-2 shall:

(1) when implemented, manage the implementation of the proposal to meet the requirements of condition 9-1;

(2) be prepared in accordance with the *Guidelines for Preparing Mine Closure Plans*, *June 2011* (Department of Mines and Petroleum and Environmental Protection Authority) or its revisions; and

(3) be to the requirements of the CEO on advice of the Department of Mines and Petroleum.

9-4 Within 12 months of commissioning of additional mine pits or as otherwise agreed by the CEO the proponent shall implement the approved Mine Closure Plan and continue implementation until otherwise agreed by the CEO.

9-5 Revisions to the Mine Closure Plan may be approved by the CEO on the advice of the Department of Mines and Petroleum.

9-6 The proponent shall implement revisions of the Mine Closure Plan required by condition 9-5.

[Signed 11 June 2014]

HON ALBERT JACOB MLA
MINISTER FOR ENVIRONMENT; HERITAGE

Schedule 1

Table 1: Summary of the Proposal

Proposal title	West Angelas Iron Ore Project
Proponent name	Robe River Mining Co. Pty. Ltd.
Short description	Development and operation of an open-cut iron ore mine and associated infrastructure at the West Angelas Iron Ore Mine, 130 kilometres west of Newman in the Pilbara region (Figure 1). Iron ore is to be mined from above and below the water table in Deposits A, B and E. The general lay out of the mine and facilities are documented in Figure 2. The mining operations are supplied with water from the mine dewatering bores and water from the Turee Creek B Borefield, located approximately 30 kilometres west of the minesite. Railway infrastructure from West Angelas to the port facilities at Cape Lambert (Figure 3).

Table 2: Location and authorised extent of physical and operational elements

Column 1	**Column 2**	**Column 3**
Element	**Location**	**Authorised Extent**
Mining Area (deposits A, B and E)	Figure 2	Clearing of no more than 2,260 hectares (ha) within a 19,853 ha development envelope.
Waste Dumps	Figure 2	Clearing of no more than 1,407 ha within a 19,853 ha development envelope.
Associated infrastructure, access and accommodation	Figure 2	Clearing of no more than 1,000 ha within a 19,853 ha development envelope.

Figures (attached)

Figure 1 – Regional Location of West Angelas

Figure 2 – West Angelas Iron Ore Mine Indicative Layout and Approval Outline

Figure 3 – West Angelas Railway

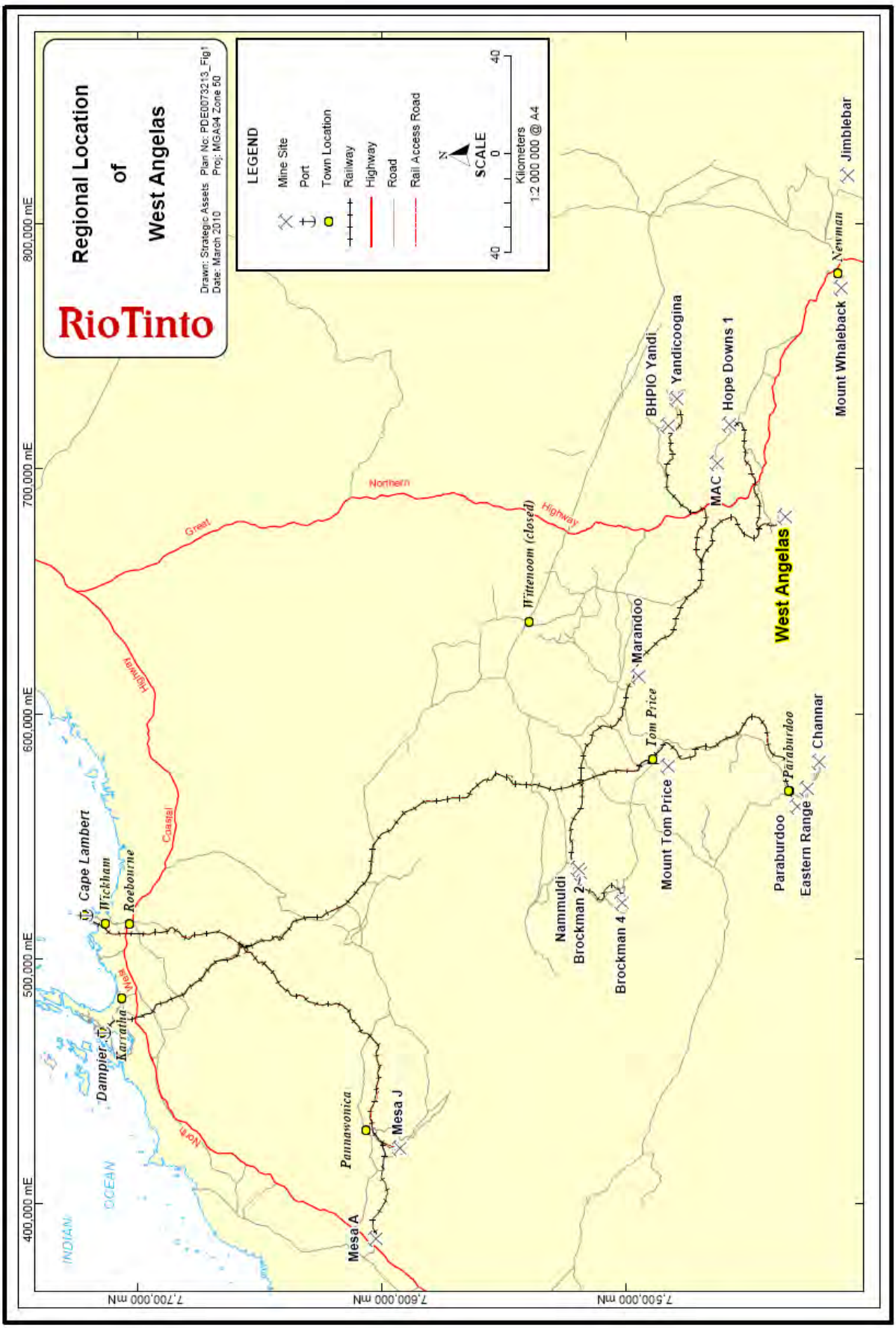

Figure 1: Regional Location of West Angelas

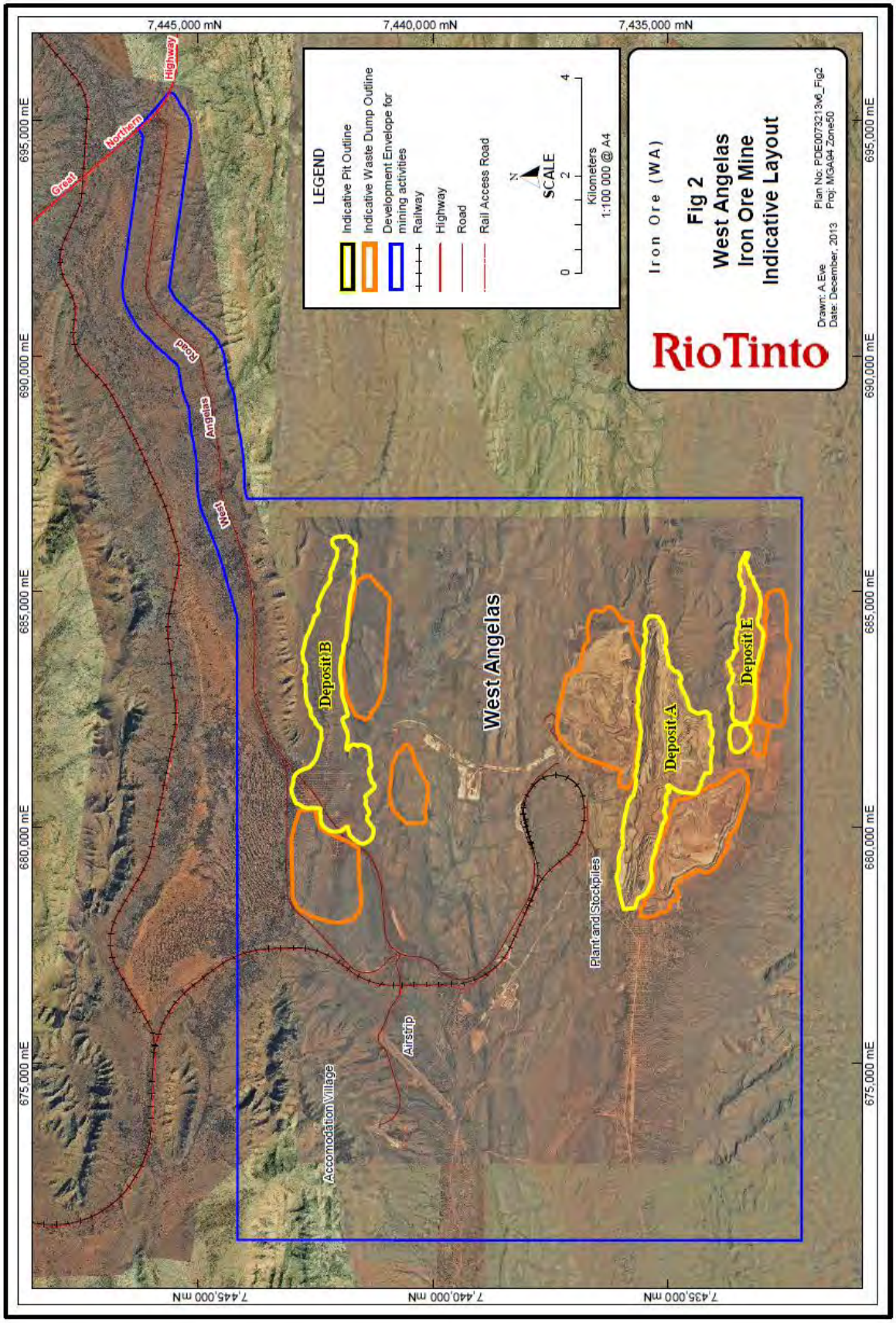

Figure 2: West Angelas Iron Ore Mine Development Envelope and Indicative Layout

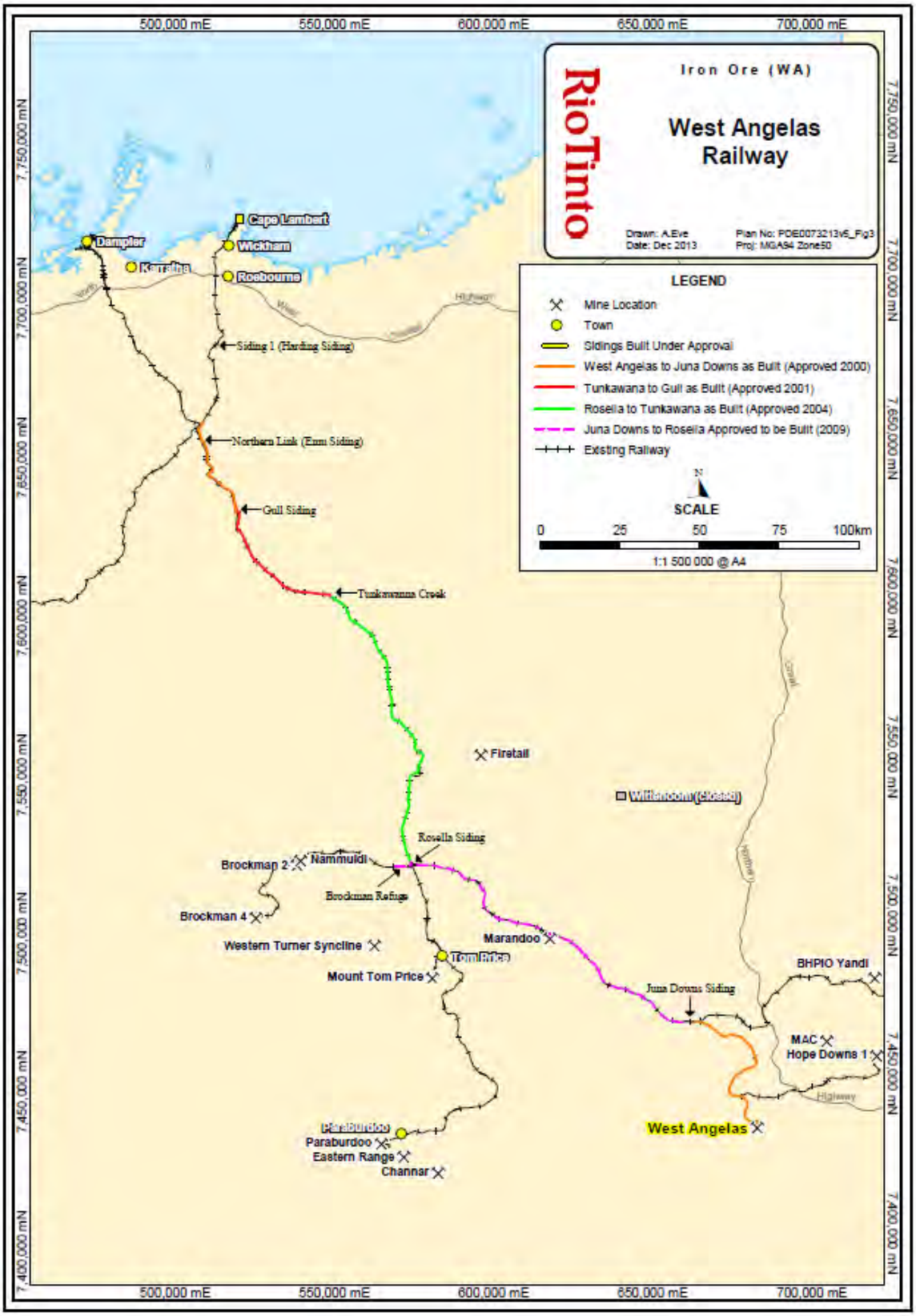

Figure 3: West Angelas Railway

Schedule 2

West Angelas Iron Ore Project

Coordinates defining the development envelope are held by the Office of the Environmental Protection Authority, dated 31 December 2013.

Schedule 3

Notes

The following notes are provided for information and do not form a part of the implementation conditions of the Statement:

- The proponent for the time being nominated by the Minister for Environment under section 38(6) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal unless and until that nomination has been revoked and another person is nominated.

- If the person nominated by the Minister, ceases to have responsibility for the proposal, that person is required to provide written notice to the Environmental Protection Authority of its intention to relinquish responsibility for the proposal and the name of the person to whom responsibility for the proposal will pass or has passed. The Minister for Environment may revoke a nomination made under section 38(6) of the *Environmental Protection Act 1986* and nominate another person.

- To initiate a change of proponent, the nominated proponent and proposed proponent are required to complete and submit Post Assessment Form 1 – Application to Change Nominated Proponent.

- The General Manager of the Office of the Environmental Protection Authority was the Chief Executive Officer of the Department of the Public Service of the State responsible for the administration of section 48 of the *Environmental Protection Act 1986* at the time the Statement was signed by the Minister for Environment.

RECOMMENDED ENVIRONMENTAL CONDITIONS

STATEMENT THAT A REVISED PROPOSAL MAY BE IMPLEMENTED

(PURSUANT TO THE PROVISIONS OF SECTION 46 OF THE

***ENVIRONMENTAL PROTECTION ACT 1986*)**

WEST ANGELAS IRON ORE PROJECT – REVISED PROPOSAL

Proposal:	The Proposal is a revision of the existing West Angelas Iron Ore Project, the subject of Ministerial Statement 970, dated 12 June 2014 and Ministerial Statement 1015, dated 21 August 2015. The Proposal involves above and below water table, open-cut iron ore mining and the construction and operation of associated infrastructure at West Angelas, located approximately 130 kilometres west of Newman in the Pilbara region of Western Australia, as documented in Schedule 1 of this Ministerial Statement.
Proponent:	Robe River Mining Co. Pty. Ltd. Australian Company Number 008 694 246
Proponent Address:	152-158 St Georges Terrace PERTH WA 6000 GPO Box A42, PERTH WA 6001
Assessment Number:	xxxx
Report of the Environmental Protection Authority:	xxxx
Previous Report of the Environmental Protection Authority:	1914 and 2046
Previous Ministerial Statement Number:	970 and 1015

Pursuant to section 45, read with section 45B of the *Environmental Protection Act 1986,* it has been agreed that:

1. the Proposal described and documented in Schedule 1 of this Statement may be implemented; and
2. from the date of this Statement, the implementation of the Proposal is subject to the following revised implementation conditions which replace and supersede all previous conditions of Ministerial Statements 970 and 1015.

1 Proposal Implementation

1-1 When implementing the Proposal, the proponent shall not exceed the authorised extent of the Proposal as defined in Table 2 in Schedule 1 of this Statement, unless amendments to the Proposal and the authorised extent of the Proposal have been approved under the *Environmental Protection Act 1986*.

2 Contact Details

2-1 The proponent shall notify the Chief Executive Officer (CEO) of any change of its name, physical address or postal address for the serving of notices or other correspondence within twenty eight (28) days of such change. Where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State.

3 Compliance Reporting

3-1 The proponent shall prepare, submit and maintain a Compliance Assessment Plan to the satisfaction of the CEO prior to the first Compliance Assessment Report required by condition 3-6, or as agreed in writing by the CEO.

3-2 The Compliance Assessment Plan shall indicate:

(1) the frequency of compliance reporting;

(2) the approach and timing of compliance assessment;

(3) the retention of compliance assessment;

(4) the method of reporting of potential non-compliance and corrective actions taken;

(5) the table of contents of Compliance Assessment Reports; and

(6) public availability of Compliance Assessment Reports.

3-3 After receiving notice in writing from the CEO that the Compliance Assessment Plan satisfies the requirements of condition 3-2, the proponent shall assess compliance with conditions in accordance with the Compliance Assessment Plan required by condition 3-1.

3-4 The proponent shall retain reports of all compliance assessments described in the Compliance Assessment Plan required by condition 3-1 and shall make those reports available when requested by the CEO.

3-5 The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that non-compliance being known.

3-6 The proponent shall submit to the CEO the first Compliance Assessment Report by 30 April each year addressing compliance in the previous calendar year, or as agreed in writing by the CEO. The first Compliance Assessment Report shall be submitted by 30 April 2019 addressing the compliance for the period from the date of issue of this Statement, notwithstanding that the first reporting period may be less than 12 months.

The Compliance Assessment Report shall:

(1) be endorsed by the proponent's Chief Executive Officer or a person delegated to sign on the Chief Executive Officer's behalf;

(2) include a statement as to whether the proponent has complied with the conditions;

(3) identify all potential non-compliances and describe corrective and preventive actions taken;

(4) be made publicly available in accordance with the approved Compliance Assessment Plan; and

(5) indicate any proposed changes to the Compliance Assessment Plan required by condition 3-1.

4 Public Availability of Data

4-1 Subject to condition 4-2, within a reasonable time period approved in writing by the CEO of the issue of this Statement and for the remainder of the life of the Proposal, the proponent shall make publicly available, in a manner approved in writing by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products e.g. maps) required under this Statement.

4-2 If any data referred to in condition 4-1 contains particulars of:

(1) a secret formula or process; or

(2) confidential commercially sensitive information

the proponent may submit a request for approval from the CEO to not make this data publicly available. In making such a request the proponent shall provide the CEO with an explanation and reasons why the data should not be made publicly available.

5 Condition Environmental Management Plans

5-1 The proponent shall prepare and implement a Condition Environmental Management Plan to the satisfaction of the CEO. This plan shall demonstrate that the **environmental outcomes** specified in in condition 6-1, condition 7-1 and condition 8-1 will be met.

5-2 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.

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.

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 as required by condition 5-6(1). 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 the investigations required by condition 5-5(3) and 5-5(4);

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.

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.

6 Hydrological Processes and Flora and Vegetation – Dewatering, discharge and riparian vegetation

6-1 The proponent shall manage the implementation of the Proposal to meet the following environmental outcomes:

(1) The proponent shall ensure that there is no irreversible impact, as a result of the proponent's dewatering activities, to groundwater dependant vegetation within Karijini National Park, as delineated in Figure 6 of Schedule 1 and defined by the geographic coordinates in Schedule 2.

(2) The proponent shall ensure that there is no irreversible impact, as a result of the proponent's discharge of excess water, to the health of riparian vegetation of Turee Creek East.

7 Flora and Vegetation – Conservation significant vegetation communities; West Angelas Cracking Clay Priority Ecological Communities

7-1 The proponent shall manage the implementation of the Proposal to meet the following environmental outcomes:

(1) The proponent shall ensure that there is no disturbance to the West Angelas Cracking Clay Priority Ecological Community (PEC-2015-5) as delineated in Figure 4 of Schedule 1 and defined by the geographic coordinates in Schedule 2,

(2) The proponent shall ensure no more than 20 ha of disturbance to other representations of the West Angelas Cracking Clay Priority Ecological Community that are not authorised to be cleared in Schedule 1.

8 Terrestrial Fauna – Conservation significant fauna species; Ghost bat (*Macroderma gigas*)

8-1 The proponent shall manage the implementation of the Proposal to meet the following environmental outcomes:

(1) The proponent shall ensure that there is no disturbance to the Ghost Bat roost; Cave AA1 as delineated in Figure 5 of Schedule 1 and defined by the geographic coordinates in Schedule 2.

(2) The proponent shall minimise disturbance to other Ghost Bat roosts; Caves A1, A2, L2 and L3 as delineated in Figure 5 of Schedule 1 and defined by the geographic coordinates in Schedule 2.

8-2 The proponent shall avoid the use of barbed wire in the Proposal area except where there is a statutory requirement to do so, and where avoidance is not possible, minimise the impact of barbed wire on Ghost bats.

9 Closure

9-1 The proponent shall manage the implementation of the Proposal to meet the following environmental objective:

(1) '*ensure that the Proposal is rehabilitated and decommissioned in an ecologically sustainable manner*'.

9-2 Within 12 months of the issue of this Statement the proponent shall prepare and submit a Mine Closure Plan in accordance with the *Guidelines for Preparing Mine Closure Plans*, May 2015, (or any subsequent revisions of the guidelines), to the requirements of the CEO, on advice of the Department of Mines and Petroleum.

9-3 The proponent shall review and revise the Mine Closure Plan required by condition 9-2 at intervals not exceeding three years, or as otherwise specified by the CEO, and submit the plan to the CEO at the agreed interval.

9-4 The proponent shall implement the latest revision of the Mine Closure Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 9-2.

10 Offsets

10-1 In view of the residual impacts and risks as a result of implementation of the Proposal, the proponent shall contribute funds to offset clearing of 'good to excellent' condition native vegetation, including the loss of habitat for conservation significant species, in the Hamersley IBRA subregion, and calculated pursuant to condition 10-2. This funding shall be provided to a government-established conservation offset fund or an alternative offset arrangement providing an equivalent outcome as determined by the Minister.

10-2 The 4,667 ha of clearing of native vegetation previously approved under Ministerial Statement 970 is exempt from the requirement to offset under condition 10-1.

10-3 The proponent's contribution to the initiative identified in condition 10-1 shall be paid biennially, the first payment due two years after commencement of the additional ground disturbance defined in Table 2 of Schedule 1. The amount of funding would be made on the following basis and in accordance with the approved Impact Reconciliation Procedure required by condition 10-5:

(1) $750 AUD (excluding GST) per hectare of 'Good to Excellent' condition vegetation cleared within the West Angelas Mine Development Envelope (delineated in Figure 2 and defined by the geographic coordinates in Schedule 2) within the Hamersley IBRA subregion; and

(2) $1500 AUD (excluding GST) per hectare of conservation significant vegetation; West Angelas Cracking Clay Priority Ecological Community cleared within the West Angelas Mine Development Envelope (delineated in Figure 5 and defined by the geographic coordinates in Schedule 2) within the Hamersley IBRA subregion;

(3) $1500 AUD (excluding GST) per hectare of conservation significant vegetation; riparian vegetation communities within Turee Creek East affected by discharge (delineated in Figure 5 and defined by the geographic coordinates in Schedule 2).

(4) $50,000 AUD (excluding GST) per hectare of potentially groundwater dependant vegetation within Karijini National Park affected by dewatering (delineated in Figure 5 and defined by the geographic coordinates in Schedule 2).

10-4 The proponent shall prepare and submit an Impact Reconciliation Procedure to the satisfaction of the CEO within six months of the date of this Statement, or as approved by the CEO.

10-5 The Impact Reconciliation Procedure required pursuant to condition 10-4 shall:

(1) include a methodology to identify clearing of 'good to excellent' condition native vegetation in the Hamersley IBRA subregion;

(2) include a methodology for calculating the amount of clearing undertaken during each biennial time period; and

(3) state dates for the commencement of the biennial time period and for the submission of results of the Impact Reconciliation Procedure, to the satisfaction of the CEO.

10-6 The real value of contributions described in condition 10-2 will be maintained through indexation to the Perth Consumer Price Index (CPI), with the first adjustment to be applied to the first contribution.

Schedule 1

Table 1: Summary of the Proposal

Proposal title	West Angelas Iron Ore Project
Short description	The Proposal is located approximately 130 kilometres west of Newman in the Pilbara region of Western Australia (Figure 1). The Proposal involves above and below water table, open-cut iron ore mining and the construction and operation of associated infrastructure including but not limited to the following: a 413 km railway network from West Angelas to port facilities located at Cape Lambert with a spur loop at West Angelas and sidings (including but not limited to: Juna Downs, Rosella, Bellbird, Brockman Refuge and Emu); dewatering and excess water management infrastructure; surface water management infrastructure; linear infrastructure; processing and support facilities. The Turee Creek B Borefield, located approximately 30 km west of the mine site supplies potable water to mine and camp facilities and, when required, for operational purposes. Mine dewatering, which dewaters the ore bodies to allow below water table mining, supplies water for operational purposes. Surplus dewatering water, exceeding the operational requirement, is discharged to the environment. The mine and associated infrastructure described above will be contained within the West Angelas Mine and Linear Infrastructure Development Envelopes (Figure 2 and Figure 3). Disturbance within the Development Envelopes will not exceed those values indicated in Table 2.

Table 2: Location and authorised extent of physical and operational elements of the Proposal

Element	Location	Authorised Extent
Mine and associated infrastructure	Figure 2, Figure 4, Figure 5 and geographic coordinates in Schedule 2	Clearing of no more than 12,200 hectares (ha) within a 26,400 ha Mine Development Envelope, including: • No clearing within the Ghost Bat Cave AA1 Exclusion Zone. • No clearing within the West Angelas Cracking Clay Priority Ecological Community, PEC-2015-5. • No more than 20 ha of other representations of the West Angelas Cracking Clay Priority Ecological Community. Below water table pits are to be backfilled to a level to prevent the formation of permanent pit lakes.
Linear infrastructure	Figure 3	A 413 km rail network transports processed ore from West Angelas to port facilities located at Cape Lambert. Clearing no more than 1,500 ha within a 19,400 ha Linear Infrastructure Development Envelope, including: • Five existing sidings; Spoonbill, Bellbird, Rosella, Brockman Refuge and Emu and potential additional sidings to support the rail network. • Turee Creek B borefield, pipeline, powerline, access roads and other associated infrastructure.

Surplus water management	Figure 6 and geographic coordinates in Schedule 2	Dewatering water will be used onsite in the first instance to supply water for operational purposes. Surplus dewatering water, exceeding the operational requirement, is discharged to a local ephemeral tributary of Turee Creek East. The surface discharge extent will not extend within the boundary of Karijini National Park.

Table 3: Abbreviations and Definitions

Acronym or Abbreviation	**Definition or Term**
AUD	Australian dollar
CEO	The Chief Executive Officer of the Department of the Public Service of the State responsible for the administration of section 48 of the *Environmental Protection Act 1986*, or his delegate.
Clearing	As defined in the *Environmental Protection Act 1986*.
Conservation significant fauna	Any terrestrial fauna species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* or the *Western Australia Wildlife Conservation Act 1950*
Conservation significant flora	Any flora species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* or the Western Australia *Wildlife Conservation Act 1950* or are considered by Parks and Wildlife to be Priority Species.
CPI	Consumer Price Index
EPA	Environmental Protection Authority
GL/a	Gigalitres per annum
ha	Hectare
km	Kilometre
OEPA	Office of the Environmental Protection Authority
Wetting front	The extent of the surface expression of water from surplus water discharge under natural no-flow conditions.

Figures (attached)

Figure 1 – Regional Setting

Figure 2 – West Angelas Iron Ore Project Mine Development Envelope and indicative layout

Figure 3 – West Angelas Iron Ore Project Linear Infrastructure Development Envelope

Figure 4 – Conservation significant vegetation communities, subject to offsets

Figure 5 – Ghost bat (*Macroderma gigas*) roosts

Figure 6 – Surplus dewatering water surface discharge extent