Eliwana Iron Ore Mine Project

Environmental Review Document

EW-RP-EN-0003_0 October 2018
EPA ASSESSMENT NO: 2125 EPBC REFERENCE NO: 2017/8024



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	Eliwana Iron Ore Mine		
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Author	Checker	Approver	Rev No.	Status	Issued Date
Matt Dowling	**Squad Check**	**Sean McGunnigle**	A	**IFR**	20/02/2018
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Matt Dowling	**Sean McGunnigle**	**Brett McGuire**	C	**IFR**	24/08/2018

Front Cover: Typical steep hill within the Eliwana Mine Development Envelope. The hill is vegetated by a community of scattered *Eucalyptus leucophloia* and Acacia shrubs over a spinifex hummock grassland, which is typical vegetation on the hills of the Hamersley Ranges.

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this proposal.

Fortescue Metals Group Limited (Fortescue) proposes the development of the Eliwana Iron Ore Project (the Proposal), consisting of an iron ore mine located approximately 90 km west-north-west of Tom Price in the Pilbara Region of Western Australia. The Environmental Review Document has been prepared in accordance with the EPA's ***Procedures Manual (Part IV Divisions 1 and 2***). The ERD is the report by the proponent on their environmental review which describes this proposal and its likely effects on the environment.

The ERD is available for a public review period of 4 weeks from DATE, closing on DATE.

Information on the proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposal to the Minister for Environment.

Why write a submission?

The EPA seeks information that will inform the EPA's consideration of the likely effect of the proposal, if implemented, on the environment. This may include relevant new information that is not in the Environmental Review Document, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the Environmental Review Document.

When making comments on specific elements in the ER document:

- Clearly state your point of view and give reasons for your conclusions.
- Reference the source of your information, where applicable.

- Suggest alternatives to improve the outcomes on the environment.

What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your contact details – name and address.
- Date of your submission
- Whether you want your contact details to be confidential.
- Summary of your submission, if your submission is long.
- List points so that issues raised are clear, preferably by environmental factor.
- Refer each point to the page, section and if possible, paragraph of the ERD.
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for public submissions is: DATE

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at **https://consultation.epa.wa.gov.au**.

Alternatively submissions can be:

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERTH WA 6892, or
- delivered to: the Environmental Protection Authority, Level 8, The Atrium, 168 St Georges Terrace, Perth 6000.

If you have any questions on how to make a submission, please contact the Office of the Environmental Protection Authority on 6145 0800.

SCOPING CHECKLIST

Task No.	Required Work	Section and Page No.
Hydrological Processes and Inland Waters Environmental Quality		
1	Characterise the current hydrology and hydrogeological regimes, both in a local and regional context, including but not limited to: a) geological framework b) water levels c) water quantity d) stream flows e) flood patterns f) catchment boundaries g) environmental values of significance.	Sections a) 2.4.2, 4.4.4.1. b) 4.4.4.1 c) 4.4.4.1 d) 4.4.4.3 e) 4.4.4.3 f) 4.4.4.3 4.4.4.3, 4.4.4.5, 4.6.4.7
2	Characterise the baseline water quality and provide analysis of existing water chemistry and water quality data, both in a local and regional context.	Section 4.5.4.1 and Section 4.5.4.2
3	Provide conceptual models of the surface and groundwater systems, including the extent of connectivity between surface and groundwater systems.	Section 4.4.4.1, 4.4.4.3 and 4.4.4.4.
4	Provide a conceptual mine water balance over the life of the Proposal to discuss the capacity to reuse surplus groundwater obtained during mine dewatering.	Section 4.4.4.2
5	Provide a conceptual mining void water balance assessment over the life of the Proposal.	Section 4.4.5.6
6	Discuss current and future potential water users in the Proposal area and how they may be impacted by the water abstraction during construction, operation and post-closure.	Section 4.4.5.1, 4.4.6.2, Table 14.
7	Discuss the potential environmental impacts and benefits of identified surplus water management options (i.e. reuse on site, injection, discharge and storage in mining voids, controlled surface discharge) and discuss the most appropriate water management strategy for the Proposal.	Section 4.4.6.1, 4.4.6.2
8	Analyse, discuss and assess surface water and groundwater impacts during operations and post-closure. The analysis should include but not be limited to: a) changes in groundwater levels and changes to surface water flows associated with the Proposal; b) the nature, extent, and duration of impacts; c) cumulative impacts with other projects and referred Proposals, for which relevant information is publicly available d) impacts to current and future potential water users in the Proposal area; and e) impacts on the environmental values of significant receptors.	Sections: a) 4.4.6.1 b) 4.4.6.1 c) 4.4.6.1, 4.4.6.2 d) 4.4.6.1, 4.4.6.2 e) 4.4.6.3, 4.6.5.9, 4.6.5.10
9	Document and include any potential pathways for contamination including but not limited to: a) dust; b) operational leaks and spills;	Section 4.5.5, 4.5.6.

Task No.	Required Work	Section and Page No.
	c) seepage from sewage treatment plants; d) drainage from and erosion of disturbed areas of landform surfaces; e) disposal of excess water via surface discharge or groundwater injection; and f) saline final void pit lake contaminating surrounding groundwater.	
10	Describe Geochemical and physical properties of the waste streams for each of the proposed disposal methods into the waste dumps and tailings disposal (both above and below ground) identify if any alternative management is required.	Section 4.5.4.3
11	Provide materials and waste characterisation work including available static and kinetic test results and existing water chemistry to enable through assessment of acid and metalliferous drainage risk posed by the project. If Potentially Acid Forming (PAF) material is identified, provide mine scheduling detail to demonstrate that PAF material will not be disturbed during mining and/or that effective strategies will be in place to ensure PAF material is adequately managed should it be exposed and/or disturbed.	Section 4.5.4.3, 4.5.6.1, Appendix 13
12	Include details on the pit lake characteristics (e.g. flow-through or sink).	Section 4.4.5.6
13	Provide a conceptual mining void water body salinity assessment over the life of the Proposal.	Section 4.5.6.1, Section 4.5.6.4
14	Discuss the potential environmental impacts and benefits of identified surplus water management options in relation to water quality (i.e. reuse on site, injection, surface discharge).	Section 4.4.6.1
15	Analyse, discuss and assess surface water and groundwater impacts. The analysis should include but not be limited to: a) changes to salinity of groundwater and changes to surface water quality associated with the Proposal; b) the nature, extent, and duration of impacts; c) cumulative impacts with other projects and referred Proposals, for which relevant information is publicly available.	Sections: a) Section 4.5.6.3 b) Section 4.5.6.3 Section 4.4.5.1, 4.4.6.2
16	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to Hydrological Processes (including post-closure).	Section 4.4.7, 4.4.7.1, 4.4.7.2
17	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to Inland Waters Environmental Quality (including post-closure).	Section 4.5.7
18	Discuss management measures, outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted. Include identification of water quality trigger levels, to be implemented during construction, operation and following closure to ensure that the EPA's objectives for these factors are met.	Table 16, Section 4.5.7
19	Prepare a Mine Closure Plan consistent with DMP and EPA *Guidelines for Preparing Mine Closure Plans* (2015), which addresses the development of completion criteria to maintain the hydrological regimes and the quality of groundwater and surface water so that environmental values are maintained post-closure.	Appendix 2.
20	Provide a site-specific Surface Water Management Plan and a site-specific Groundwater Management Plan.	Appendix 10 and 11

Task No.	Required Work	Section and Page No.
21	Demonstrate and document in the ERD how the EPA's objective for these factors can be met.	Section 4.4.8 and 4.5.8
Flora and Vegetation		
22	Identify and characterise flora and vegetation within the Mine Development Envelope in accordance with the requirements of *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*, December 2016. Demonstrate how surveys are relevant and representative and demonstrate consistency with EPA policy. Include a summary of survey findings.	Section 4.6.4. Section 4.6.3
23	Undertake weed mapping of the Mine Development Envelope.	Section 4.6.4.11
24	Provide an analysis of the vegetation and significant flora species present and likely to be present within the Mine Development Envelope, including any indirect impact areas outside of the Mine Development Envelope. Include an assessment of the significance of flora and vegetation in a local and regional context. Include a quantitative assessment of levels of impact on significant flora and significant vegetation. For flora, this includes: a) numbers and proportions of individuals in a local and regional context, and b) numbers and proportions of populations directly or potentially indirectly impacted; and c) numbers/proportions/populations within the conservation estate (where known). For ecological communities and vegetation units this includes: a) the area (in hectares) and proportions directly or potentially indirectly impacted. b) proportions/hectares of ecological community or vegetation unit currently protected within conservation estate (where known).	Sections: a) 4.6.4.9 b) 4.6.4.9 c) 4.6.4.9 Sections: a) 4.6.4.2, 4.6.4.4, 4.6.5.1, 4.6.5.3 4.6.5.1, 4.6.5.3
25	Provide a clear set of data, including tables and maps; that shows the proposed impact (direct and indirect) for the Proposal, including but not limited to impacts to: a) significant flora b) significant vegetation c) conservation areas (including Karijini National Park and DBCA-managed lands).	Sections: a) 4.6.5.4, Table 27, Figure 20 b) 4.6.5.3, Figure 23 c) There are no impacts to conservation areas.
26	Provide a detailed description of the cumulative impacts (direct and indirect) associated with the Proposal. Discuss and determine significance of potential direct, indirect and cumulative impacts to flora and vegetation as a result of the Proposal at a local and regional level.	Section 4.6.5.11
27	Demonstrate that all practicable measures have been taken to reduce both the area of the proposed disturbance footprint and the Mine Development Envelope based on progress in the Proposal design and understanding of the environmental impacts.	Section 4.6.6, 4.6.6.1
28	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to flora and vegetation (including post-closure).	Section 4.6.6
29	Discuss management measures, outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 4.6.6

Task No.	Required Work	Section and Page No.
30	Prepare a Mine Closure Plan consistent with DMP and EPA *Guidelines for Preparing Mine Closure Plans* (2015), which includes methodologies and criteria to ensure progressive rehabilitation of disturbed areas with vegetation composed of local Pilbara native species.	Appendix 2
31	Describe rehabilitation and revegetation measures relevant to flora and vegetation, including relevant practice and demonstrated outcomes, as consistent with the *Rehabilitation and Revegetation Management Plan* (45-PL-EN-0023).	Section 4.6.6.2
32	Review and revise the existing, approved *Fortescue Significant Flora and Vegetation Management Plan* (45-PL-EN-0017) or *Vegetation Health Monitoring and Management Plan* (100-PL-EN-1020) [whichever is currently approved by the EPA at the time of ERD submission] to incorporate the Proposal.	Appendix 17
33	Describe the impacts for the Proposal and analyse these impacts to identify and detail any that are significant.	Section 4.6.5
34	Predict the inherent and residual impacts before and after applying the mitigation hierarchy and identify whether the residual impacts are significant by applying the Significant Residual Impact Model in the WA Environmental Offsets Guideline.	Section 4.6.7
35	Quantify any significant residual impacts by completing the Offset Template, spatially defining the area of 'good' to 'excellent' native vegetation that will be disturbed as a result of this proposal and propose an offsets package that demonstrates application of the WA Environmental Offsets Policy and Guideline.	Section 4.6.8, Section 6.2, Table 76.
36	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	Section 4.6.7
Terrestrial Fauna		
37	Conduct a Level 2 terrestrial fauna survey (incorporating a desktop assessment) in areas that are likely to be directly or indirectly impacted. Surveys are to be undertaken in accordance with relevant EPA and DOEE policy and, where available, species-specific survey guidelines for relevant species listed under the *Wildlife Conservation Act 1950* and the *Environment Protection Biodiversity Conservation Act 1999*. Demonstrate how surveys are relevant and representative and demonstrate consistency with EPA policy.	Section 4.7.3, 4.7.4
38	Conduct a Level 2 short-range endemic fauna survey (incorporating a desktop assessment) in accordance with *Technical Guidance – Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2016). Demonstrate how surveys are relevant and representative and demonstrate consistency with EPA policy.	Section 4.7.4.2
39	Provide a summary of survey findings, including a comprehensive listing of: a) fauna known or likely to occur in the habitats present b) identification of short range endemic species of conservation significance known or likely to occur in the area c) identification of conservation significant vertebrate fauna species known or likely to occur in the area.	Sections: a) 4.7.4, 4.7.4.1 b) 4.7.4.2 4.7.4.1
40	Conduct additional targeted surveys for conservation significant fauna that are known to or likely to occupy habitats in the Proposal area if	Section 4.7.3.1

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	demonstrated to be required based on the results of the Level 2 surveys.	
41	Identify and map the fauna habitat types within the Mine Development Envelope. Consider habitat types that provide important ecological function within the Proposal area (e.g. geological features which may support unique ecosystems).	Figure 28
42	Provide information on the conservation value of each habitat type from a local and regional perspective, including the percentage representation of each habitat type to be disturbed in relation to its local and regional extent.	Table 34, Table 37
43	For each relevant conservation significant species known or likely to occur within the Proposal area, provide: a) baseline information on distribution (including known occurrences), ecology, and habitat preferences at both the site and regional levels; b) size and the importance of the population from a local and regional perspective and potential percentage loss of the conservation significant species locally due to loss of habitat; c) maps illustrating the known recorded locations of conservation significant species in relation to fauna habitat and the proposed disturbance and areas to be impacted d) discussion of known existing threats to the species, with reference to relevant impacts from the proposed action (including taking into consideration any relevant guidelines, policies, plans and statutory provisions); e) detailed description of the potential direct, indirect and cumulative impacts to the species within the Proposal area and on a regional scale.	Section 4.7.4.1, Figure 28. Section 5 (MNES) Northern Quoll 5.2.1 Pilbara Leaf-nosed Bat 5.3.1 Ghost bat 5.4.1 Pilbara Olive Python 5.5.1 Night Parrot 5.6.1
44	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to terrestrial fauna (including post-closure).	Section 4.7.6
45	Discuss management measures, outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 4.7.6
46	Describe the residual impacts for the Proposal and analyse these impacts to identify and detail any that are significant.	Section 4.7.7
47	Review and revise the existing, approved Fortescue *Conservation Significant Fauna Management Plan* (100-PL-EN-0022) to incorporate the Proposal.	Appendix 20
48	Predict the inherent and residual impacts before and after applying the mitigation hierarchy and identify whether the residual impacts are significant by applying the Significant Residual Impact Model in the WA Environmental Offsets Guideline.	Section 4.7.7, 4.7.8
49	Quantify any significant residual impacts by completing the Offset Template, spatially defining the habitat area for each significant fauna species that will be disturbed as a result of this proposal and propose an offsets package that demonstrates application of the WA Environmental Offsets Policy and Guideline. Demonstrate how the project has considered the WA guidance for offsets. Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	Section 6.2, Table 76.

Task No.	Required Work	Section and Page No.
Subterranean Fauna		
50	Conduct a Level 2 subterranean fauna survey (incorporating a desktop assessment) in areas that are likely to be directly or indirectly impacted as a result of the Proposal in accordance with the requirements of *Technical Guidance – Sampling methods for subterranean fauna* and *Technical Guidance – Subterranean fauna survey*. Demonstrate how surveys are relevant and representative and demonstrate consistency with EPA policy. Provide a summary of survey findings, including: a) a comprehensive listing of subterranean fauna known or likely to occur in the habitats present, and b) identification of conservation significant fauna species known or likely to occur in the area.	Section 4.8.4 a) 4.8.5.1, 4.8.5.2 4.8.5.1, 4.8.5.2
51	Assess the impacts to subterranean fauna with reference to relevant impacts from the proposed action (including taking into consideration any relevant guidelines, policies, plans and statutory provisions). For species which are likely to be impacted, provide information, including maps of habitat extent (linked to geological and hydrological information) and an appropriate explanation of the likely distribution of species within those habitats including evidence to demonstrate whether there is habitat connectivity.	Section 4.8.7, Figures 32 to 48
52	Provide a detailed description of the potential direct, indirect and cumulative impacts to conservation significant species, species which are only known from the area of impact and other species within the Proposal area and on a regional scale.	Section 4.8.7
53	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to subterranean fauna (including post-closure).	Section 4.8.8
54	Discuss management measures, outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 4.8.8
55	Describe the residual impacts for the Proposal and analyse these impacts to identify and detail any that are significant.	Section 4.8.9
56	Review and revise the existing, approved Fortescue *Subterranean Fauna Survey Plan* (45-PL-EN-0010) to incorporate the Proposal (if required).	To be determined
57	Predict the inherent and residual impacts before and after applying the mitigation hierarchy and identify whether the residual impacts are significant by applying the Significant Residual Impact Model in the WA Environmental Offsets Guideline. Quantify any significant residual impacts by completing the Offset Template and propose an appropriate offsets package that demonstrates application of the WA Environmental Offsets Policy and Guideline.	Section 4.8.9, Section 6.2, Table 76.
58	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	Section 4.8.9
Matters of National Environmental Significance		
59	Specify any MNES being assessed as part of the accredited assessment. For specific MNES species (or any other flora or fauna MNES species identified within the Mine Development Area), address the following: i. Pilbara Leaf-nosed Bat and Ghost Bat a) Provide a review of bat populations and habitat in the local and regional area.	Sections: Pilbara Leaf Nosed Bat and Ghost Bat – 5.2.2.2, 5.3.3.3, 5.2.2.6 Northern Quoll – 5.2.1.2, 5.2.1.3, 5.2.1.6

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	b) Investigate and provide a description of any potential bat populations and habitat in the Mine Development Envelope, and potential impacts from the Proposal. c) Detail the extent to which clearing will remove foraging/hunting habitat for these species and the likely impacts of this on the local population. ii. Northern Quoll: a) Provide a review of quoll populations and habitat in the local and regional area. b) Detail the extent to which clearing will remove critical habitat and be expected to impact the species; and iii. Pilbara Olive Python: a) Provide a review of python populations and habitat in the local and regional area. b) Detail the extent to which clearing will remove critical habitat and be expected to impact this species. iv. Night Parrot: a) Provide a review of Night Parrot records and potentially suitable habitat in the local and regional area. b) Detail the extent to which clearing will remove critical habitat and be expected to impact this species.	Pilbara Olive Python – 5.2.4.2, 5.2.4.5 Night Parrot – 5.2.5.2, 5.2.5.3, 5.2.5.5
60	Assess direct and indirect impacts on MNES fauna, and fauna habitats. Provide figures showing the likely extent of loss of habitat types and the extent of habitat areas expected to recover from both direct and indirect impacts and provide information on the potential outcome of clearing habitat on the fauna populations.	Sections 5.2.1.6, 5.2.2.6, 5.2.3.6, 5.2.4.5, 5.2.5.5
61	Review and revise the existing, approved Fortescue *Conservation Significant Fauna Management Plan* (100-PL-EN-0022) to incorporate the Proposal. This Plan addresses the following: i. Identification of potential direct and indirect impacts to conservation significant fauna and their critical habitats ii. Establishment of management strategies to minimise the potential impacts to conservation significant fauna and their critical habitats iii. Development of monitoring programs to detect any impacts on conservation significant fauna and their critical habitats, identifying: 1. Monitoring sites for each species 2. Monitoring methods and parameters 3. Trigger criteria and contingency measures.	Appendix 20
62	Provide an assessment of consistency of the proposed action with any relevant Recovery Plan and Threat Abatement Plan.	Sections 5.2.1.4, 5.2.2.4, 5.2.3.4, 5.2.4.4, 5.2.5.4
63	Describe potential regulation for each environmental aspect associated with matters of national environmental significance, including an assessment of the sufficiency of likely EP Act regulation in protecting MNES.	Section 6. Section 4.7.8. Fortescue considers the offset proposed for the loss of good to excellent condition will result in net environmental benefit for

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		those fauna species inhabiting that vegetation, including MNES species.
Social Surroundings		
64	Characterise the heritage of proposed disturbance areas and any other areas that may be indirectly impacted to identify Aboriginal heritage places and their relevance within a wider regional context.	Section 4.9.4.5
65	Conduct surveys to identify Aboriginal heritage places.	Section 4.9.3
66	Undertake consultation to identify concerns in regard to impacts from proposed mining operations on Aboriginal heritage places.	Section 4.9.4.5, Section 3
67	Provide a description of the known heritage values within the Mine Development Envelope and provide a figure(s) of the native title determination areas, heritage locations and proposed disturbance.	Section 4.9.4.5, 4.6.4.6
68	Provide a description of nearby conservation areas including National Parks and DBCA-managed areas and provide a figure(s) of these areas in relation to the proposed disturbance.	Section 4.9.4.4
69	Assess the impacts of the Proposal on Aboriginal heritage places as a result of implementation of the Proposal, including those arising from changes to the environment.	Section 4.9.6
70	Discuss management measures, outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 4.9.7
71	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to social surroundings.	Section 4.9.7
72	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	Section 4.9.8
Air Quality		
73	Describe the environmental setting of the proposal in relation to proximity to sensitive receptors.	Section 4.10.4
74	Describe the scale and nature of power generation/combustion activities associated with the Proposal.	Section 4.10.6
75	Characterisation of greenhouse gas emission sources from the Proposal.	Section 4.10.6.3
76	Estimation of expected Scope 1 (direct) and Scope 2 (energy indirect) greenhouse gas emissions in accordance with the National Greenhouse and Energy Reporting Act 2007 (NGER Act).	Section 4.10.6.3
77	Analysis of greenhouse gas intensity (i.e. quantity of CO_2-e generated per tonne of product produced).	Section 4.10.6.3
78	Estimation of expected pollutants (such as oxides of nitrogen, particulates and VOCs) resulting from the Proposal.	Section 4.10.6.2
79	Assess the mineralogy for likelihood of asbestiform minerals occurring.	Section 4.10.6.5
80	Demonstrate application of the mitigation hierarchy to avoid and minimise impacts to air quality (greenhouse gases).	Section 4.10.7
81	Review and revise the existing, approved Fortescue *Greenhouse Gas Emissions and Energy Reporting Management Plan* (100-PR-GH-0001) to incorporate the Proposal.	Appendix 25

Task No.	Required Work	Section and Page No.
82	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	Section 4.10.8

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EXECUTIVE SUMMARY

Fortescue Metals Group (Fortescue) is proposing to develop the Eliwana Iron Ore Mine Project (the Proposal), 90 km west-north-west of Tom Price, in the Pilbara region of Western Australia in the Pilbara region of Western Australia (Figure ES1)

The Proposal includes the development of mine pits and associated infrastructure, processing facilities, water management infrastructure for groundwater abstraction and surplus water disposal, temporary and permanent waste landforms and tailings storage facilities. The Proposal involves disturbance of up to 7,900 ha within a 43,804 ha Mine Development Envelope (MDE) (Figure ES 2).

Background and Context

The purpose of this Public Environmental Review (PER) is to present an environmental impact assessment of the Proposal for public review and consideration by EPA. The PER includes a detailed impact assessment and description of proposed mitigation and management measures for the environmental factors identified in the Environmental Scoping Document.

This document has been prepared in accordance with the *Environmental Impact Assessment Administrative Procedures 2016* (Government of Western Australia, 2016) and the *Instructions on How to Prepare and Environmental Review Document* (EPA, 2016a). This document also satisfies the requirements for an accredited assessment under the EPBC Act.

The Proposal was referred to the Western Australia Environmental Protection Authority (EPA) under Section 38 of the EP Act on 7 July 2017. The EPA determined the Proposal required assessment under Part IV of the EP Act and set the level of assessment at PER on 27 July 2017.

The Proposal was also referred under Section 68 of the EPBC Act to the DoEE on 23 August 2017. DoEE determined the Proposal was a controlled action on 7 November 2017.

Overview of the Proposal

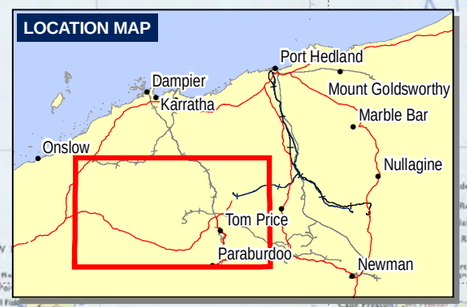
The Proposal includes the development of mine pits and associated infrastructure, processing facilities, non-processing infrastructure, water management infrastructure for groundwater abstraction and surplus water disposal, temporary and permanent waste landforms and tailings storage facilities. Table ES1 and Table ES2 summarise the key characteristics of the Proposal. The Proposal has an overall ground disturbance of approximately 7,900 ha inclusive of all infrastructure.

Table ES 1: Summary of the Proposal

Proposal Title	Eliwana Iron Ore Mine
Proponent Name	Fortescue Metals Group Ltd
Short Description	The Proposal is to develop above and below water table iron ore deposits, 90 km west-north-west of Tom Price, in the Pilbara region of Western Australia (Figure ES1). The Proposal includes the development of mine pits and associated infrastructure, processing facilities, water management infrastructure for groundwater abstraction and surplus water disposal, temporary and permanent waste landforms and tailings storage facilities.

Table ES 2: Location and Proposed Extent of Physical and Operational Elements

Element	Location	Proposed Extent	
Physical Elements			
Mine and Associated Infrastructure	Figure ES 2	Clearing of up to 7,900 of native vegetation within the 43,804 ha Mine Development Envelope	
Operational Elements			
Mining voids	NA	Eliwana Area • Below water table mining • Episodic mining void water body • Permanent and episodic post-closure mining void water body	Flying Fish Area • Above water table mining • Episodic mining void water body
Ore processing (waste)	NA	Disposal of up to 1.2 Gt of waste rock to temporary and permanent waste dumps	
Ore processing (tailings)	NA	Disposal of up to 84 Mt of tailings into tailings storage facilities	
Power supply	NA	Overhead transmission line or onsite power generation	
Water supply	NA	Up to 12 GL/a, supplied from a combination of mine dewatering and water supply borefields.	
Dewatering	NA	Abstraction of up to 14 GL/a of groundwater	
Surplus Water Management	NA	Up to 4 GL/a of surplus water will be managed through a combination of surface discharge and controlled aquifer reinjection.	



400,000 500,000 600,000 700,000 800,000 900,000

7,700,000 7,600,000 7,500,000

Solomon

Eliwana

Cloudbreak

Christmas Creek

LEGEND

- FMG Rail Alignments
- BHPB Rail
- Rio Tinto Rail
- Roy Hill Rail
- Fortescue Projects
- Mine Development Envelope

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 20 40 60 80
Kilometres

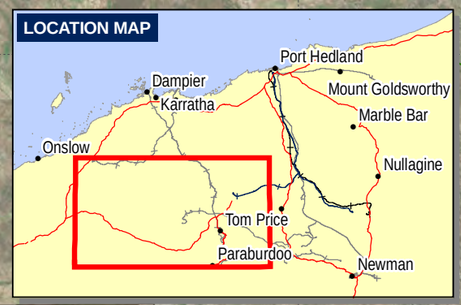
Requested By: R. Sharp
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
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Figure ES1
Proposal Location

Fortescue Metals Group Ltd
The New Force in Iron Ore



400,000 450,000 500,000 550,000 600,000 650,000

7,600,000 7,550,000 7,500,000 7,450,000

Solomon

Silvergrass

Brockman 2
Nammuldi

Eliwana

Brockman 4

Turner West

LEGEND

- Fortescue
- Rio Tinto
- Mine Development Envelope
- Pastoral Lease Relinquishments
- FMG Rail Alignments
- Rio Tinto Rail
- 5(1)(g) Reserve
- Conservation Park
- Former Leasehold
- National Park
- Nature Reserve

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 5 10 15 20 25
Kilometres

Requested By: M.Dowling
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:750,000
Coordinate System: GDA 1994 MGA Zone 50
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Figure ES2
Proposal Context

Fortescue Metals Group Ltd
The New Force in Iron Ore

Table ES 3: Summary of Potential Impacts, Proposed Mitigation and Outcomes

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
Hydrological Processes	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	Instructions on how to prepare an Environmental Review Document (EPA, 2016a) Statement of Environmental Principals, Factors and Objectives (EPA, 2016c) Environmental Factor Guideline: Hydrological Processes (EPA, 2016b) Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans (EPA, 2016a) Western Australian Water in Mining Guideline (DoW, 2013a) Strategic Policy 2.09: Use of Mine Dewatering Surplus (DoW, 2013b).	**Groundwater** Groundwater within the MDE occurs within both deep, fractured rock aquifers and near the surface along dissected creeks and within gorges. The main aquifers relevant to dewatering and water supply identified (Golder Associates, 2017c) are: • The Wittenoom Aquifer found within the Bee George, Paraburdoo and West Angela Members of the Wittenoom Formation comprising dolomite, banded iron and minor chert; • The mineralised Marra Mamba Aquifer found within the upper mineralised Mount Newman Member of the Marra Mamba Formation; and • The mineralised Brockman Aquifer associated with the target ore body of the Brockman Iron Formation members. Hydrogeological investigations have identified three main stratigraphic aquitards and a number of low permeability dolerite dykes that compartmentalise the Eliwana groundwater system: • The Lower Marra Mamba and Fortescue Group to the north of Eliwana; • The un-mineralised Brockman Iron Formation and Weeli Wolli Formation to the south of Eliwana; • The Mount McRae shale which separates the Wittenoom and Mineralised Brockman Aquifer; and Dolerite dykes dissecting the valley basement rocks, traversing in both north-west to south-east and north-east to south-west directions The low permeability aquitards to the north and to the south and the presence of dolerite dykes cutting across the east-west strike length of the valley groundwater results in very low through flow between groundwater compartments, a critical aspect of the impact assessment for this factor. **Surface Hydrology** The Proposal is located in the Hamersley Ranges within the Duck Creek catchment, a tributary of the Ashburton River. Major tributaries of Duck Creek include Boolgeeda Creek and Caves Creek, with Barnett Creek and Wackilina Creek forming the upper section of Caves Creek.	**Groundwater** • Groundwater drawdown and alteration of hydrological processes as a result of mine dewatering and water supply abstraction; • Groundwater mounding in areas of surplus water injection or release of water into inactive mining voids; • Controlled release of excess water into inactive mining voids or via surface discharge; and • Altered hydrogeology and water balance associated with the creation of permanent and episodic mining void water bodies **Surface Hydrology** • Surface water flow resulting from controlled surface discharge; • Permanent modification to existing catchments and associated impacts to flow paths and inundation areas of surface water streamflows; • Shadowing in areas of surface water sheetflow impacted by infrastructure or landform placement.	The broad Proposal footprint avoids interaction with significant surface water features such as major rivers and major creeks where possible. Where possible, infrastructure and landforms will be placed to avoid interaction with minor surface water features. Where possible exhaust all alternative water reuse or storage options before controlled discharge is considered for surplus mine dewater. Fortescue has developed geological and hydrogeological models of the MDE in order to allow impacts to be quantified. Fortescue has undertaken modelling of proposed groundwater drawdown associated with mine dewatering and water supply abstraction in order to allow impacts to be quantified. Fortescue has completed surface water modelling in order to allow impacts to be quantified. Minimise disturbance to existing hydrologic regime wherever possible through the implementation of the Fortescue Surface Water Management Plan. Divert significant surface water flows around pits and mining infrastructure where practicable to minimise impact on hydrologic regime. Implementation of the *Groundwater Management Plan 100-PL-EN-0029* Surface water management measures will be implemented in accordance with the *Surface Water Management Plan 100-PL-EN-1015.* Mine dewatering and water supply abstraction will be managed in accordance with approved Groundwater Operating Strategies. Design, review, revise and update closure landforms throughout the life of the mine to stabilise creeks and minimise groundwater table exposure where practical, in accordance with *the Eliwana Mine Closure Plan EW-PL-EN-0001*.	**Groundwater** A loss of stored water from the Brockman syncline, however this is not anticipated to be significant as there are no other users identified for the groundwater impacted by drawdown. Due to the compartmentalised local aquifers drawdown is restricted to individual groundwater sub-catchments. Surplus mine dewater may be discharged into nearby creek systems. Impacts from this discharge are temporary and there are no areas of significant environmental values identified downstream of discharge points. Following closure, a range of residual groundwater level drawdown between 1 and 37 m has been predicted for groundwater sub-catchments of the MDE. In some mine voids, the recovered groundwater table may be exposed at the surface, creating pit lakes. Closure landforms will be designed to ensure that impacts resulting from any changes to the groundwater aquifers are limited to the specific sub-catchments associated with the mine void. **Surface Hydrology** There is expected to be changes to the volume of water flowing through some creeks downstream of the proposed disturbance with the potential for some creeks to be captured and contained within mine voids during operations and following closure. There is also the potential for these creek inflows to create pit lakes. On closure, the land will be rehabilitated to ensure that indirect impacts resulting from any changes to the hydrological regimes are limited to the specific creeks, reaches of local tributaries and Pinarra Creek.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome

			The Proposal area can be divided into two catchments made up of six sub-catchments know as:
			• Boolgeeda Sub-catchments
			  o Pinarra Creek
			  o Strike East
			  o Flying Fish 1
			  o Flying Fish 2
			• Duck Creek Sub-catchment
			  o West Creek
			  o Combined Infrastructure Areas
			Many gorges are present throughout the Proposal area and are associated with the strike valley. This includes instances where the northern and southern parallel ridges move close together and where drainage lines cross either, or both, of the parallel ridges
			Creeks in the Pilbara are typically ephemeral, and except for pools and groundwater fed springs, are dry for the majority of the year. Pilbara soils typically have high initial infiltration rates for dry catchment conditions (i.e. when the moisture content of the soils is low). Significant streamflow usually occurs when moisture content of the soils is high, which is caused by significant rainfall in the days or weeks preceding a storm event.
			Some surface water pools are evident in the far west of the MDE. However, these appear to be semi-permanent as they have been recorded dry late in the dry season.
			There is limited surface water and groundwater connectivity in the MDE. Surface water catchments are not co-incident with groundwater catchments and the presence of surface water drainage features does not have a widespread impact on groundwater levels, except where groundwater is shallow and only following periods of significant streamflow.
					Mine void options analysis follows a cycle of risk assessment, planning, implementation, monitoring, validation and adjustment/re-evaluation. This ensures risks are identified and management strategies are effective. The selection of mitigation strategies is part of the adaptive management process; that is, the mitigation strategy will be informed by ongoing monitoring, modelling and risk assessments.	

Inland Waters Environmental Quality	To maintain the quality of groundwater and surface water so that environmental values are protected.	National Water Quality Management Strategy (NWQMS) (ANZECC & ARMCANZ, 2000a) Guidelines for Groundwater Protection in Australia (ANZECC & ARMCANZ, 2013) Preventing Acid and Metalliferous Drainage (DIIS, 2016); Water in Mining Guideline (DoW, 2013a); Pilbara Regional Water Plan (DoW, 2010); State Water Quality Management Strategy (GWA, 2003) Mining and Mineral Processing - Mine dewatering: Water Quality	**Groundwater Quality** Groundwater in the Eliwana Mine area is of a calcium/magnesium-bicarbonate type while Flying Fish groundwater contains significant bicarbonate but is dominated by sodium/magnesium-chloride type water. Alkalinity is abundant with pH values all in the alkaline range and elevated hardness. Salinity across the project area ranges from approximately 400 - 2,500 µS/cm. **Surface Water Quality** Generally, surface water meets most ADWG (NHMRC, 2011). All pH values are in the alkaline range, salinity is considered “fresh” and most samples have elevated (>30 mg $CaCO_3$/L) hardness. Two samples contain one detection each of copper and zinc. For all samples aluminium and iron exceed the aesthetic taste	Negative impact on groundwater and surface water quality as a result of: • Dewatering discharges where the water quality (temperature, heavy metals, carbonates) is a concern; • Direct discharge of wastewater to surface water systems; • Alteration of the land surface or dewatering of aquifers that exposes acid sulfate soils or creates acid rock drainage; • Creation of pit lakes leading to storage of poor quality water; • Erosion from disturbed surfaces resulting in increased turbidity of surface water.	The Proposal avoids interaction with significant surface water features such as major rivers and major creeks where practicable; Where possible, infrastructure and landforms will be placed to avoid interaction with minor surface water features. Fortescue will ensure that appropriate handling and storage procedures are in place to avoid impacts to water quality associated with chemical or hydrocarbon spills. Where practicable and cost effective, mining voids may be redesigned, to avoid exposing deleterious material in walls.	Minimal impacts to surface water quality are expected from erosion and sedimentation caused from clearing and construction of mine infrastructure. The quality of water discharged to creeklines from mine dewatering activities is not considered to be deleterious to the health of creekline ecosystems. The discharge of mine void water during operations into the creeks is not expected to significantly impact water quality. The water will be tested to confirm the suitability for discharge and/or treated to render the water suitable for discharge. The creation of permanent pit lakes is expected at closure. Closure strategies will be progressively developed and

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
		Protection Guidelines No. 11 (WRC, DME & DEP, 2000b). State Water Quality Management Strategy (Government of Western Australia, 2003)	limits with minor concentrations of boron, barium and manganese. All other elements that were tested occurred below the limit of reporting.		Deleterious rock material will not be used for construction or exposed during infrastructure installation. Mount McRae Shale and West Angela units will not be used as construction material. Waste rock landforms will be designed to encapsulate or otherwise manage deleterious waste rock using mitigation measures to minimise the risk of acid and/or metalliferous drainage generation. Fortescue will continue the detailed geochemical assessment of waste rock to facilitate segregation and appropriate disposal of deleterious materials within WRLs. Closure landforms will be designed to be acceptably stable in order to minimise impacts to water quality associated with erosion and sedimentation. Disposal of surplus mine dewater is considered as a last resort option after all other potential uses, including storage in pits or re-injection have been investigated. Fortescue will undertake water quality testing of mine void water prior to discharge of water into the creeklines. Carbonaceous shale material should be sent for self-heating and auto-ignition risk assessment testing prior to operations commencing. Fortescue will develop and review closure strategies in consultation with key stakeholders to ensure changes to water quality do not adversely impact downstream environmental or heritage values in accordance with the *Eliwana Mine Closure Plan EW-PL-EN-0001*. Fortescue will progressively rehabilitate disturbed areas at the end of their serviceable or operational life where appropriate.	reviewed throughout the mine life to ensure that the closure objectives relating to water quality can be met on closure. Impacts from hydrocarbon and chemical spills are not expected to impact surface water or groundwater quality.
Flora and Vegetation	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	Environmental Factor Guideline: Flora and Vegetation (EPA, 2016e) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact (EPA, 2016f)	The Eliwana MDE lies entirely within the Hamersley IBRA sub-bioregion. Vegetation communities and species diversity are representative of the surrounding Hamersley sub-bioregion. Vegetation condition within the MDE is almost entirely in good to excellent condition. Some drainage features are considered to be in poor condition due to existence of weeds and grazing pressure.	• Direct loss of vegetation at local and regional level; • Direct loss of conservation significant vegetation; • Direct loss of Conservation Significant Flora; • Degradation of vegetation due to indirect impacts such as: o Fragmentation, leading to edge effects. o Dust deposition. o Altered fire regimes.	Implementation of a revised *Vegetation Health Monitoring and Management Plan 100-PL-EN-1020* (Attachment 20) and Fortescue's Significant Flora and *Vegetation Management Plan 45-PL-EN-0017*. Measures include: • Review the proposed project design against the vegetation survey data to avoid/minimise clearing of significant flora and vegetation.	Clearing of 7,900 ha of native vegetation, 99.7% in good to excellent condition; Clearing of 41.4 ha of vegetation representative of the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* Priority 3 Ecological Community; Disturbance to small numbers of 9 Priority Flora Species; Changes in community structure and species content of approximately 20 ha of Groundwater Dependent Vegetation as a

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
			A total of 17 Priority flora species occur within the MDE, comprising two Priority 1, three Priority 2, seven Priority 3 and five Priority 4 species. Two vegetation communities considered representative of the Priority 3 Ecological Community *Triodia sp. Robe River assemblages of mesas of the West Pilbara* have been recorded within the MDE. Two vegetation communities considered to be Groundwater Dependent Ecosystems (GDE) and a further two communities that may be considered potential GDE have been recorded within the MDE or within areas impacted by groundwater drawdown.	o Chemical, hydrocarbon spills, leaks from containment structures or Acidic or Metalliferous Drainage (AMD). o Changes to surface hydrology. o Groundwater abstraction.	• Minimise clearing and vegetation disturbance to ensure significant flora and vegetation are protected. Conduct vegetation clearing in accordance with a permit issued under the *Land Use Certificate Procedure 100-PR-TA-0001*, the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042*, and/or the *Exploration Environmental Management Plan E-PL-EN-0002*. • Ensure staff and contractors are aware of the location of significant flora and vegetation on site and their responsibility to ensure they are protected. • Ensure all vehicles, plant and equipment, including trailered equipment, are clean, inspected and certified prior to entry into the Fortescue Operations Area in accordance with the *Weed Management Plan 100-PL-EN-1017*. • When constructing a fire break or carrying out a prescribed burn where significant flora and/or vegetation have been identified, adhere to the requirements outlined in the *Bushfire Management Plan 100-PL-EM-0009*. • To minimise the potential for dust deposition on vegetation, implement dust suppression measures in accordance with the *Mine and Rail Dust Management Plan 45-PL-EN-0030*. • Chemicals and hydrocarbons should be stored in accordance with AS 1940, AS 3833 or AS 3780 to minimise the potential for environmental harm. Storage should only be in designated areas and within the limits specified in applicable Licence conditions under the EP Act (see Table 2). • Where a chemical or hydrocarbon spill has occurred, manage the spill including any contaminated material, in accordance with the *Chemical and Hydrocarbon Spills Procedure 100-PR-EN-0014* and investigate and report the incident in accordance with the *Incident Event Management Procedure 100-PR-SA-0011*. • Conduct a risk assessment to determine the likelihood of a	result of mine dewatering and surface water changes; Changes in community structure and species content in riparian communities over an area of approximately 314 ha as a result of fragmentation and changes to surface water flow; Temporary changes in community structure (vegetation density) as a result of surplus mine dewater discharge to downstream riparian environments;

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
					change to the surface water regime that may lead to unacceptable environmental impacts. • Drainage infrastructure location, design, construction and operation to design specifications which reflect risk assessment outcomes in minimising interference and disruption of natural surface water flows and quality where practicable in accordance with the *Standard Engineering Specification for Drainage and Flood Protection 100-SP-CI-0004* and the *Standard Engineering Specification for Road Design for Projects 100-SP-CL-0002*. • Protect natural drainage lines from construction impacts where possible to minimise impacts to water quality. • Where possible, utilise water from dewatering for onsite activities, such as dust suppression and OPF operations. • When construction or maintenance activities results in abstraction volumes in excess of what can be disposed of in accordance with the applicable Groundwater Operating Strategy. • Prior to undertaking groundwater management activities and constructing supporting infrastructure, conduct a risk assessment to identify high risk areas. Develop and implement management strategies that reflect risk assessment outcomes. • Establish monitoring bores to monitor and where necessary mitigate the effects of dewatering and injection on phreatophytic vegetation in accordance with the *Significant Flora and Vegetation Management Plan 45-PL-EN-0017*	
Terrestrial Fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016g) Technical Guidance – Terrestrial Fauna Surveys (EPA, 2016h) Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA, 2016i) Guidance Statement No. 20: Sampling of short-range endemic invertebrate fauna for environmental impact assessment	Seven broad habitat types have been described within the MDE: • Drainage Line/River/Creek (Major) • Drainage Line/River/Creek (Minor) • Gorges/Gullies • Hills/Ranges/Plateau • Lower Slopes/Hillslopes • Plain (Shrubland) • Plain (Stony/Gibber) Fauna surveys have resulted in a total of ten significant fauna species that have been recorded from within the MDE. An additional	• Habitat loss from direct clearing of fauna habitat, including habitat for SRE invertebrates. • Habitat fragmentation, resulting in: o Restriction or removal of access to breeding habitat, foraging habitat or water sources through placement of infrastructure; o Increased feral animal species; o Increased weed species; o Increased vehicle strike. • Changes to surface water regime.	Implementation of Fortescue's *Conservation Significant Fauna Management Plan 100-PL-EN-0022* (Appendix 20). Mitigation measures to address potential impacts include: • Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat. • Ensure staff and contractors are provided with appropriate training	Loss of 7,900 ha of fauna habitat. There may be some permanent loss of habitat such as Gorges/Gullies, Drainage Line/River/Creek habitat. No fauna habitat type will be substantially cleared within the MDE (between 6-13% habitat removed on a regional scale and 9-25% on a local scale), therefore direct and indirect impacts to terrestrial fauna on a local and regional scale are considered to be minimal. Almost all the potential SRE invertebrate taxa recorded in the MDE to date have also been

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
		(EIA) in Western Australia (EPA, 2009).	three species are considered to have a high likelihood of occurrence based on preferred habitat type. These are: • Northern Quoll (EN) • Pilbara Leaf-nosed Bat (VU) • Ghost Bat (VU) • Pilbara Olive Python (VU) • Grey Falcon (VU) • Peregrine Falcon (S7) • Fork-tailed Swift (MI) • Rainbow Bee-eater (MI) • Gane's Blind Snake (P1) • Pilbara Barking Gecko (P2) • Long-tailed Dunnart (P4) • Western Pebble-mound Mouse (P4) • Western Striped Snake-eyed Skink (P4) One (1) confirmed SRE species *Antichiropus 1021DNA02* occurs within the MDE.	• Altered fire regimes.	to ensure conservation significant fauna and associated habitat are protected. • Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the *Land Use Certificate Procedure 100-PR-TA-0001_0* • Conduct progressive rehabilitation of disturbed areas, particularly those areas with known conservation significant fauna and associated habitat, in accordance with the *Exploration Environmental Management Plan E-PL-EN- 0002* or *Eliwana Mine Closure Plan EW-PL-EN-0001*. • Develop and implement a Feral Animal Program to effectively manage and control feral animals within Fortescue controlled sites to minimise impacts on conservation significant fauna. • Manage waste materials and on-site landfill facilities in accordance with the *Waste Management Plan 45-PL-EN-0014* to minimise potential impacts on fauna and the likelihood of increases in feral animal numbers. • To minimise the potential for fauna injuries or deaths on haul and access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving. • Ensure all vehicles, plant and equipment, including trailered equipment, are clean, inspected and certified prior to entry into Fortescue controlled sites to prevent the degradation of priority fauna habitat in accordance with the *Weed Management Plan 100-PL-EN-1017*. • Drainage infrastructure location, design, construction and operation to design specifications which reflect risk assessment outcomes in minimising interference and disruption of natural surface water flows and quality where practicable in accordance with the *Standard Engineering Specification for Drainage and Flood Protection 100-SP-CI-0004* and the *Standard*	recorded outside the study area and therefore have distributions beyond the MDE. The exception to this is *Dampetrus* 1021DNA02 which has been reclassified as *Dampetrus* sp. indet and it is now uncertain if this species is the same as other *Dampetrus* sp. indet collected outside the MDE. Rehabilitation will establish habitat for fauna species post-disturbance to restore ecological linkage for some species. Whilst the vegetation communities on rehabilitated surfaces are unlikely to be similar to those removed, the resulting habitats will be generally used by fauna species present. Some permanent landforms may provide new habitat for some fauna species post-closure. There may be some impacts to surface water flow as a result of the proposal, which may cause local changes to vegetation density and structure. This could cause localised impacts to fauna that use Drainage Line/River/Creek habitats.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
					Engineering Specification for Road Design for Projects 100-SP-CL-0002.	
Subterranean Fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	Environmental Factor Guideline: Subterranean Fauna (EPA, 2016j) Environmental Assessment Guideline for Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia (EPA, 2013a) Technical Guidance – Subterranean Fauna Surveys (EPA, 2013b)	**Habitat** Troglofauna habitat within the MDE is extensive and extends beyond proposed pit shells. Habitat for troglofauna occurs in the Marra Mamba Iron Formation and the Brockman Iron Formation where it occurs above the water table. Habitat for stygofauna is categorised by the compartmentalised nature of the local aquifers as described in Hydrological Processes. Groundwater drawdown for mine dewatering will result in a loss of stygofauna habitat during operations. However, it is likely that some are of habitat will remain below areas dewatered for operations. Following closure, groundwater levels will mostly return to pre-disturbance levels, although final levels will be influenced by potential mine voids. **Troglofauna** A total of 16 troglofauna taxa recorded during current and previous surveys of the MDE are known only from within proposed pit boundaries (1 species located within the TSF footprint). Eleven of these are considered to be at low risk of significant impacts. A further two are at low-moderate risk and three species are at moderate risk. **Stygofauna** Current and previous surveys recorded nine (9) stygofauna taxa known only from the MDE. Of these, three are considered at low risk of significant impact, three are considered low-moderate risk, one is considered moderate risk and two are considered at high risk of significant impact from the Proposal. These high-risk species are: • *Brevisomabathynella* sp. B03; and • *Areacandona* sp. BOS1020	• Direct mortality and loss of habitat through mining activity; • Direct impact to subterranean fauna habitat, assemblage and individuals through groundwater abstraction and groundwater injection; • Indirect impacts from blasting; and • Indirect impacts to stygofauna due to elevated concentrations of contaminants in water due to chemical or hydrocarbon spills, leaching from waste dumps or tailings storage facilities.	Limit groundwater abstraction in borefields to that which is needed for water supply. Minimise contamination of groundwater by engineering management practices to contain hydrocarbon products. Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine life.	There will be a permanent loss of troglofauna habitat through the removal of waste rock and ore during mining. However, this continuous geological horizon extends beyond the economically viable areas to provide habitat for subterranean fauna that will provide an un-mined refuge. Groundwater abstraction and groundwater injection will alter the hydrological conditions in the subterranean habitat. Water levels will drop, potentially increasing habitat for Troglofauna, but reducing habitat for Stygofauna. Populations of subterranean fauna outside the impact area will not be affected and therefore the species will survive beyond the impact area. Impacts from dewatering are localised to individual compartmentalised aquifers. There is a very low risk of contamination of groundwater from chemical and hydrocarbon spills.
Social Surrounds	To protect social surroundings from significant harm.	Environmental Factor Guideline: Social Surroundings (EPA, 2016k).	The land on which the MDE is located is a mixture of Unallocated Crown Land and Pastoral Lease. No population centres are located within proximity to the MDE and there are no recognised tourism and recreation values within the MDE. The land on which the MDE is located is within the Puutu Kunti Kurrama and Pinikura (PKKP) and Eastern Guruma Native Title Determination areas. Fortescue has made an assessment of the ethnobotanical and ethnozoological,	• Impacts to Aboriginal heritage places. • Prevention or change to access to an Aboriginal heritage place. • Changes to the attributes of the environment which may impact on Aboriginal heritage places. • Unauthorised access to heritage places	Disturbance to places of archaeological or ethnographic significance will be avoided and minimised where practicable. Where avoidance is not possible, disturbance to places of archaeological or ethnographic significance will be planned and managed in consultation with traditional owners and the DPLH. Fortescue will continue to consult with the relevant Native Title groups and obtain approval under Section 18 of the *Aboriginal Heritage Act 1972* as	Impacts to pastoral activities will be limited. No impacts to population centres, recreation or tourism values, or non-Aboriginal heritage are anticipated. Aboriginal heritage sites may be impacted by the Proposal. Fortescue will continue to consult with traditional owners on disturbance to heritage sites and fulfil its legal obligation under the Aboriginal Heritage Act.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impact	Management Strategies	Predicted Outcome
			medicinal and cultural values of the flora and fauna within the MDE. All species of cultural significance are common Pilbara species.		required, prior to the disturbance of any heritage sites. Heritage Sites will be managed in accordance with the *Management of Aboriginal Cultural Heritage, Fortescue Project Areas, Revision 2 100-GU-HE-0003*. Fortescue will minimise dust emissions, as far as practicable, through implementation of the Fortescue *Mine and Rail Dust Management Plan 45-PL-EN-0030* Noise and vibration will be managed in accordance with the *Mine and Rail Noise Management Plan 100-PL-EN-0028*. Fortescue will develop and review closure strategies in consultation with key stakeholders, in accordance with the *Eliwana Mine Closure Plan EW-PL-EN-0001*.	Fortescue will facilitate access to country for traditional owners within safety and operational constraints. Traditional owners will continue to have access to land and the flora and fauna on that land for hunting or cultural purposes during following closure. Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Native Title Groups
Air Quality	To maintain air quality and minimise emissions so that environmental values are protected.	Environmental Factor Guideline: Air Quality (EPA, 2016l)	The Pilbara region experiences significant ambient dust levels due to the semi-arid landscape. Background particulate dust monitoring at Fortescue's Port Hedland operations indicate many occurrences annually where naturally occurring dust exceeds the National Environment Protection Measure for Ambient Air Quality (Air NEPM) criteria. The airshed around the MDE would be considered very clean compared to urban development and industrial areas such as Perth and Kwinana.	• The generation of dust and gaseous emissions to air. • Dust emissions sources include: o Excavation, handling and processing of iron ore and waste material (including potentially fibrous mineral materials); o Wheel generated dust from the movement of vehicles and equipment on unsealed roads; and o Windblown dust from disturbed areas and material stockpiles. • Gaseous emissions include greenhouse gas and other pollutants such as NOx and VOCs from: o Electricity generation; and o Diesel combustion by fixed and mobile plant and equipment.	The Eliwana Project proposes to utilise the latest available technology in the combustion of natural gas or diesel for power generation; Automated mining equipment has shown operate more efficiently than manned machinery at Fortescue's nearby Solomon Operations and will be utilised at Eliwana; Implementation of the *Mine and Rail Dust Management Plan 45-PL-EN-0030.*	Impacts from dust will be minimal. Greenhouse gas emissions are estimated to be just 0.05% of the nation's GHG missions and 0.31% of Western Australia's GHG emissions.

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1. INTRODUCTION

Fortescue Metals Group (Fortescue) is proposing to develop the Eliwana Iron Ore Mine Project (the Proposal), 90 km west-north-west of Tom Price, in the Pilbara region of Western Australia in the Pilbara region of Western Australia Figure ES1 and Figure ES 2.

The Proposal includes the development of mine pits and associated infrastructure, processing facilities, water management infrastructure for groundwater abstraction and surplus water disposal, temporary and permanent waste landforms and tailings storage facilities. The Proposal involves disturbance of up to 7,900 ha within a 43,804 ha Mine Development Envelope (MDE) (Figure 1).

1.1 Purpose and Scope

The purpose of this Public Environmental Review (PER) is to present an environmental impact assessment of the Proposal for public review and assessment by the Environmental Protection Authority (EPA). The PER includes a detailed impact assessment and description of proposed mitigation and management measures for the environmental factors identified in the Environmental Scoping Document (ESD) (Appendix 1).

This document has been prepared in accordance with the Environmental Impact Assessment Administrative Procedures 2016 (Government of Western Australia, 2016) and the Instructions on How to Prepare and Environmental Review Document (EPA, 2016a). This document also satisfies the requirements for an accredited assessment under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

1.2 Proponent

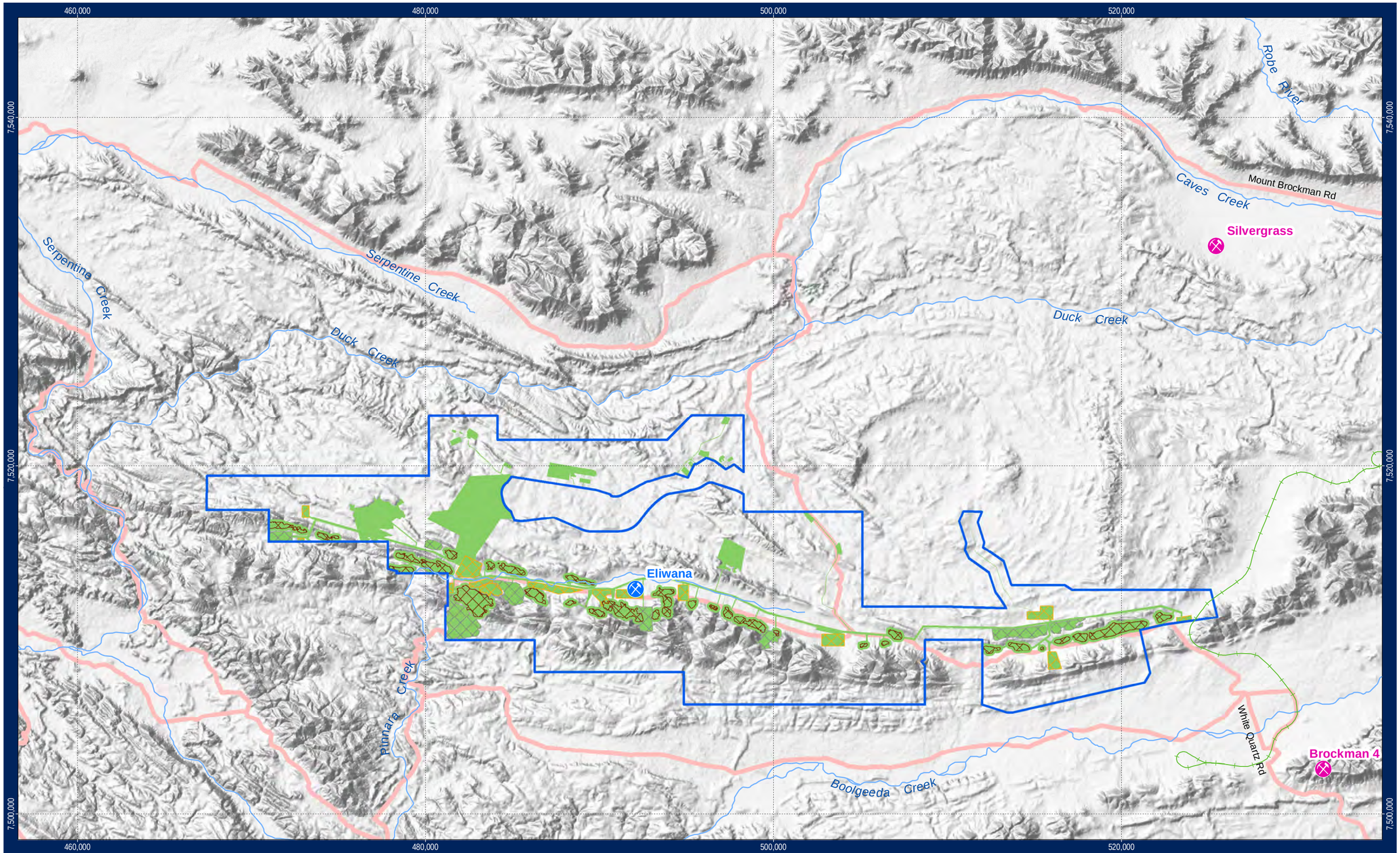
The Proponent for this Proposal is: Fortescue Metals Group Limited:

ABN: 57 002 594 872
Level 2, 87 Adelaide Terrace
East Perth Western Australia 6004

The key contact for the Proposal is:

Sean McGunnigle, Manager, Environmental Approvals
Level 2, 87 Adelaide Terrace
East Perth WA 6004
Phone: 08 6218 8415
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Fortescue Projects
Rio Tinto Mines
Major Drainage
Access Routes
Rio Tinto Rail
Mine Development Envelope

Indicative Mine Footprints

Pits
Stockpiles
Waste Dumps
Ground Disturbance

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: R. Sharp
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:200,000
Coordinate System: GDA 1994 MGA Zone 50
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Figure 1
Mine Development Envelope

Fortescue Metals Group Ltd
The New Force in Iron Ore

1.3 Environmental Impact Assessment Process

The Proposal will be assessed under the following primary environmental legislation:

- Part IV of the *Environmental Protection Act 1986* (WA) (EP Act)
- Part 8 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

The EPA will review the draft PER and when satisfied that the PER adequately addresses the requirements set out in the ESD, the EPA will approve the PER document to be released for a four-week public review period. Following the public review period, the EPA will provide to the Proponent, summaries of all submissions received.

The matters raised in the submissions will be addressed by Fortescue to the satisfaction of the EPA. The EPA will then assess the PER, submissions received and Fortescue's response to submissions in preparation of its report and recommendations to the WA Minister for the Environment. The EPA report and recommendations will also be considered by the Commonwealth Minister for the Environment.

The Proposal will not be subject to a State Agreement Act.

1.3.1 *Environmental Protection Act 1986*

The EP Act is the primary legislation governing environmental protection and impact assessment in Western Australia. Division 1 of Part IV of the EP Act provides for the referral and assessment of significant and strategic proposals.

If a proposal is likely to have a significant effect on the environment, the proposal should be referred to the EPA in accordance with section 38 of the EP Act. The EPA reviews the referral and decides whether to assess a referred proposal. The EPA then determines whether it will assess a proposal and the level of assessment for that proposal.

Where an assessment is required, the EPA or the Proponent will prepare an ESD. The ESD outlines the preliminary key environmental factors and specifies the form, content, timing and procedure of the PER to meet the requirements of section 40(3) of the EP Act. The PER (this document) must be prepared in accordance with the ESD and the *Environmental Impact Assessment Administrative Procedures 2016* (Government of Western Australia, 2016) and associated environmental assessment guidance documents. The purpose of the PER is to assess the impacts of the proposal on the preliminary key environmental factors.

The EPA will review the draft PER and when satisfied that the PER adequately addresses the requirements set out in the ESD, the EPA will approve the PER document to be released for a

public review period. Following the public review period, the EPA will provide summaries of all submissions received to the Proponent

The matters raised in the submissions will be addressed by the Proponent to the satisfaction of the EPA. The EPA will then assess the PER, submissions received, the Proponent's response to submissions, and then prepare a report and recommendations to the Minister for the Environment.

1.3.2 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act is administered by the Commonwealth Department of the Environment and Energy (DoEE) on behalf of the Commonwealth Minister for the Environment. If a Proposed Action will have, or is likely to have, a significant impact on a matter of national environmental significance (MNES), the Proposed Action must then be referred to the Minister for a decision on whether assessment and approval is required under the EPBC Act.

The MNES are:

- world heritage properties
- national heritage places
- wetlands of international importance (often called 'RAMSAR' wetlands after the international treaty under which such wetlands are listed) nationally threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mining)
- a water resource, in relation to coal seam gas development and large coal mining development.

If the Proposed Action is determined to be a Controlled Action, the Proposal will be assessed in accordance with s87 of the EPBC Act, usually under an accredited assessment between the Commonwealth and the State of Western Australia. Under an accredited assessment, the Commonwealth has endorsed the State's environmental impact assessment (EIA) process, effectively delegating the responsibility of assessing the Proposal to the State.

1.4 Other Approvals and Regulation

1.4.1 Tenure

Unallocated Crown Land in the Pilbara can be subject to a range of tenure regimes, including pastoral lease, Mining Act tenure and Crown Reserves. The MDE overlies portions of Fortescue-managed Mining Act tenure, third party Mining Act and State Agreement tenure and unallocated crown land (Figure 2). Fortescue-managed tenure within the MDE includes:

M47/1509	M47/1525 (Pending)	E47/1302	E47/2037
M47/1522	M47/1526 (Pending)	E47/1373	E47/3760
M47/1523	M47/1537 (Pending)	E47/1500	L47/806
M47/1524	M47/1553 (Pending)	E47/1533	L47/807

The MDE overlies portions of the following pastoral leases:

- Mount Stuart Station
- Cheela Plains Station
- Rocklea Station
- Hamersley Station.

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460,000
480,000
500,000
520,000
7,540,000
7,520,000
7,500,000

Robe River
Caves Creek
Silvergrass
Serpentine Creek
Serpentine Creek
Duck Creek
Duck Creek
L47/806
LIVE
E47/1500
LIVE
E47/1373
LIVE
M47/1537
LIVE
M47/1524
LIVE
M47/1523
LIVE
L47/807
LIVE
E47/2037
LIVE
Eliwana
M47/1522
LIVE
E47/1500
LIVE
L47/831
PENDING
M47/1526
PENDING
E47/1302
LIVE
M47/1509
LIVE
E47/3760
PENDING
E47/1533
LIVE
M47/1525
PENDING
M47/1553
PENDING
Pinnara Creek
E47/1302
LIVE
Boolgeeda Creek
Brockman 4

Fortescue Projects
Rio Tinto Mines
Access Routes
Rio Tinto Rail
Mine Development Envelope
Indicative Mine Footprint
FMG Tenements
FMG Mining Leases

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: R. Sharp
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:200,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.004_r1

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Figure 2
Tenure of the Proposal Area

Fortescue Metals Group Ltd
The New Force in Iron Ore

1.4.2 Decision Making Authorities

The authorities listed in Table 1 have been identified as decision-making authorities (DMAs) for the Proposal.

Table 1: Decision Making Authorities

Decision Making Authority	Relevant Legislation
Department of the Environment and Energy (Commonwealth)	*Environment Protection and Biodiversity Conservation Act 1999* – Listed threatened species and communities (s18 and 18A)
Minister for Environment	*Wildlife Conservation Act 1950* – Taking of flora and fauna EP Act Part IV – s45
Minister for Mines and Petroleum	*Mining Act 1978*
Minister for Water	*Rights in Water and Irrigation Act 1914*
Minister for Aboriginal Affairs	*Aboriginal Heritage Act 1972*
Director General, Department of Water and Environmental Regulation	*Environmental Protection Act 1986* • Part V Works Approval Licence Environmental Protection (Clearing of Native Vegetation Regulations 2004) • Clearing Permit
Executive Director Environment Division (Department of Mines, Industry Regulation and Safety)	*Mining Act 1978* – Mining Proposals including Mine Closure Plan.
Executive Director Environment Division (Department of Mines, Industry Regulation and Safety)	*Dangerous Goods Safety Act 2004* – Dangerous goods licence and approvals
State Mining Engineer	*Mines Safety and Inspection Act 1994*
Chief Executive Officer, Shire of Ashburton	*Building Act 2011* • Building permit for worker accommodation.

1.4.3 Other Approvals Required

Following primary environmental approval of the Proposal under the EP Act (Part IV) and EPBC Act, a number of other environmental approvals will be required in order to develop and operate the Proposal (Table 2).

Table 2: Other Approvals and Regulation

Proposal Activities	Land Tenure/Access	Type of Approval	Legislation Regulating the Activity
Mining and associated activities	Mining Lease	Mining Proposal	*Mining Act 1978*
Ore processing, landfill, tailings storage, power generation, sewage facilities, used tyre storage, fuel storage.	Mining Lease	Works Approval/Licence	*Environmental Protection Act 1986* Part V

Proposal Activities	Land Tenure/Access	Type of Approval	Legislation Regulating the Activity
Mine dewatering	Mining Lease	Sections 26D and 5C	*Rights in Water and Irrigation Act 1914*
Groundwater abstraction for water supply	Miscellaneous Lease/ Mining Lease	Sections 26D and 5C	*Rights in Water and Irrigation Act 1914*
Exploration and Resource Definition drilling	Exploration and Mining Lease	Programme of Works	*Mining Act 1978*
Disturbance of Aboriginal Heritage Sites	Mining Lease	Section 18	*Aboriginal Heritage Act 1972*

2. THE PROPOSAL

The Proposal includes the development of mine pits and associated infrastructure, processing facilities, non-process infrastructure, water management infrastructure for groundwater abstraction and surplus water disposal, temporary and permanent waste landforms and tailings storage facilities (Figure 1). The key characteristics of the Proposal are shown in Table 3 and Table 4. The Proposal has an overall ground disturbance of approximately 8,560 ha inclusive of all infrastructure.

Table 3: Summary of the Proposal

Proposal Title	Eliwana Iron Ore Mine Project
Proponent Name	Fortescue Metals Group Limited
Short Description	The Proposal is to develop above and below water table iron ore deposits, 90 km west-north-west of Tom Price, in the Pilbara region of Western Australia (Figure ES1). The Proposal includes the development of mine pits and associated infrastructure, processing facilities, water management infrastructure for groundwater abstraction and surplus water disposal, temporary and permanent waste landforms and tailings storage facilities.

Table 4: Location and Proposed Extent of Physical and Operational Elements

Element	Location	Proposed Extent	
Physical Elements			
Mine and Associated Infrastructure	Figure 1	Clearing of up to 7,900 ha of native vegetation within the 43,804 ha Mine Development Envelope.	
Operational Elements			
Mining voids	N/A	Eliwana Area • Below water table mining • Temporary and episodic mining void water body • Permanent and episodic pit lakes post-closure	Flying Fish Area • Above water table mining • Episodic mining void water body
Ore processing (waste)	N/A	Disposal of up to 1.2 Gt of waste rock to temporary and permanent waste dumps	
Ore processing (tailings)	N/A	Disposal of up to 84 Mt of tailings into tailings storage facilities	
Power supply	N/A	Overhead transmission line or onsite power generation	
Water supply	N/A	Up to 12 GL/a, supplied from a combination of mine dewatering and water supply borefields.	

Element	Location	Proposed Extent
Dewatering	N/A	Abstraction of up to 14 GL/a of groundwater
Surplus Water Management	N/A	Up to 4 GL/a of surplus water will be managed through a combination of surface discharge and controlled aquifer reinjection.

2.1 Background

The Proposal was referred to the Western Australia EPA under Section 38 of the EP Act on 7 July 2017. The EPA determined the Proposal required assessment under Part IV of the EP Act and set the level of assessment at Public Environmental Review (PER) on 27 July 2017.

The Proposal was also referred under Section 68 of the EPBC Act to the DoEE on 23 August 2017. DoEE determined the Proposal was a controlled action and would be assessed under an accredited assessment on 7 November 2017.

Note, Fortescue has concurrently referred the Eliwana Rail Proposal. The Eliwana Rail services the Eliwana Mine, connecting the mine to Fortescue's existing rail network.

2.1.1 Changes Since Referral

A number of changes have been made to the Proposal following referral in July 2017. The MDE has been refined, with the following specific changes being made:

- Change to delineation between the MDE and the Rail Development Envelope (associated with the Eliwana Railway Proposal). This change was instigated so that key infrastructure could be situated entirely within one proposal area rather than existing partially within the MDE and partially within the Rail Development Envelope.
- Reduction of the eastern extent of the MDE in the Flying Fish area. This change resulted from the withdrawal of one proposed mine pit as a result of stakeholder consultation related to proximity to the Rio Tinto Brockman Railway.
- Excision of areas within the MDE requiring further environmental investigation.

These changes have resulted in an approximately 38% reduction in overall area of the MDE from 70,000 ha to 43,804 ha. The revised MDE is shown in Figure 1.

The Referral also presented an indicative disturbance footprint. There have been several amendments and refinements to this indicative footprint as a result of:

- Additional baseline data (for example exploration drilling and geotechnical information)
- Additional environmental survey data (locations of conservation-significant fauna and flora species)

- Progression of engineering design of Proposal infrastructure.
- Removal of the easternmost mine pit in the Flying Fish area as a result of stakeholder consultation.
- Excision of areas requiring further environmental investigation.

Fortescue has submitted two Section 43A applications to the EPA to request amendments to its referred proposal to address these changes.

2.2 Justification

Fortescue continuously look at matching its vast resource base with market requirements. Fortescue Blend is currently a blended product consisting of ore from its Firetail Mine at Solomon and ore from its Chichester Operations. As inventory at Firetail is depleting Fortescue is looking at a replacement for its contribution to the Fortescue Blend. Through prefeasibility study work Eliwana has been identified as the best replacement option for the Firetail Component of the Fortescue Blend product. Eliwana further provides Fortescue with the opportunity to move towards a product strategy where a larger portion of our production is high grade ore (FE>60%) while maintaining its current production levels.

In November 2017, Fortescue made a public announcement that its Board had endorsed the Eliwana Proposal to proceed to full feasibility study as a replacement for the Solomon Hub Firetail Operation.

Development of the Eliwana Proposal will allow for expansion of the Fortescue business into the Western Hub area and is supported by exploration drilling leading to an inferred resource of 2,125 Mt for the Western Hub (Plate 1).

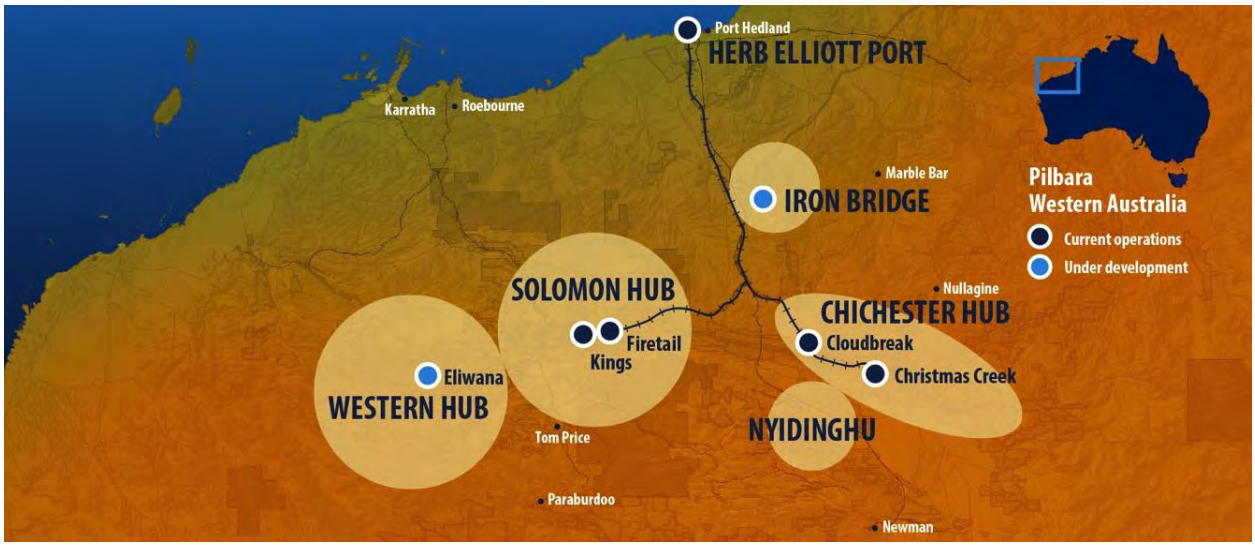


Plate 1: Fortescue Operations and Development Areas

2.2.1 Benefits of the Proposal

The Proposal would result in community benefits for Australia and Western Australia through:

- royalties and taxation payments from the sale of iron ore products
- employment and training opportunities
- encouragement in the growth of ancillary industries in WA.

Community Benefits

The Proposal is anticipated to provide contractual and full-time employment opportunities to local communities both during construction and operation. Further employment opportunities would be created by the flow-on effects to service industries and other sectors of the economy, particularly in the Pilbara.

Fortescue is committed to ensure the growth and development of our operations provide economic opportunity to local communities through the delivery of training, employment and business opportunities. Aboriginal people comprise 15% of Fortescue's workforce with a target of 20% by 2020 and have awarded close to $2 billion in contracts to Aboriginal businesses, 90% of that to Pilbara Traditional owned businesses. In addition, Fortescue awards approximately $200m per year to Pilbara based businesses and has a Pilbara based residential workforce of around 500.

In this regard, the development of the Eliwana project will lead to greater opportunities to employ more Aboriginal people and increase our residential workforce and increase the engagement of Aboriginal and Pilbara based businesses. Fortescue is committed to providing

jobs and employment to local indigenous people through the Vocational Training and Employment Centre (VTEC) developed as part of Land Access Agreement negotiations between Fortescue and native title groups. VTEC works by identifying employment opportunities within Fortescue, and with contractors who work with Fortescue, then developing courses using TAFE and other training organisations to provide indigenous people in the Pilbara with the necessary skills for those jobs.

Net Environmental Benefits

The baseline environmental studies undertaken to support this proposal and ongoing environmental monitoring during the life of the project, expands on the knowledge base of the State's unique flora and fauna. In addition, Fortescue has proposed offsets for any significant residual impacts from the Proposal. These offsets will result in a net environmental benefit from a range of landscape scale conservation initiatives under a government approved offset fund.

2.2.2 Options and Alternatives Considered

Development Options

Fortescue investigated a number of options as part of the Solomon Hub Firetail Operation replacement process. Two key locations were considered in detail: Western Hub (Eliwana Proposal) and the Nyidinghu Proposal (located south of Fortescue's Chichester Hub).

Fortescue selected the Eliwana Proposal to be progressed ahead of the Nyidinghu Proposal at this time; however, it is likely that the Nyidinghu Proposal will be further progressed in the coming years as an additional operation supporting Fortescue's strategic production targets and product strategy.

Vehicular Access Options

Existing access to the Eliwana area for exploration activities is via Tom Price, using a combination of public and private roads (Figure 1). Fortescue will use a combination of existing access options until permanent access is established via the Eliwana Railway Proposal.

Alternative access proposals previously considered for access included a new, approximately 130 km road from the west, connecting the MDE to the North West Coastal Highway. Fortescue is also investigating a short diversion around the Brockman 4 Mine.

Power Options

Fortescue is currently considering four options for power supply. Each of the options considered has the capacity to meet this demand and are able to be easily expanded to meet any future increase in demand.

1. Construction of a new 132 kilovolt (kV) overhead transmission line to connect the Eliwana mine site to Fortescue's existing Solomon power station. The approximately 135 km line length will be mostly contained within the Eliwana Railway disturbance footprint. This is Fortescue's preferred option for power supply.
2. Construction of a new gas fired power station at Eliwana with a nominal capacity of 25 Mega Watt (MW) and a new buried gas pipeline to connect the power station to the Fortescue River Gas Pipeline at Solomon. The gas pipeline length is approximately 145 km and may utilise the rail corridor.
3. Construction of a new gas fired power station at Eliwana with a nominal capacity of 25 MW and a new buried gas pipeline to connect the power station to the Goldfields Gas Pipeline west of Eliwana. The pipeline length is approximately 85 km.
4. Construction of a new diesel fired power station at Eliwana with a nominal capacity of 25 MW that would rely on diesel deliveries through the diesel supply chain methods needed for the mining operations.

No Development Option

In a no-development scenario, there would be no potential environmental impacts associated with the Proposal. However, there would also be a loss of social and economic benefit at a local, regional and state level, such as:

- New infrastructure for the Pilbara, including roads, power transmission and potable water supply.
- A lack of employment and training opportunities for remote and isolated communities
- Missed opportunity for landscape scale biodiversity conservation and management

2.3 Proposal Description

The Eliwana Iron Ore Mine will mine iron ore via traditional mining methods. Commercial grade iron ore is extracted from mine pits, transported to an ore processing plant before being loaded onto trains for export. The following description provides further detail for each stage of the process.

Pre-stripping

Pre-stripping is required to remove vegetation, topsoil and overburden (rock waste) prior to the commencement of mining activities. Vegetation and topsoil are generally stripped and stored

separately, and the material removed is either transported to areas of active rehabilitation or stockpiled separately for future use.

Mine Dewatering

Mine dewatering will be required where mine pits intersect groundwater. Mine dewatering will not be required for all proposed pits. Mine dewatering uses a series of abstraction bores situated either within, or in close proximity, to the pit to gradually lower the groundwater table in the local area.

Drill and Blast

Drilling and blasting is used to allow areas of hard rock to be removed. Drilling and blasting will be undertaken, generally incorporating the following steps:

1. A series of holes are drilled into the rock.
2. The holes are filled with explosives and detonated.
3. The rock breaks up or collapses after detonation and the rock rubble is then removed.
4. The cleared rock face is ready for drilling and the steps are repeated.

Mining

Mining will continue to employ conventional open pit methods of drill and blast followed by load and haul, similar to the methods employed at Fortescue's Solomon Operations and at other open cut mines in the Pilbara. Material will be drilled and blasted for ore and waste, and then mined by excavators into haul trucks.

Mine sequencing will be dependent on a number of variables including grade, mining costs and product demand from customers and will change over the life of the Proposal. A number of mine pits will be actively mined at any given time.

Remote Crushing

Remote crushing is currently being considered and may be undertaken at a number of locations within the MDE. A remote crushing facility allows for the primary sizing of mined material in preparation for processing in the Ore Processing Facility (OPF). Remote crushing infrastructure generally consists of:

- ROM bin
- mineral sizer
- gyratory crusher
- crushed ore vault.

- Overland conveyor (and associated infrastructure e.g. substations, transfer points)

Once material has been crushed, it would be transported by truck or conveyor.

Transport to Run of Mine (ROM) Pad

Transport from active mining areas to the ROM will be undertaken by a fleet of haul trucks. Options are currently under consideration for the full or partial use of autonomous trucks and overland conveyors.

2.3.1 Waste Rock Management

Geological waste rock will be used on site for earthworks purposes, where possible. Excess waste rock will be stored in waste dumps, which may be either permanent or temporary. The process for designing and constructing permanent waste dumps is addressed within the *Eliwana Mine Closure Plan EW-PL-EN-0001* (Appendix 2)

The selection of sites for waste rock dumps will be based on a range of considerations. These considerations include finding suitable geological and topographic settings, obtaining the desired capacity with minimum earthworks, proximity to proposed mining areas, productivity of the mining equipment, consideration of the expected waste rock characteristics including erosion and acid and/or metalliferous drainage (AMD) potential, proximity to sensitive environmental receptors including surface water and proximity to sites of heritage value.

The waste dumps will be designed to be suitably stable, in consideration of industry accepted geotechnical design scenarios and stakeholder agreed acceptable erosion rates, and where possible, reflect the natural topography. Where waste rock with the potential to generate AMD is identified, the deleterious waste rock will be encapsulated within 10m or more of benign waste rock, to minimise oxidation and to ensure the material is not exposed to the surface post-closure. Details on the geochemical nature of the waste rock is provide in Section 2.4.2.

As part of the normal mine planning process, Fortescue will construct each waste rock dump to ensure the appropriate placement of waste materials to ensure the ability to achieve the closure landform design objective is not compromised.

2.3.2 Low Grade Ore Stockpiles

Low grade stockpiles will be used to temporarily or permanently store material that does not meet current product strategy specifications. This material may be used if product strategies change over time or as a source of lower grade material for blending with high grade ore. These stockpiles will be designed in accordance with waste rock landform designs and parameters as per Section 2.3.1.

2.3.3 Ore Processing

Ore extracted during mining requires some processing to ensure that the final product meets customer demands with regards to iron content and impurities. This section briefly discusses the proposed processing of extracted, crushed ore.

Primary Crushing

Ore material delivered to the ROM pad will be stored in nominated ROM dump pads adjacent to a permanent ROM wall for primary crushing. Ore will pass through a primary crusher, resulting in a product stream of coarse ore less than 250 mm in diameter to be delivered to the OPF.

Conveyor to OPF

Following primary crushing, coarse ore will be transported from the ROM pad to the OPF via an overland conveyor. The overland conveyor is a rubber belt which operates over a distance of approximately 4 km. The overland conveyor discharges to a wider, 800 m long belt transfer conveyor via a transfer station and transfer chute. The transfer conveyor delivers coarse ore to the screening building in the OPF.

Ore Processing Facility

The OPF consists of two plant areas - screening and crushing. The coarse ore feed to the screening plant is received from the transfer conveyor via a conveyor shuttle into the scalping screen bins.

Vibrating screens separate ore by size. Oversized ore is recycled back to crushing until all ore meets the required particle size (<10 mm).

The current plan is for the OPF to operate as a dry plant. If necessary, additional modules can be added to allow for wet processing.

Stockyard

Processed product will be stored in a stockyard area prior to train load out. The stockyard design currently incorporates four linear stockpiles, each with a length of approximately 600m. A linear stacker will discharge to the stockpiles and ore will be collected using a bucket wheel reclaimer. The reclaimer will discharge ore to a reclaim conveyor belt, from which ore will be transported to the train load out via a load out conveyor. The load out conveyor will include a direct load option from the OPF so that product can be transferred directly between the OPF and the train load out (bypassing the stockyard). Other design options may be considered prior to construction.

Train Load-Out

Ore received from the stockyard is loaded into individual ore cars.

2.3.4 Tailings Management

Processing of iron ore may produce a waste stream of fine iron oxides, otherwise known as tailings. As a result of their fine particle size, tailings are stored in a Tailings Storage Facility (TSF) to ensure they are not released to the environment.

The ore processing facility will operate as a dry plant for the first few years of operation. During this time, not wet tailings are expected to be produced. Ore processing will include a wet process either as a result of product requirements or the commencement of below water table mining and this will produce a wet tailings stream. Indicative tailings production parameters are provided in Table 5 below.

Table 5: Tailings Properties

Aspect	Unit	Value
Tailings Production	Mtpa	3.53
Stored Dry Density	t/m^3	1.5
Total Tailings Tonnage	Mt	85
Required Storage Volume	Mm^3	57

Tailings storage options may include the following:

- in-pit tailings storage (either below or above the water table)
- external tailings storage.

Typically, external Tailings Storage Facilities (TSF) will be developed using a valley fill approach with a constructed embankment across the selected valley. Tailings will be deposited from a series of spigots along the TSF embankment, progressively filling up the valley slope. A number of potential TSF locations have been considered and a final location selected in a valley in close proximity to the processing plant.

Tailings produced from processing of iron ore are generally benign. As part of a broader subsurface materials characterisation study undertaken for the Proposal, a small number of indicative tailings samples were assessed for acid, saline and metalliferous drainage potential. These details are provided in Section 4.6 (Inland Waters Environmental Quality).

2.3.5 Services and Utilities

All operating mines require a host of service and utility infrastructure logistical support of mining. This section provides a brief overview of these requirements.

Accommodation

Two accommodation villages are required; a construction camp to house the workforce during construction and a permanent accommodation village to house operational staff. Typically, the construction village is larger than the permanent village as a larger workforce is required during construction compared to operations. Fortescue will investigate whether both accommodation villages can be combined prior to construction.

Wastewater Management

One wastewater treatment plant currently operates at Eliwana to service the existing exploration camp (Registration R2451/2017/1). Additional wastewater treatment plants will be developed to service the two accommodation camps. Treated effluent will either be reused for dust suppression purposes or disposed of by irrigation.

Small wastewater treatment facilities, such as biomax units will also be used for crib huts, workshops and office areas around the site. Effluent from these small units will be disposed into leach drains or transported to the licenced facilities for treatment.

Airport

An airport is proposed to be developed to allow the construction and operation workforce to travel to and from site. The airport will be located approximately 6 km north of the mining area and 8 km from the permanent accommodation village.

Buildings and Laydown Areas

The majority of the buildings, offices, washdown areas and workshops on site will be located either adjacent to the OPF or close to the ROM pad. Additional laydown areas, storage areas, heavy vehicle parking areas and contractor office areas will be located throughout the site, generally adjacent to active pit and work areas.

Fuel Storage and Re-fuelling

Bulk fuel storage will be required. Additional satellite fuel storage areas will be located across the site, generally in close proximity to major work areas and mine pits.

Explosives Storage

Explosive materials will be stored at the Ammonium Nitrate Facility. The Ammonium Nitrate Facility stores ammonium nitrate and diesel fuel, high explosives and detonators are stored in the vicinity with required separation distances to ensure safe storage.

Waste Management

Solid waste will be generated during construction and operational phases from clearing of native vegetation, disposal of chemical storage containers, plastic, paper, wood, scrap metal, tyres, rubber, batteries and domestic solid (including putrescibles) wastes.

Waste will be predominately disposed of in an onsite landfill facility and a bioremediation facility will be developed to manage hydrocarbon-contaminated soils onsite.

Used tyres will be buried on site, buried in completed pit voids or incorporated into waste rock dump landforms.

Roads

Roads within the Proposal area will likely include some segregated light and heavy vehicle roads and some combined-use roads. Roads will be unsealed with water trucks used for dust suppression.

Communications

A number of communication towers supporting radio, telephone and internet, will be installed at various locations across the site according to operational requirements. In-ground fibre will also be installed.

2.3.6 Workforce

Construction of the proposal will require a construction workforce of approximately 1100 people. As a result of the remote location of the site, personnel arrive at site via the proposed airport.

Operation of the proposal will require a permanent workforce of approximately 650 people.

2.3.7 Access

Access to the MDE will be via the Mount Brockman Road. Access from Tom Price would use Bingarn Road, Nanutarra Road, Hamersley Road, Mt Brockman Road and the proposed Mine Access Road (Figure 1).

2.3.8 Resource Requirements

Water Supply

Up to 12 GL/a of potable and process water will be required for the operation of the Proposal. Water will be supplied from a combination of mine dewatering and water supply borefields.

Power Supply

The electricity demand for the Proposal is estimated to reach a maximum of 20 Mega Watts (MW) with an annual average consumption of 122,640 mega Watt-hours (MWh) per annum.

2.3.9 Timing

Fortescue's overarching strategy for the Proposal is to achieve first ore on train by mid-2020. Pending receipt of all necessary approvals, construction of the Proposal is planned to commence in mid-2019.

2.4 Local and Regional Context

The Proposal is located 90 km west-north-west of Tom Price, in the Pilbara region of Western Australia. The Proposal's local and regional context is described in more detail below.

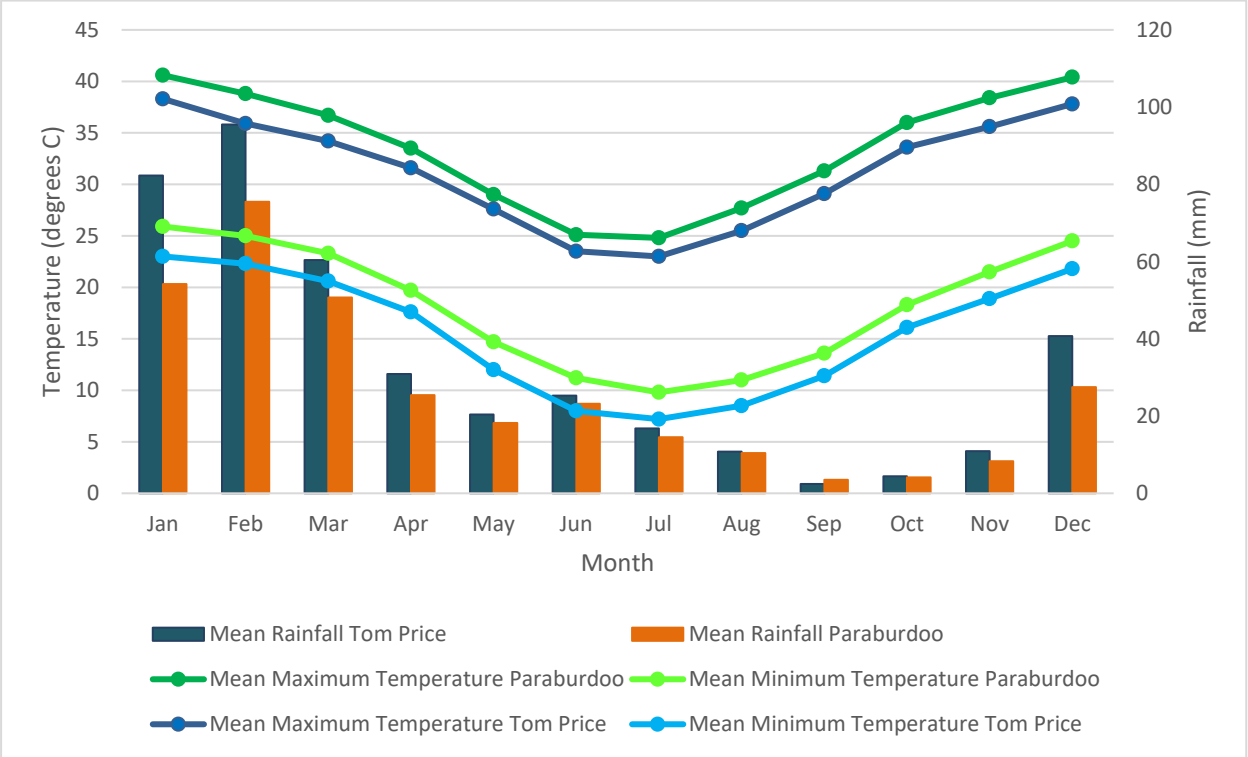
2.4.1 Climate

The Proposal is located within the Pilbara region, which includes two broad climatic zones. Coastal areas, as well as some higher rainfall inland areas, have a semi-desert tropical climate, which experience between 9 and 11 months of dry weather, with hot humid summers and warm winters. The remaining inland areas have a dry desert climate, typically with higher temperatures and lower rainfall, and often experience up to 12 months of dry weather, with hot dry summers and mild winters (van Vreeswyk, et al., 2004). The Proposal is situated within the drier inland area.

The monthly rainfall and temperature averages for the Tom Price (BoM, 2017a) and Paraburdoo (BoM, 2017b) Bureau of Meteorology (BoM) stations, located 60 km east and 80 km south-east of the Proposal area, respectively are shown in Graph 1.

Monthly maximum temperatures range from an average of 23°C in July to 41°C in January, whereas minimum temperatures range between 7°C in July and 26°C in January (BoM 2017a; 2017b).

Annual rainfall in the Pilbara has a substantial yearly variation. Tropical cyclones, many of which originate in the Timor Sea, along with local thunderstorms, produce much of the summer and early autumn rainfall. The driest months are in spring (September to October), and the wettest in summer (January to March) (BoM 2017a; 2017b).



Graph 1: Climate Averages (Tom Price and Paraburdoo)

2.4.2 Physical Environment

Regional Geology

A detailed description of the regional geology of the Pilbara region has previously been reported by van Vreeswyk et al., (2004). The Proposal area occurs within the Hamersley Province which covers an approximate area of 80,000 km^2. The Hamersley Province contains late Archaean to Lower Proterozoic age sediments of the Mount Bruce Supergroup. This Supergroup contains the Fortescue, Hamersley and Turee Creek Groups, which are overlain by remnants of the Wyloo Group (Figure 3).

The Fortescue Group is a sequence of basalts, inter-bedded clastic sediment, minor chemical sediment and doleritic intrusions. This Group contains the following Formations: the Mount Roe Basalt, the Hardey Formation, the Kylena, Boongal, Tumbiana and Maddina Formations, and the Jeerinah Formation.

The Hamersley Group overlies the Fortescue Group, and is approximately 2,500 m thick containing a sequence of banded iron formations (BIF) dolomites, pyroclastic/hemipelagic shale, and acid volcanics.

Local Geology

The iron ore deposits within the Proposal area are principally of a bedded iron ore deposit (BID) type, found within enriched units of the Brockman and Marra Mamba Iron Formations of the Hamersley Group. The Proposal is situated in a valley trending generally east-west up to 2 km in width and bound by hills having relative relief of 50 to 150 metres from the valley floor (Figure 3).

The geomorphology of the valley is a consequence of the erosional characteristics of these units, with the more resistant Brockman Iron Formation to the south forming high, steep ridges and the Marra Mamba Iron Formation forming lower rounded hills along the northern flank of the valley. The less resistant bedrock of the Wittenoom, Mt McRae and Mt Sylvia Formations have been weathered and eroded to a greater extent. The resulting valley has subsequently been infilled with Tertiary and Quaternary sediments of various origins, including BIF derived colluvium/alluvium, clay and carbonate precipitates (calcrete).

Both the Brockman and the Marra Mamba Iron Formations will be a focus for iron ore mining for the Proposal. Current potential mining inventory is significant for the region, totalling over 1 Billion tonnes of Mineral Resource between the Eliwana and Flying Fish deposits (ASX release 18 August 2017).

2.4.3 Bioregions

The Proposal area lies in the Pilbara biogeographic region of the Interim Biogeographic Regionalisation for Australia (IBRA). The Pilbara biogeographic region incorporates 17,928,700 ha and includes four subregions: Chichester, Roebourne, Hamersley, and Fortescue Plains.

The Proposal is located within the Hamersley subregion of the Pilbara bioregion (Figure 4). The Interim Biogeographic Regionalisation of Australia (IBRA) bioregions are defined as large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. Their purpose is to capture the large-scale geophysical patterns that occur across the Australian continent (Thackway & Creswell, 1995). These patterns influence fauna assemblages at the broad scale.

460,000 480,000 500,000 520,000

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

A4 - -Pp

Mount Brockman Rd

Silvergrass

A3b

Eliwana

-Ppn

A4f

-Ppn

-Ppv

A4 - -Pp

A4 - -Pp

A4f

A4f

A4 - -Pp

White Quartz Rd

Brockman 4

460,000 480,000 500,000 520,000

Fortescue Projects
Rio Tinto Mines
Access Routes
Rio Tinto Rail

Mine Development Envelope
Indicative Mine Footprint

-Ppn, sedimentary rocks
-Ppv, sedimentary rocks
A3b, mafic volcanics
A4 - -Pp, sedimentary rocks
A4f, felsic volcanics

Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

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Kilometres

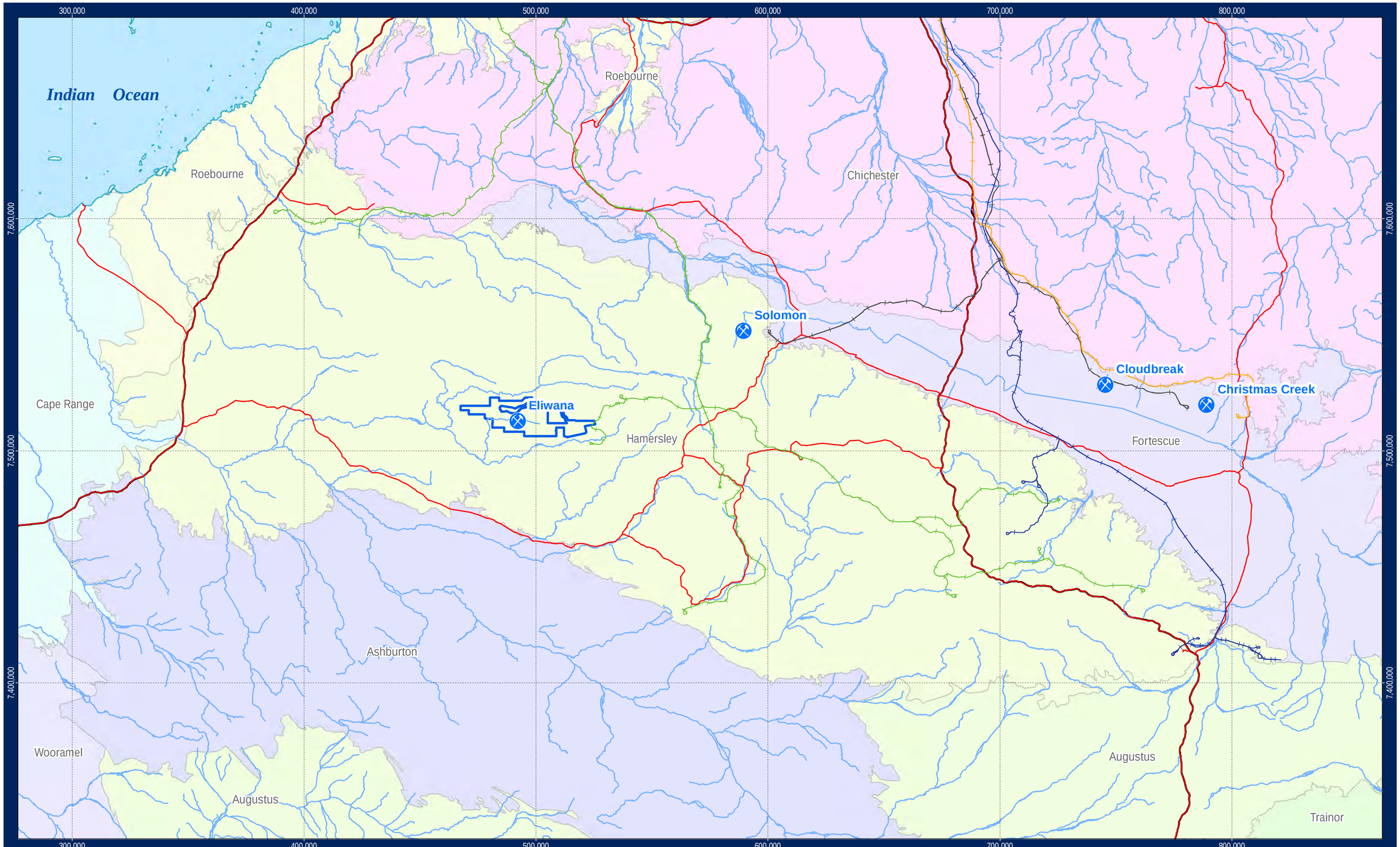
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Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:200,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.006_r2

Date: 20-Aug-18
Size: A3L
Revision: 0
Confidentiality: 1

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Figure 3
Geology of the Proposal Area

Fortescue Metals Group Ltd
The New Force in Iron Ore



LEGEND

- Fortescue Projects
- Mine Development Envelope
- Major Drainage
- FMG Rail
- BHPB Rail
- Rio Tinto Rail
- Roy Hill Rail

IBRA Subregions

- Ashburton
- Augustus
- Cape Range
- Chichester
- Fortescue
- Hamersley
- Roebourne
- Trainor
- Wooramel

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

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Kilometres

Requested By: R. Sharp
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
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Confidentiality: 1

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Figure 4
IBRA Subregions of the Proposal Area

Fortescue Metals Group Ltd
The New Force in Iron Ore

The Hamersley sub-bioregion, described by Kendrick (2002), consists of a mountainous area of Proterozoic sedimentary ranges and plateaus dissected by gorges. The vegetation consists of Mulga low woodland over bunch grasses on valley floors with *Eucalyptus leucophloia* over Triodia on skeletal soils of ranges. The climate is semi-desert tropical, averaging 300 mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon. Surface drainage flows into either the Fortescue River to the north, the Ashburton River to the south or the Robe River to the west. Environmental features of conservation value in the sub-bioregion include the gorges of the Hamersley Range (particularly in Karijini National Park), Palm Spring and Duck Creek, the Themeda grasslands of the Pilbara, and isolated areas of mulga on Red Hill Station. Land use in the region is dominated by pastoral grazing and mining. The areal extent of the Hamersley sub-bioregion is 6,215,092 ha.

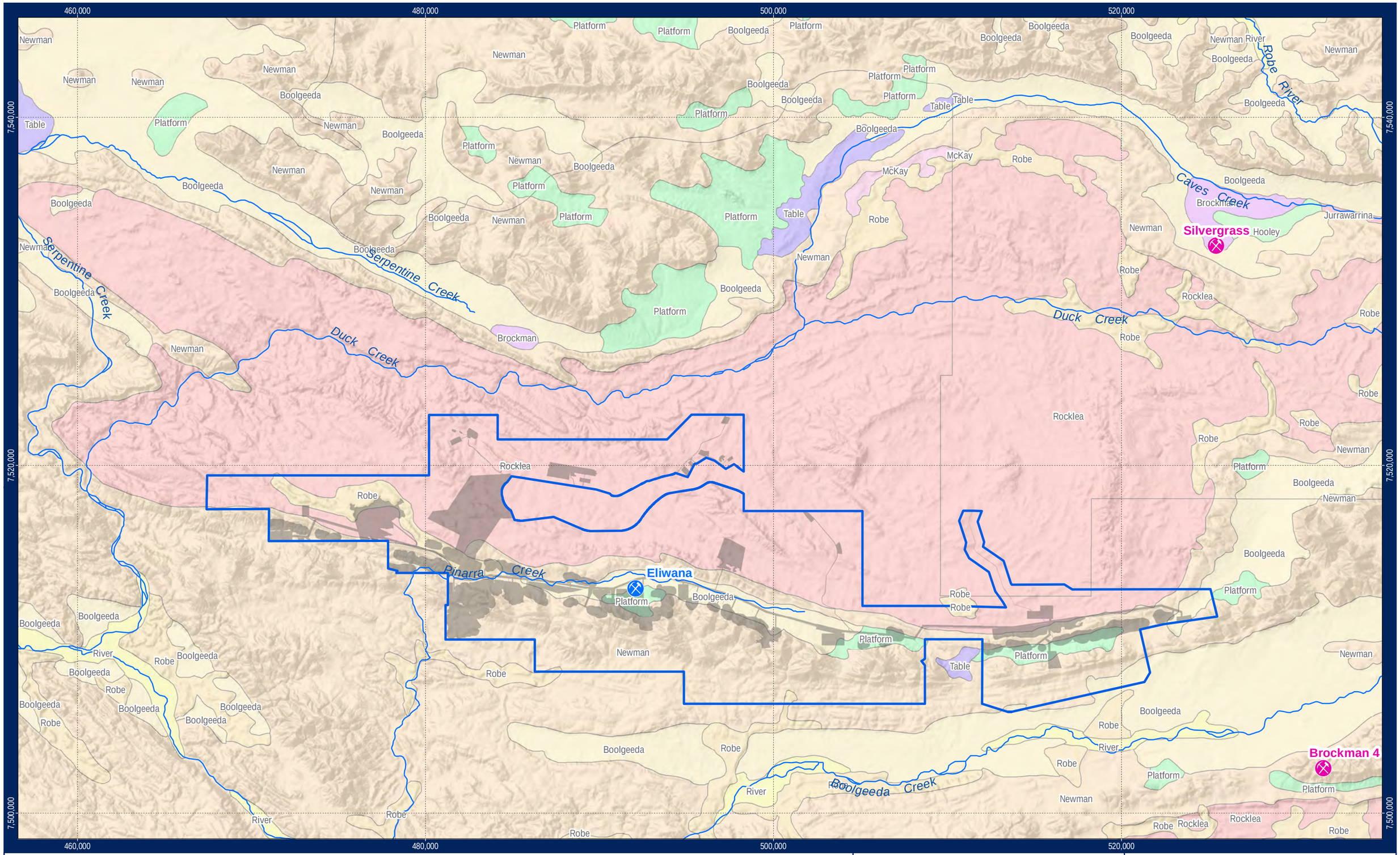
2.4.4 Land Systems

The Department of Agriculture and Food, as part of its rangeland resource surveys, has comprehensively described and mapped the biophysical resources of the Pilbara region (van Vreeswyk, et al., 2004). As part of this process an inventory of land system units, the Pilbara Regional Inventory (PRI) was established based on landform, soil, vegetation, drainage characteristics and condition. According to the PRI mapping, five land systems occur within the MDE. The Newman land system makes up the majority of the Proposal area, followed by the Rocklea land system, with smaller representation of the remaining land systems. These extents are described in Table 6 and illustrated in Figure 5.

Table 6: Land Systems of the Proposal Area

Land System	Description	Extent within MDE (ha)	Mapped Extent (ha)
Boolgeeda System	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	3,060	774,800
Newman System	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	17,579	1,458,000
Platform System	Dissected slopes and raised plains supporting shrubby hard spinifex grasslands.	1,549	157,000
Robe System	Low plateaux, mesas and buttes of limonite supporting soft spinifex and occasionally hard spinifex grasslands.	1,595	86,500
Rocklea System	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.	19,713	2,299,300

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Fortescue Projects
Rio Tinto Mines
Mine Development Envelope
Indicative Mine Footprint

Land Systems

- Boolgeeda System
- Brockman System
- Hooley System
- Jurrawarrina System
- McKay System
- Newman System
- Platform System
- River System
- Robe System
- Rocklea System
- Table System

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: R. Sharp
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Figure 5
Land Systems of the Proposal Area

Fortescue Metals Group Ltd
The New Force in Iron Ore

2.4.5 Soils

The PRI incorporates a regional soil characterisation based on land system delineation (van Vreeswyk, et al., 2004). The majority of the land systems present in the MDE are associated with the 'stony soil' Western Australia Soil Group. The Boolgeeda Land System is the exception to this, and is associated with the red/brown non-cracking clay and red shallow loam Western Australia Soil Groups

The stony soil group is predominantly associated with the Marra Mamba Iron and Brockman Iron Formations in the surrounding hills and ridges, which will be a focus of mining operations at Eliwana. In contrast, the red/brown non-cracking clay and red shallow loam soils of the Boolgeeda Land System were largely associated with the Wittenoom Formation, and are primarily found in younger quaternary alluvium deposited in the valley floor.

A soil characterisation study undertaken for the Proposal has identified two main soil groups that could be managed during future mining operations; these being soils in the Boolgeeda and Platform Land Systems (Group 1), and soils in the Newman, Rocklea and Robe Land Systems (Group 2) (SoilWater, 2017). The absence of differentiating features between the two soil classes and similarity in vegetation communities supported by the soil classes suggests there is limited benefit to storing recovered topsoil in separate stockpiles. Similarly, there was no notable differentiation in soil profile characteristics that would warrant specialised reconstruction of a soil profile during rehabilitation to support revegetation performance. The skeletal soil that dominates the area is expected to be very difficult to recover from the ridgelines, due to the rugged terrain.

2.4.6 Conservation Reserves

The nearest conservation reserve (including former pastoral leasehold land proposed for conservation) is Karijini National Park. Karijini National Park is located approximately 67 km east of the eastern extent of the MDE. Other conservation estate in the regional area is listed below:

- Millstream Chichester National Park (71 km north of the MDE)
- Unallocated crown land; ex Mt Florance Station (82 km east of MDE)
- Cane River Conservation Park (87 km south of the MDE)
- Barlee Range Nature Reserve (92 km south-west of the MDE)
- Unallocated crown land; ex Nanutarra Station (94 km north-west of MDE)
- Unallocated crown land; ex Wanna Station (96 km north-west of MDE).

2.4.7 RAMSAR Wetlands

The nearest RAMSAR wetland is located at Eighty Mile Beach, approximately 380 km north-east of the MDE.

2.4.8 Other Developments

A number of existing iron ore mining operations are located in relative close proximity to the Proposal. These include the following mines, located within 50 km of the Proposal, which are all owned and operated by Rio Tinto Iron Ore (Figure ES2):

- Silvergrass
- Nammuldi
- Brockman 4
- Western Turner Syncline.

3. STAKEHOLDER ENGAGEMENT

Stakeholder consultation for the Proposal has formed part of the broader stakeholder engagement programme for Fortescue projects undergoing environmental approvals. The overarching objectives of the program are:

- To inform stakeholders about the Project and its impacts to the environment and to describe the outcomes of consultation on project design; and
- To establish relationships with key stakeholders that enable ongoing dialogue though implementation and regulation of the Proposal.

3.1 Key Stakeholders

Key stakeholders have been identified through Fortescue's experience in the Pilbara. Fortescue has also adopted previous recommendations from State government agencies on stakeholders that should be included in the program. Key stakeholders identified to date are listed in Table 7.

Table 7: Key Stakeholders for the Proposal

Government Agencies	Community and Surrounding Land Users	Pastoral and Mining Companies
Department of the Environment and Energy (DoEE)	Pilbara Development Commission	Rio Tinto Iron Ore (RTIO)
Department of Water and Environmental Regulation (DWER)	Tom Price Community	BHP Billiton Iron Ore P/L (BHPB)
Department of Mines, Industry Regulation and Safety (DMIRS)	Eastern Guruma People (Wintawari Guruma)	Mt Stuart Pastoral Station
Department of Jobs, Tourism, Science and Innovation (DJTSI)	Puutu Kunti Kurrama Pinikura People (PKKP)	Rocklea Pastoral Station
Shire of Ashburton	Conservation Council of WA	Hamersley Pastoral Station
Department of Biodiversity, Conservation and Attractions (DBCA)	Wildflower Society of WA	Cheela Plains Pastoral Station
Department of Planning, Lands and Heritage (DPLH)	Wilderness Society of WA	

3.2 Stakeholder Engagement Process

Fortescue commenced consultation for the proposal in early 2017 by a combination of face to face meetings, presentations and letters to key community stakeholders.

Consultation undertaken to date has provided Fortescue with the opportunity to discuss the Proposal with stakeholders and gain valuable feedback. This feedback was considered during the development of the Proposal.

In order to undertake effective consultation, a consultation program was developed specifically for this Proposal. The objectives of the consultation program included the following:

- to identify and engage key stakeholders
- to identify and verify areas of stakeholder feedback for social and environmental values
- to establish a robust consultation approach and demonstrate that appropriate consultation has been undertaken
- to assess stakeholder issues/concerns so that proposed impacts are minimised to as low as reasonably practicable.

Key consultation activities included the following:

- correspondence to potentially impacted parties providing information on the Proposal, requesting feedback and offering detailed briefings
- meetings with decision making authorities to discuss and obtain feedback on the Proposal
- one-on-one briefings and feedback sessions with specific stakeholders.

Integrated engagement ensured efficient use of stakeholders' available time and resources by avoiding multiple briefings for multiple projects.

3.3 Stakeholder Consultation

The consultation activities undertaken to date and the feedback received are summarised in Table 8.

Table 8: Record of Stakeholder Consultation

Stakeholder	Date	Feedback	Outcome of Consultation
Puutu Kunti Kurrama Pinikura People (PKKP)	23 March 2017 (Working Group Meeting)	Flora and Fauna survey update. Environmental approval process.	Commitment for ongoing consultation through the Working Group Meeting process as the project progresses.
Department of Environment and Energy	19 May 2017	Presentation on Proposal noted	
Eastern Guruma People	28 August 2017 (Working Group Meeting)	Proposal overview and detailed response to comments raised regarding Eliwana Rail Proposal.	
Department of Water and Environmental	22 September 2017	Environmental Scoping Document (ESD) briefing.	EPA Services will send draft scoping document to DMAs for comment.

Stakeholder	Date	Feedback	Outcome of Consultation
Regulation (DWER) - EPA Services			
Puutu Kunti Kurrama Pinikura People (PKKP)	10 October 2017 (Working Group Meeting)	Eliwana Proposal split into Mine and Rail – separate referrals to EPA and DoEE. Survey work update. Discussed Social Surroundings factor.	Fortescue to send letter Formally introducing Proposal and inviting consultation or comment.
Department of Water and Environmental Regulation (DWER) – EPA Services, RSW and RSE	2 November 2017 (Meeting)	Proposal overview and ESD briefing.	DWER requested that any scope to minimise the MDE should be investigated. Proposal changes subject to s43 process.
Department of Biodiversity, Conservation and Attractions (DBCA)	9 November 2017 (Meeting)	Fortescue provided Proposal briefing – ESD DBCA topics: • Consultation with Stakeholders • New species of Triodia • TECPEC • Water supply options • GDE • Caves present.	Fortescue is undertaking ongoing consultation with Stakeholders. The new species of Triodia will be assessed as a part of the Flora and Vegetation factor. Water supply options and GDEs will be assessed as a part of the Flora and Vegetation factor. Fortescue has undertaken a detailed bat survey which will be discussed as a part of Terrestrial Fauna factor.
Department of Jobs, tourism, Science and Innovation (DJTSI)	9 December 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date
Department of Planning, Lands and Heritage (DPLH)	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date
Shire of Ashburton	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Conservation Council of WA	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Wildflower Society of WA	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Pilbara Development Commission	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Mt Stuart Pastoral Station	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Cheela Plains Pastoral Station	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.

Stakeholder	Date	Feedback	Outcome of Consultation
Department of Planning, Lands and Heritage (DPLH)	9 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	Request for Proponent to consult with Native Title groups.
Department of Mines, Industry Regulation and Safety (DMIRS)	14 November 2017 (Meeting)	Proposal overview and ESD briefing.	DMIRS have provided comments on ESD directly to DWER.
Department of Water and Environmental Regulation (DWER) - EPA Services	17 November 2017	EPBC Act decision on referral – Accredited assessment. ESD – DMA comments Minor and preliminary works proposal.	Accredited assessment has been proposed ESD to be presented at December Board meeting. Fortescue to provide attendees and presentation in advance of EPA Board Meeting 14 December.
Puutu Kunti Kurrama Pinikura People (PKKP)	22 November 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation regarding the Social Surrounding factor.	No response provided to date.
Department of Mines, Industry Regulation and Safety (DMIRS)	30 November 2017	Discussion on mine access options, Proposal update.	-
Wilderness Society of WA	9 December 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Rocklea Pastoral Station	9 December 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Hamersley Pastoral Station	9 December 2017 (Letter)	Letter sent to provide an update on the Proposal and invitation for further consultation.	No response provided to date.
Department of Water and Environmental Regulation (DWER) and EPA	14 December 2017	EPA Board Meeting – ESD.	ESD approved
Puutu Kunti Kurrama Pinikura People (PKKP)	3 March 2018	Western Hub Project update given, Heritage issues r/t Western Hub discussed, including s.18. Additional on-country consultation offered	NA
Eastern Guruma People	6 March 2018	Environmental Data provided to WGAC	NA
Puutu Kunti Kurrama Pinikura People (PKKP)	3 April 2018	Eliwana Mine and Rail Project overview given. Locations and alignments presented. Social Surroudings – proposed site visit discussed. FMG emphasis on continued engagement and discussion with PKKP throughout	Site visit arranged for late May

Stakeholder	Date	Feedback	Outcome of Consultation
		project development process and operation phase	
Puutu Kunti Kurrama Pinikura People (PKKP)	18 April 2018	Phone call advising that MPW application has been made public	NA
Puutu Kunti Kurrama Pinikura People (PKKP)	26-27 May 2018	Eliwana Site Visit undertaken with PKKP working group representatives 26-27 May. Ethnobotanist also present	Two parties to continue to work together to reach mutually agreed objectives for protection of heritage and cultural values.
Eastern Guruma People	31 May 2018	Letter providing WGAC with environmental survey reports	NA
Puutu Kunti Kurrama Pinikura People (PKKP)	15 August 2018	Presentation to Land Council on Final Eliwana Mine and Rail ERD.	PKKP to review documents as they become public.

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4. ENVIRONMENTAL PRINCIPLES AND FACTORS

This section identifies the environmental factors relevant to the Proposal and outlines the overall assessment methodology presented in this document. A summary of Fortescue's Environmental Management System is provided along with the detailed environmental impact assessment of each preliminary key environmental factor.

As part of the EPA's decision on referral, seven preliminary key environmental factors relevant to the Proposal were identified:

- hydrological processes
- inland waters environmental quality
- flora and vegetation
- terrestrial fauna
- subterranean fauna
- social surroundings
- air quality.

Matters of National Environmental Significance will also be assessed to satisfy the requirements of the EPBC Act. These preliminary key environmental factors associated with the Proposal are addressed in this environmental assessment document in the following format:

- statement of EPA objective
- discussion of relevant policy and guidance, and summary of how this guidance has been addressed
- description of the receiving environment relevant to the factor
- definition of potential direct, indirect and cumulative impacts on the environmental values for this factor
- assessment of the extent and significance of impacts to the environmental values for this factor
- description of mitigation, including application of the mitigation hierarchy (avoid, minimise, rehabilitate)
- description of the predicted environmental outcome as assessed against the EPA objective for this factor.

4.1 Principles

Fortescue's consideration of the EP Act principles of environmental protection in relation to the Proposal is shown in Table 9.

Table 9: EP Act Principles

Principle	Consideration
1. 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.	Fortescue maintains an environmental management system (EMS) that addresses activities with a potential to affect the environment. A key element of the EMS includes assessing risk to identify potential impacts early in the process to enable planning for avoidance and/or mitigation. Fortescue has conducted scientific studies to understand the Proposal area and the potential risks to the environment. The proposal has sought to avoid, minimise and mitigate environmental impacts. The environmental risks associated with the Proposal have been assessed.
2. 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 Proposal meets the principle of intergenerational equity by ensuring the health of the environmental values, maintaining ecological functions for future generations, whilst minimising any impacts on the environment.
3. The Principle of the Conservation of Biological Diversity and Ecological Integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The conservation of biological diversity and ecological integrity was a fundamental consideration in the assessment of this proposal. Clearing has been avoided or minimised wherever possible and infrastructure sited away from ecologically significant areas, wherever possible.
4. 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. 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.	Fortescue acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when practicable. For example: • environmental factors have played a role in determining infrastructure locations. • procedures are in place to ensure that emissions and discharges are minimised as far as practicable. • the cost of rehabilitation and closure has been incorporated into the costs of the product from the commencement of operation.
5. The Principle of Waste Minimisation	Waste management is addressed in construction and operations management.

Principle	Consideration
All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Fortescue's approach to waste management, in order of priority is: • avoid and reduce at source • reuse and recycle • treat and/or dispose.

4.2 Environmental Management System

The mitigation and management measures detailed in this document will be implemented as part of the Proposal to ensure potential environmental impacts are minimised. These measures will be implemented via Fortescue's Environmental Management System (EMS) which is guided by Fortescue's Environmental Policy.

Fortescue's Environment Policy communicates the following:

- Fortescue is committed to the protection of the environment, including the prevention of pollution in the environment in which we operate, demonstrating a proud history of environmental engagement to minimise, mitigate and remediate the impacts of its operations.
- Fortescue strives to achieve effective and sustainable environmental outcomes through disciplined environmental management. This includes the consideration of innovative environmental management techniques in Proposal development, operations and rehabilitation.
- Fortescue will continually review and improve the environmental performance and processes of its business, ensuring that compliance with all relevant environmental laws and obligations is the minimum standard to which Fortescue operates and the minimum requirement against which environmental performance is measured.
- The protection of the environment is a cornerstone of Fortescue's success and sustainability. This success benefits not just Fortescue but its families, communities and future generations.

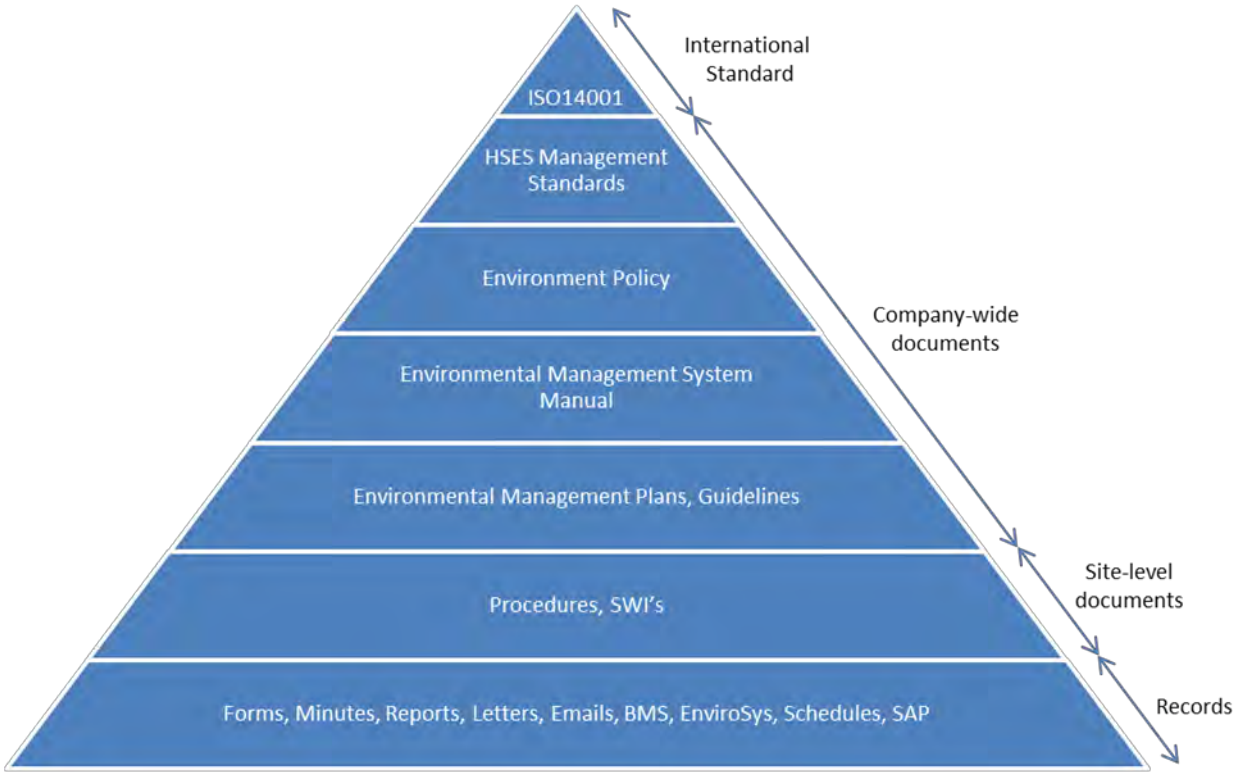
Fortescue's EMS is aligned with ISO 14001 – Environmental Management Systems – Requirements for guidance and use. Under Fortescue's EMS:

- Environmental risks are identified, analysed and evaluated, and controls established.
- Responsibility for meeting environmental objectives, targets and obligations, and the implementation of controls are clearly communicated.
- Regular checks are undertaken to determine whether environmental objectives, targets, obligations and controls are being met.

- Environmental performance is monitored and reviewed to ensure continuous improvement.

4.3 Environmental Management Plans

Management plans are a critical component of Fortescue's EMS. Their hierarchy within Fortescue's EMS is depicted in Schematic Map 1.



Schematic Map 1: EMS Document Hierarchy

The potential impacts of the Proposal and the proposed management measures and performance standards are detailed in Sections 4.5 – 4.11 and Section 5. Management measures are primarily based on the implementation existing management plans and procedures. Management plans that will be implemented to mitigate and manage the potential impacts are discussed for each environmental factor.

4.3.1 Environmental Monitoring

Environmental monitoring will be undertaken during the implementation of this Proposal as required by Fortescue's management plans and approvals. Fortescue's environmental management plans, guidelines and site-specific procedures will provide the specific details of monitoring requirements including the following:

- parameters to be monitored
- frequency and timing
- review and evaluation.

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4.4 Hydrological Processes

Hydrological Processes was identified as an environmental factor relevant to the Proposal in the Environmental Scoping Document (EPA, 2017). The following sections provide an environmental impact assessment for this factor.

Hydrological processes refer to the occurrence, distribution, connectivity, movement, and quantity of surface water and groundwater. Surface water and groundwater are valuable resources that sustain many ecological and social functions (EPA, 2016b). Modifications to hydrological processes can occur interruptions, bulk earthworks construction and mining activities. This chapter describes the surface water and groundwater systems which are potentially impacted by the Proposal and should be read in conjunction with the associated section on Inland Waters Environmental Quality (Section 4.5).

4.4.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for hydrological processes as follows:

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

4.4.2 Policy and Guidance

The following policy and guidance is relevant to this factor:

Instructions on how to prepare an Environmental Review Document (EPA, 2016a)

This guideline is relevant to all Environmental Factors and will only be discussed once in this document. This EPA guideline provides a template for the structure of the ERD and the minimum requirements for an ERD (including tables and figures). It also provides guidance for preparing each section of the ERD and details the spatial data requirements.

Statement of Environmental Principals, Factors and Objectives (EPA, 2016c)

This guideline is relevant to all Environmental Factors and will only be discussed once in this document. This guideline communicates how the EPA undertake the following, during their assessment process:

- considers the object and principles of the *Environmental Protection Act 1986*
- uses environmental factors and objectives to organise and systemise environmental impact assessment and reporting

- takes a holistic view of the environment and a proposal or scheme's potential impact on the environment
- considers significance when determining whether or not to assess a proposal or scheme and recommend whether or not an assessed proposal or scheme may be implemented.

Environmental Factor Guideline: Hydrological Processes (EPA, 2016b)

This guideline provides an outline of how hydrological processes are considered by the EPA in the EIA process. Relevant matters discussed in Guideline include the following:

- description of EIA considerations, including:
- application of the mitigation hierarchy
- the environmental values associated with hydrological processes affected by the proposal
- the potential impacts and the activities that will cause them
- analyses required
- the current state of knowledge of hydrological processes and the level of confidence underpinning the predicted residual impacts.
- describes issues commonly encountered by the EPA during EIA of this factor
- provides a summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

Fortescue has specifically considered this guidance in the following ways:

- surveys and analysis completed and describe the receiving environment and its significance;
- identified activities which may lead to impacts to hydrological processes; and
- applied the mitigation hierarchy in elements of project design

Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA, 2016a)

This instruction provides an outline for proponents as to how to prepare Environmental Management Plans required during an EPA assessment. This guidance will be utilised for the review and revision of the existing environmental management plans relevant to hydrological processes.

Western Australian Water in Mining Guideline (DoW, 2013a)

The *Western Australian Water in Mining Guideline* (DoW, 2013a) provides guidance to proponents on the *Rights in Water and Irrigation Act 1914* approval process and outlines objectives more management of water within mining operations.

Fortescue has specifically considered this guidance in the following ways:

- During consultation with Department of Water and Environment Regulation;
- Whilst undertaking water resource evaluation and assessment; and
- In preparation of this environmental review document.

Strategic Policy 2.09: Use of Mine Dewatering Surplus (DoW, 2013b)**.**

The *Strategic Policy 2.09: Use of Mine Dewatering Surplus* (DoW, 2013b) outlines the Department of Water and Environment Regulation's position in regard to the appropriate use of surplus mine dewatering. Fortescue has utilised this policy when considering options for management of surplus mine dewatering associated with the Proposal.

4.4.3 Studies and Surveys

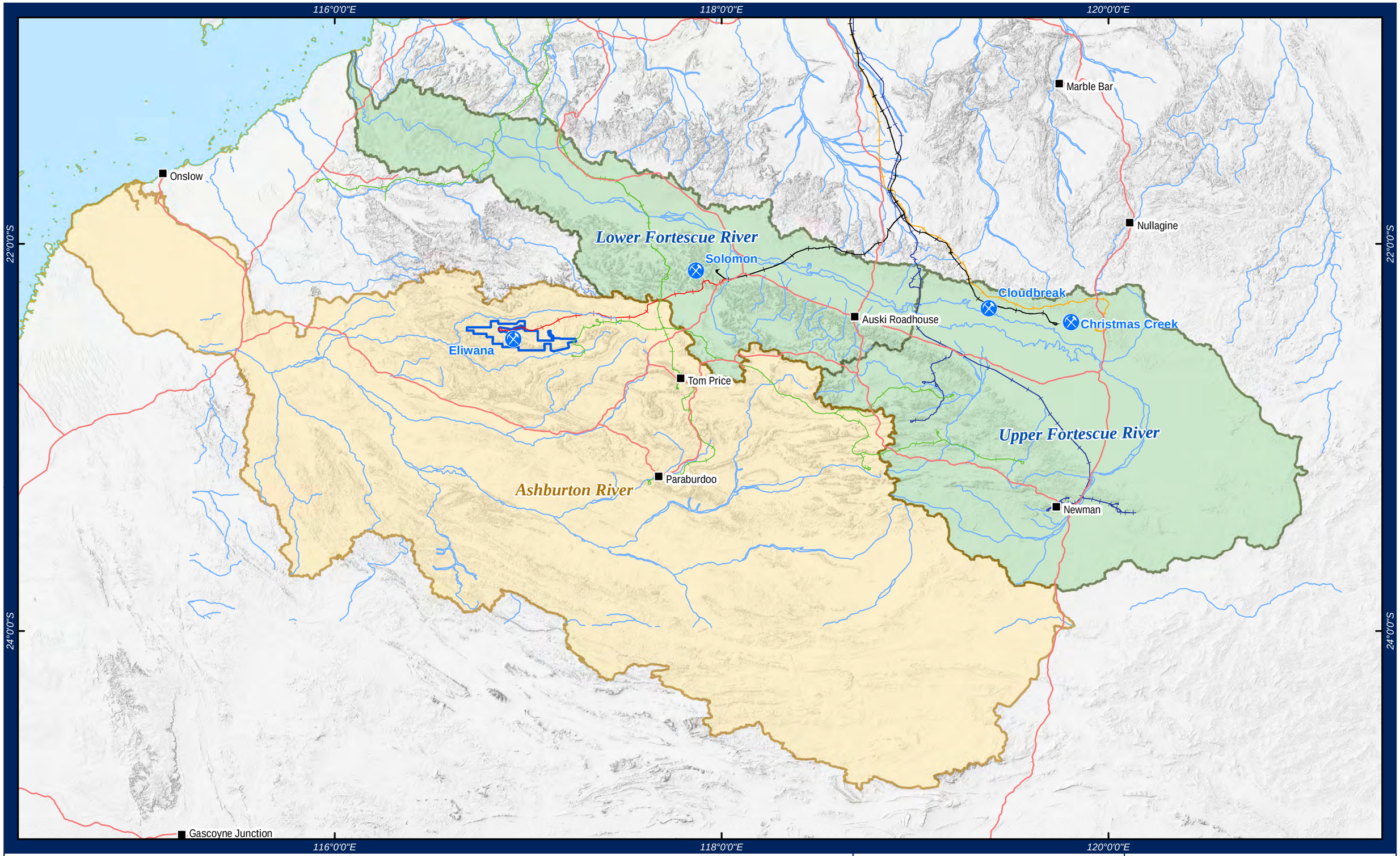
The following studies and surveys have been undertaken to understand hydrological processes at Eliwana and assess potential environmental impacts associated with developing the Proposal:

- Eliwana Mine Proposal – Surface Water Impact Assessment (Appendix 3)
- Baseline Geomorphology Assessment for Eliwana and Flying Fish Deposits Fortescue Western Hub (Tetra Tech, 2017a). (Appendix to Surface Water Impact Assessment)
- Baseline Geomorphology Assessment for Eliwana and Flying Fish Deposits Fortescue Western Hub: Potential Impacts Assessment (Tetra Tech, 2017b) (Appendix to Surface Water Impact Assessment).
- Hydrogeological Conceptual Model (Golder Associates, 2017a) (Appendix 4)
- Numerical Groundwater Model Setup and Calibration Report (Golder Associates, 2017b) (Appendix 5)
- Mine Dewatering and Water Supply Assessment (Golder Associates, 2017c) (Appendix 6)
- Eliwana Mining Proposal Groundwater Impact Assessment (Golder Associates, 2017d) (Appendix 7)

- Eliwana Mine Project Discharge Assessment (Water Technology, 2017) (Appendix 8)

4.4.4 Receiving Environment

The MDE falls within the Ashburton River catchment and the Duck Creek sub catchment (which encompasses Caves Creek and Boolgeeda Creek). Duck Creek and Caves Creek are located to the north of the MDE and Boolgeeda Creek to the south of the MDE. Duck Creek/Caves Creek and Boolgeeda Creek flow west to the Ashburton River, which runs north-west and reaches the coast just west of Onslow (Figure 6).



LEGEND

- Towns
- Roads
- FMG Rail Alignments
- Proposed Rail Alignment
- BHPB Rail
- Rio Tinto Rail
- Roy Hill Rail
- Major Drainage
- Ashburton River
- Fortescue River Catchment

Data Sources:
SRTM, Drainage, Roads, Geoscience Aus.
Towns, Landgate.
3rd Rail, BHPB, RTIO, RHIO.
Catchments, DOW, 2014.

N

0 20 40 60 80 100
Kilometres

Requested By: J. Levett
Drawn By: J. Burke
Revised By: scostello
Approved By:
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Figure 6
Eliwana Regional Catchments

Fortescue Metals Group Ltd
The New Force in Iron Ore

Fortescue's surveys and studies have identified a number of groundwater dependent or potentially groundwater dependent ecosystems, discussed further in Section 4.6.

4.4.4.1 Hydrogeology

Groundwater within the MDE occurs within both deep, fractured rock aquifers and nearer the surface along dissected creeks and within gorges. The main aquifers relevant to dewatering and water supply categorised by Golder Associates (2017c) are:

- The Wittenoom Aquifer found within the Bee George, Paraburdoo and West Angela Members of the Wittenoom Formation comprises dolomite, banded iron and minor chert;
- The mineralised Marra Mamba Aquifer found within the upper mineralised Mount Newman Member of the Marra Mamba Formation; and
- The mineralised Brockman Aquifer associated with the target ore body of the Brockman Iron Formation members.

Compartmentalisation

Hydrogeological investigations have identified three main stratigraphic aquitards and a number of low permeability dolerite dykes that compartmentalise the groundwater system of the MDE:

- The lower Marra Mamba and Fortescue Group to the north of Eliwana;
- The un-mineralised Brockman Iron Formation and Weeli Wolli Formation to the south of Eliwana;
- The Mount McRae shale which separates the Wittenoom and Mineralised Brockman Aquifers; and
- Dolerite dykes dissecting the valley basement rocks, traversing in both north-west to south-east and north-east to south-west directions (Figure 7).

Some, if not all of the dyke structures are considered to relate to the D2 Panhandle Orogeny, and their influence in compartmentalising aquifer systems is known from existing mining projects in the Brockman Syncline. Water table differences of tens of metres either side of dolerite dykes have been observed in investigations within the MDE. Test pumping of bores in the Wittenoom Aquifer have also demonstrated the effect of dolerite dykes limiting the propagation of drawdown (Golder Associates, 2017d). The cross sections below (Plate 2) illustrate the geology, groundwater levels and influence of the dolerite dykes at various points across the MDE.

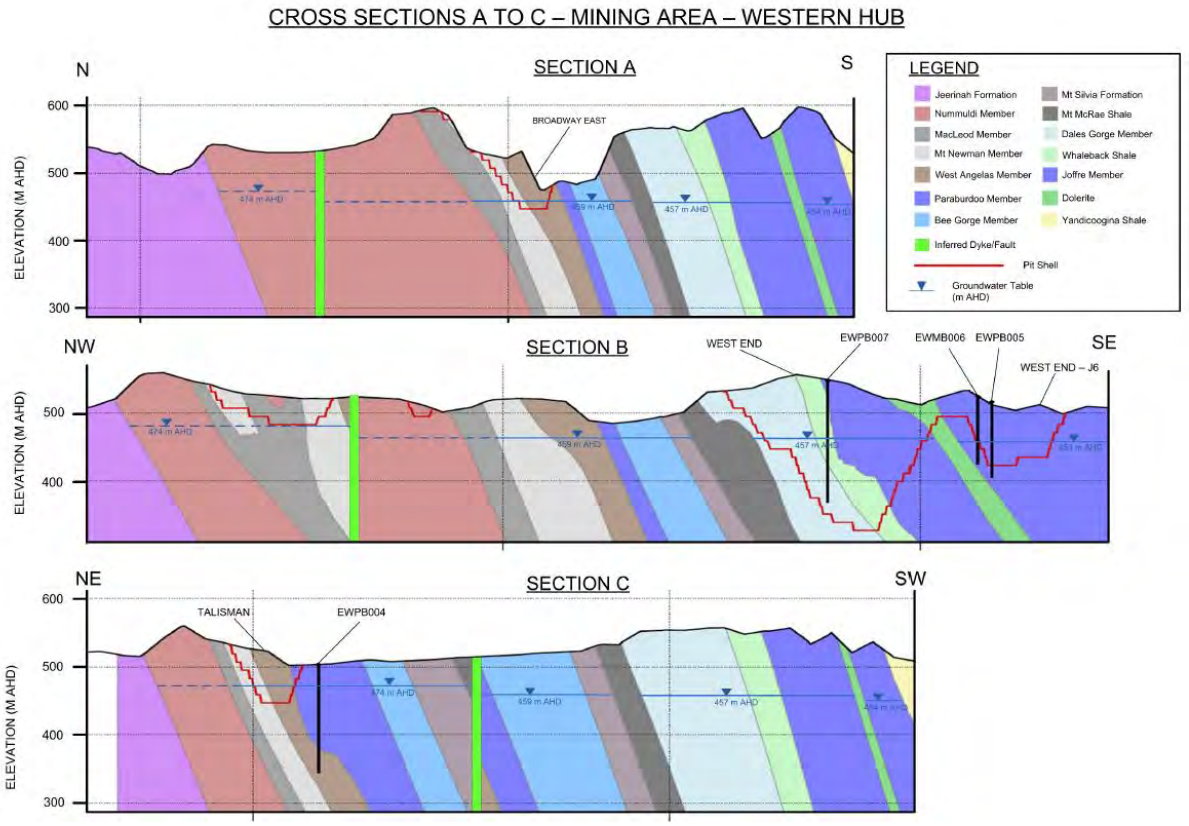


Plate 2: Hydrogeological Cross Sections (Golder Associates, 2017a)

480,000 500,000 520,000

7,520,000

Silvergrass

Eliwana

7,500,000

480,000 500,000 520,000

Fortescue Projects
Rio Tinto Mines
Rio Tinto Rail
Mine Development Envelope
Dolerite Dykes

Geology
Dolerite Sill
Jeerinah Formation
Mount McCrae Shale
Yandicoogina Shale

Data Sources:
Rio rail, RTIO.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

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Figure 7
Aquifer Compartmentalisation

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Groundwater Balance

The groundwater setting along the Eliwana valley can be described as a number of sub-catchments each separated by the intersecting dolerite dykes. The groundwater levels fall across the valley from 572 mAHD in the east to 497 mAHD at the western end of the strike valley (Golder Associates, 2017a) (Plate 3).

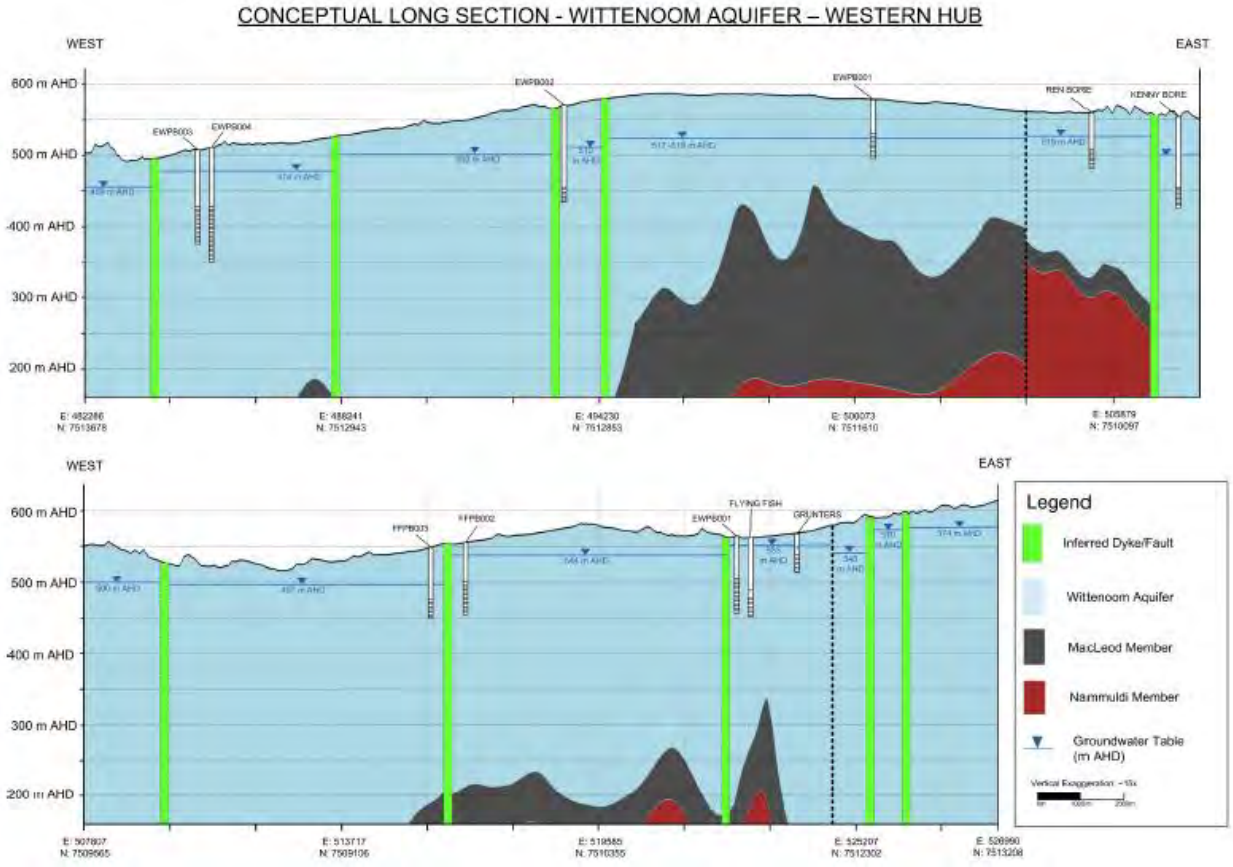


Plate 3: Hydrogeological Long-section (Golder Associates, 2017a)

Groundwater through-flow is considered to be very low owing to the low permeability aquitards to the north and to the south and the presence of dolerite dykes cutting across the east-west strike length of the valley. This is supported by the observed variations in water levels either side of the dolerite dykes (Golder Associates, 2017d). Groundwater storage within each sub catchment is considered more significant than groundwater through-flow. Using hydrogeological drill results and test pumping data, Golder Associates (2017a) have estimated aquifer storage in the MDE may be up to 465 GL.

Groundwater response to rainfall is not evident at all locations in the MDE, based on long-term groundwater monitoring data.

Only groundwater sub-catchments with shallow depth to groundwater appear to receive recharge from major rainfall events, or a series of events, particularly along drainage channels.

Sub-catchments with deeper depths to groundwater are thought to possess sufficient moisture deficit such that no recharge is discernible following rainfall events (Golder Associates, 2017d). However, as discussed later in Section 4.4.4.4, the impact of recharge events identified in monitoring data is negligible compared to groundwater storage. It is likely other recharge mechanisms are present in the MDE that have not yet been observed in the available data. Fortescue's experience in similar hydrogeological settings have identified direct rainfall recharge to valley fill deposits as well as bedrock outcrop zones as alternative recharge pathways to the aquifers of the MDE.

Groundwater is discharged from the sub-catchments through internal transfer through the aquitards (very minor), through saturated alluvium or through evapotranspiration by groundwater dependent ecosystems.

4.4.4.2 Water Demand

The proposed Eliwana mine will require water for a variety of purposes including:

- Dust suppression;
- Mineral processing;
- Plant and equipment maintenance; and
- Potable water supply.

The preliminary estimated water demand ranges from a minimum of 4 GL/a up to approximately 6.2 GL/a. The variations in annual demand are due to water use during construction activities and the potential to introduce wet mineral processing as the mine develops.

The strategy to meet the required water demand is to use mine dewatering water as a preference to minimise potential impacts on groundwater resources. Where water demand exceeds available mine dewater, early dewatering of future BWT mining pits will be scheduled. Where water demand cannot be met from mine dewatering the alternative option is to develop water supply bores progressively along the valley towards the east of the MDE.

4.4.4.3 Surface Hydrology

The Proposal is located in the Hamersley Ranges within the Duck Creek catchment, a tributary of the Ashburton River. The Duck Creek catchment area covers approximately 6,800km^2 at the confluence with the Ashburton River. The Ashburton River basin has a total area of 78,777 km^2 (Fortescue, 2017a).

Major tributaries of Duck Creek include Boolgeeda Creek and Caves Creek, with Barnett Creek and Wackilina Creek forming the upper section of Caves Creek. These catchments boundaries are presented in Figure 8. The areal extents of each catchment are summarised in Table 10.

The majority of the proposed disturbance is located within the Boolgeeda Creek sub-catchment. The remainder of the proposed disturbance, consisting of process and non-process infrastructure and a small number of mine pits and waste rock landforms, is located in the Duck Creek catchment between the Caves Creek confluence and Boolgeeda Creek confluence. This distribution of the disturbance across the regional catchment areas is shown in Figure 9 (Fortescue, 2017a).

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460,000
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Caves Creek
Duck Creek
Duck Creek
Duck Creek
Eliwana
Boolgeeda Creek
Boolgeeda Creek

LEGEND

- Watercourses
- Railways
- Mine Development Envelope
- Ground Disturbance

Duck Creek Subcatchments

- Duck Creek
- Boolgeeda Creek
- Caves Creek

Data Source(s):
SRTM, 250K Topo: GA Aust,
All other data: FMG, 2014

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0 2 4 6 8 10
Kilometres

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Drawn By: J. Burke
Revised By: scostello
Approved By:
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Figure 8
Eliwana Regional Sub-Catchments

Fortescue Metals Group Ltd
The New Force in Iron Ore

460,000 480,000 500,000 520,000

7,540,000

7,520,000

7,500,000

Robe River

Caves Creek

Mount Brockman Rd

Silvergrass

Serpentine Creek

Serpentine Creek

Duck Creek

Duck Creek

Eliwana

Pinnara Creek

White Quartz Rd

Brockman 4

Boolgeeda Creek

Fortescue Projects
Rio Tinto Mines

- Major Drainage
- Access Routes
- Rio Tinto Rail
- Mine Development Envelope
- Ground Disturbance

Mine Area Catchments
- Flying Fish 1
- Flying Fish 2
- Pinarra Creek
- Strike East
- West Creek

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

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Figure 9
Eliwana Project
Sub-Catchments

Fortescue Metals Group Ltd
The New Force in Iron Ore

Table 10: Eliwana Surface Water Catchment Areas

Catchment Description	Area (sq. km)
Ashburton River Basin	78,777
Duck Creek (at confluence with Ashburton River)	6,800
Duck Creek (at Confluence with Boolgeeda Creek)	3,691
Boolgeeda Creek	1,658
Duck Creek (at confluence with Caves Creek)	578
Caves Creek	1,535
Barnett Creek	520
Wackilina Creek	210

The Duck Creek catchment includes a variety of physiographic types. In the eastern parts of the catchment, the upper sections of Caves Creek include parts of the Weelumurra flats and other low relief terrain areas north of Tom Price. In the central Duck Creek catchment around the proposed mine areas, terrain becomes more undulating and channels more confined, with numerous gorges in the area. Pools are common along Duck Creek in this area, suggesting regular outcropping of bedrock. The confluence of Duck Creek and Ashburton River is beyond the western extent of Hamersley range where low relief terrain dominates (Fortescue, 2017a).

Proposal Catchments

The studies and investigations to identify the potential impacts of the Proposal have focussed on the catchments and sub-catchments within the central Duck Creek catchment. The Proposal area can be divided into two catchments made up of six sub-catchments know as:

- Boolgeeda Sub-catchments
  - Pinarra Creek
  - Strike East
  - Flying Fish 1
  - Flying Fish 2
- Duck Creek Sub-catchment
  - West Creek
  - Combined Infrastructure Areas

The proposed disturbance is focussed along the catchment divide between Duck Creek and Boolgeeda Creek, as shown in Figure 6. Mineralisation occurs within two parallel ridges near the catchment divide, with an east-west strike orientation, as shown in the local geology (Figure 9). Measured from Duck Creek to Mt Brockman, the line of target mineralisation extends approximately 70km. The main valley segments that form between these two ridges, (referred

to as the Eliwana valley), drain either westward or eastward, with varying channel morphology types are controlled either by the slope of the valley, the width between the two ridges or localised occurrences of bedrock outcropping (Fortescue, 2017a).

The Eliwana valley catchments typically traverse the southern ridge (exiting the Eliwana valley) and then drain further southwards to Boolgeeda Creek. This includes Pinarra Creek, a named tributary of Boolgeeda Creek and several other catchments informally named as Strike East, Flying Fish 1 and Flying Fish 2. The exception is the western extent of the Eliwana deposit where the Eliwana valley (part of the informally named West Creek catchment) drains directly to Duck Creek upstream of the Boolgeeda confluence. The project sub-catchments are shown in Figure 9 and catchment areas are summarised in Table 11, in accordance with their receiving sub-catchment.

Many gorges are present throughout the Proposal area and are associated with the strike valley. This includes instances where the northern and southern parallel ridges move close together (as seen in West Creek and Pinarra Creek) and where drainage lines cross either or both of the parallel ridges.

Table 11: Eliwana Sub-catchment Areas (Fortescue, 2017a)

Sub-catchments	Area (ha)
Boolgeeda Sub-catchments	
Pinarra Creek	6,033
Strike East	4,569
Flying Fish 1	6,013
Flying Fish 2	5,998
Duck Creek Sub-catchments	
West Creek	6,885
Combined Infrastructure Areas	3,981

A more detailed description of each of the Proposal sub-catchment areas is provided in Appendix 3 - *Eliwana Mine Project – Surface Water Impact Assessment*.

Stream Flows

Creeks in the Pilbara are typically ephemeral, and with the exception of pools and groundwater fed springs, are dry for the majority of the year. Pilbara soils typically have high initial infiltration rates for dry catchment conditions (i.e. when the moisture content of the soils is low). Significant streamflow usually occurs when moisture content of the soils is high, which is caused by significant rainfall in the days or weeks preceding a storm event. There are typically two different types of climatic events which cause flood response in the Pilbara, namely: Cyclonic activity or Tropical Low Pressure Systems and localised diurnal thunderstorms (Fortescue, 2017a).

Cyclonic activity can result in severe and widespread flooding generally on a river catchment scale. This flooding activity can be forecast in advance (albeit with significant uncertainty). This type of flooding typically produces large peak flows and may result in damage to infrastructure due to magnitude of flows and total volume of water. However, not all cyclones will result in severe flooding.

Isolated thunderstorms have the potential to create fast and localised flooding, referred to as flash flooding. These events are much harder to predict as they can occur in the upper reaches of catchments. These events generally have a lower potential for widespread damage as the extent and magnitude of flooding is much smaller than cyclonic events.

Surface Water Geomorphology

A baseline geomorphology assessment was undertaken, *Baseline Geomorphology Assessment - Eliwana and Flying Fish Deposits*, to understand and characterise the geomorphology and sediment transport regime of the catchments within the Proposal area (Tetra Tech, 2017a) (Appendix 3). This assessment included a site inspection focussing on sediment sampling within catchments likely to be most affected by mining including Pinarra Creek, West Creek and the Flying Fish sub-catchments. The subsequent desktop review included catchment and stream order analysis, comparison of channel planform and morphology, incipient motion analysis and sediment continuity analysis.

Hydrological Characterisation

The site hydrology was investigated using a variety of techniques including rainfall-runoff routing and hydraulic modelling of the ungauged sub-catchments described above. The focus in this investigation was to review available catchment information and determine an appropriate methodology for application of rainfall temporal patterns and losses in order to develop conceptual hydraulic models for analysis of present hydrologic conditions and potential impacts of the Proposal. This exercise was undertaken to ensure that the adopted modelling approach and assumptions were consistent with guidance of the recent update to the Australian Rainfall and Runoff (ARR) (Ball, 2016)

Hydraulic modelling has been undertaken using the TUFLOW two-dimension modelling software using rainfall inputs onto a grid developed from surveyed elevation data in order to characterise flood patterns for current condition (baseline) and to estimate Proposal impacts.

The hydraulic modelling was applied to all catchments including areas downstream. The model domains ended at a point of confluence with a similar or larger order watercourse/tributary which was outside of the MDE. A total of 6 separate model domains were developed including:

- West Creek,
- Pinarra Creek,

- Flying Fish (capturing Strike East Creek and Flying Fish 1);
- Flying Fish Downstream (from the Flying Fish domain to the Boolgeeda Creek Confluence);
- Flying Fish East (capturing Flying Fish 2); and
- Infrastructure (capturing a series of small catchments around the proposed infrastructure areas).

This investigation and modelling is detailed in the *Eliwana Mine Project Surface Water Impact Assessment* (Appendix 3), which includes design rainfall information and consideration of available monitoring data.

Modelling Scenarios

Hydraulic modelling was undertaken for a Baseline Scenario and a Maximum Scenario (largest potential impact). The Baseline Scenario reflects current conditions, where the catchments are largely undisturbed, with some minor alteration arising from pastoral uses and existing exploration activities. The Maximum Scenario aims to quantify the maximum possible impact to surface water flows due to Proposal disturbance. The Maximum Scenario assumes the following:

- All pits are developed to full depth with no in-pit backfill (for maximum case impacts); and
- No pit diversions are in place, with surface water runoff allowed to freely enter pit voids.

The Maximum Scenario is considered a conservative estimate of impacts as it is likely that pits would be developed progressively rather than concurrently and overburden/mineral waste from new pits may be disposed into adjacent exhausted pits where a shorter haul distance makes this viable.

Where practicable, it would be desirable for creek diversions be put in place to limit both environmental and operational impacts, however it is likely topographic (e.g. gorges) and tenure constraints may preclude creek diversion in a number of instances. The rationale for assessing this Maximum Scenario is to set an upper limit on the potential level of impact of the Proposal on the reaches of the creek immediately downstream of the Proposal footprint.

Model Outputs

The Model identified that the 6-hour storm event was critical for peak flows and flood extent for a number of catchments in the MDE including Pinarra Creek at the model outlet (Appendix 3). Consequently, this event duration was then used to assess changes arising from the Proposal for all model domains. While some locations in the upper reaches of the model domains have a different critical duration, the 6-hour storm was most representative over the MDE, and for areas downstream of the proposed disturbance.

A series of figures (see Appendix 3) have been prepared for each model domain for the 50%, 10% and 1% AEP 6-hour events, which have been selected to represent scenarios of a frequent, rare and very rare flood events. The figures illustrate:

1. Baseline flow depths
2. Baseline flow velocities
3. Ultimate flow depths and inundation extent comparison
4. Water level difference plots

Baseline Scenario

Analysis of the model outputs provided the following observations of baseline conditions:

- Main channel alignments and morphology are strongly controlled by the strike valley;
- Adjacent floodplains are active in rare flood events;
- Significant gorge features with high depths and velocities occur at constrictions within the strike valley where flows cross the northern ridge; and
- It is a channel flow dominated environment with minimal overland or sheetflow even for rare events.

Impact Scenario

Observations from comparison between the Ultimate Scenario and baseline model results were observed as follows:

- Significant interception of surface water flows in pit voids, resulting in ponded water in pits;
- Reduction in flow downstream of pit boundaries, as shown by reduction in depth and flood extent; and
- Flood extent reductions are most severe immediately downstream of pits and progressively reduce with increasing distance downstream towards the model boundaries, as additional catchment area (outside of disturbance footprint) feeds into creek channels.

Observations specific to each model domain are discussed further in Section 4.4.6.2.

Surface Water and Groundwater Connectivity

There is limited surface water and groundwater connectivity in the MDE. Surface water catchments are not co-incident with groundwater catchments and the presence of surface water drainage features does not have a widespread impact on groundwater levels.

Analysis of hydrographs by Golder Associates (Appendix 4) suggests a response in groundwater levels to rainfall events (and by inference surface water flow events) in two areas where groundwater levels are < 10 m bgl. The shallow depth to groundwater, coupled with potentially higher permeability creek bed material, may facilitate a degree of connection not observed elsewhere in the MDE.

4.4.4.4 Surface and Groundwater Connectivity

Based on a review of rainfall records, stream flow and groundwater levels, the surface water/groundwater interaction along surface water drainage channels is interpreted to be dependent on the magnitude, intensity and frequency of rainfall events. Conceptual representations of the surface water/groundwater interactions along surface water drainage channels for a 'low rainfall' and a 'high rainfall' scenario is shown in Plate 4 and Plate 5 below.

Both groundwater level and daily rainfall data has been recorded in the MDE between November 2016 and April 2018. No responses to rainfall were noted in groundwater monitoring bores during the 2017/2018 wet season (November to April). The maximum daily rainfall during this period was 24 mm, the total cumulative rainfall was 207 mm. Since the daily maximum and cumulative rainfalls were both low, any wetting of the creek bed alluvium caused by direct rainfall and stream flow is interpreted to be lost by a combination of direct evaporation from the soil and evapotranspiration through the riparian vegetation. Therefore, as shown in the 'low rainfall' scenario in Plate 4, no recharge to groundwater occurs.

During the same period in 2016/2017, the maximum daily rainfall total was 77 mm (28 February 2017) with a cumulative rainfall total of 729 mm. Groundwater level responses were recorded in monitoring bores along Pinarra creek both in early February, 128 mm in 9 days, and late February, 124 mm in 6 days. Although these rainfall events were not individually significant, the cumulative effect of soil wetting and enhanced runoff resulted in streamflow events. This is interpreted to have caused sufficient saturation of the creek bed alluvium to result in groundwater recharge as illustrated in the 'high rainfall' scenario in Plate 5.

Although groundwater level increases of up to 0.5 m have been measured in monitoring bores adjacent to Pinarra Creek, it should be recognised that this is a localised response in proximity to the creek beds. The total volume of groundwater recharge occurring as a result of these events on a groundwater sub-catchment wide basis is considered to be negligible in comparison to groundwater storage.

The mechanisms governing the two scenarios described above are dependent on a large number of variables. Consequently, a conservative approach has been taken in groundwater and surface water modelling with respect to the interaction between groundwater and surface water. Infiltration rates are conservatively estimated so that groundwater recharge is not overstated. Conversely, the upper range of loss rates for surface water simulations are adopted

so that any predicted impacts to the surface water flow regime are conservatively assessed. Furthermore, it is known that cyclones that generate very large rainfall (e.g TC Heidi at Fortescue's Cloudbreak Operation and TC Peta at Fortescue's Solomon Operation) can generate very large volumes or recharge that can impact on groundwater levels. However, as these events are random and do not have a dependable frequency, they were not factored into modelling in order to ensure the models are conservative.

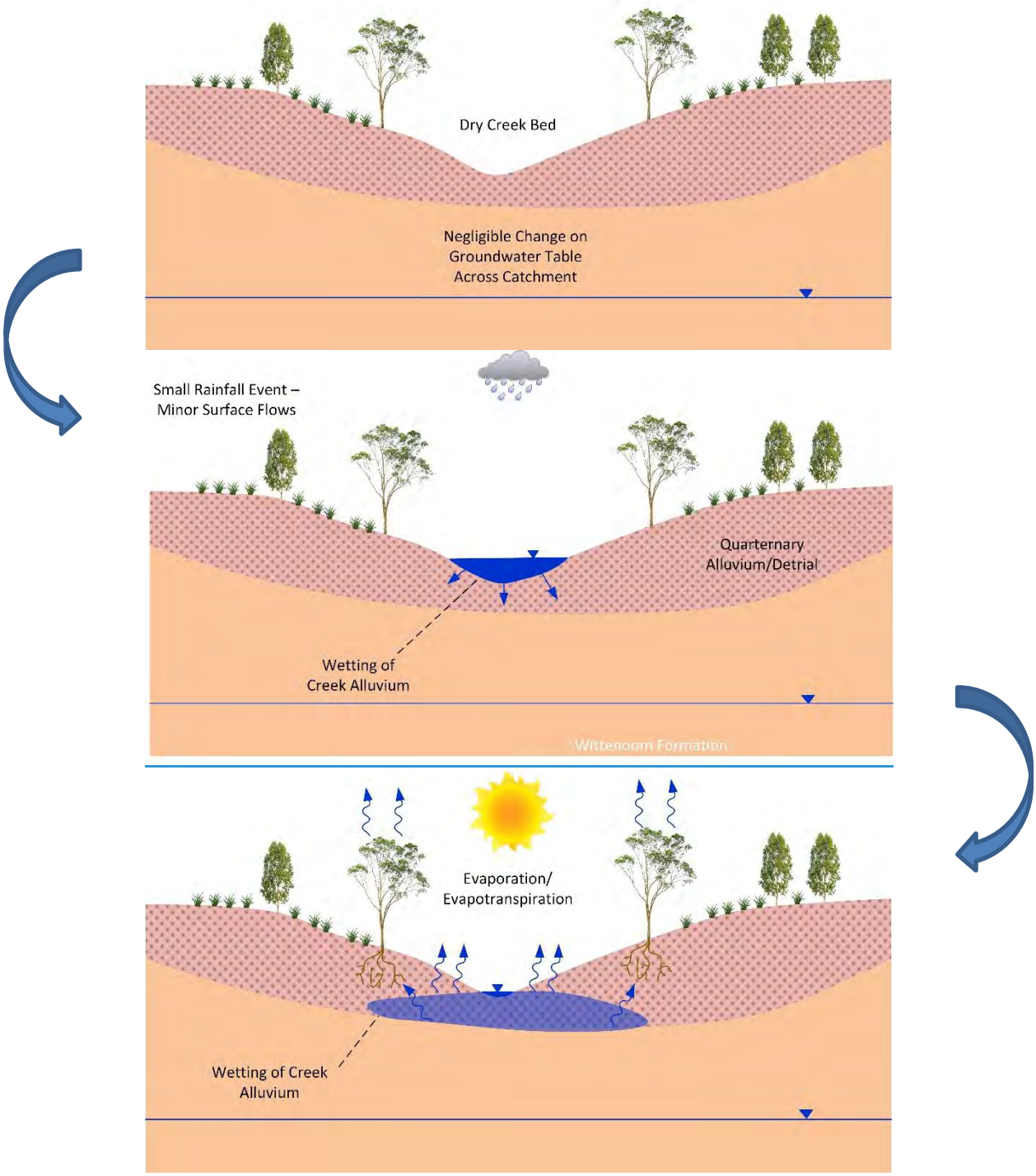


Plate 4: Low Rainfall Surface Water and Groundwater Connection Schematic

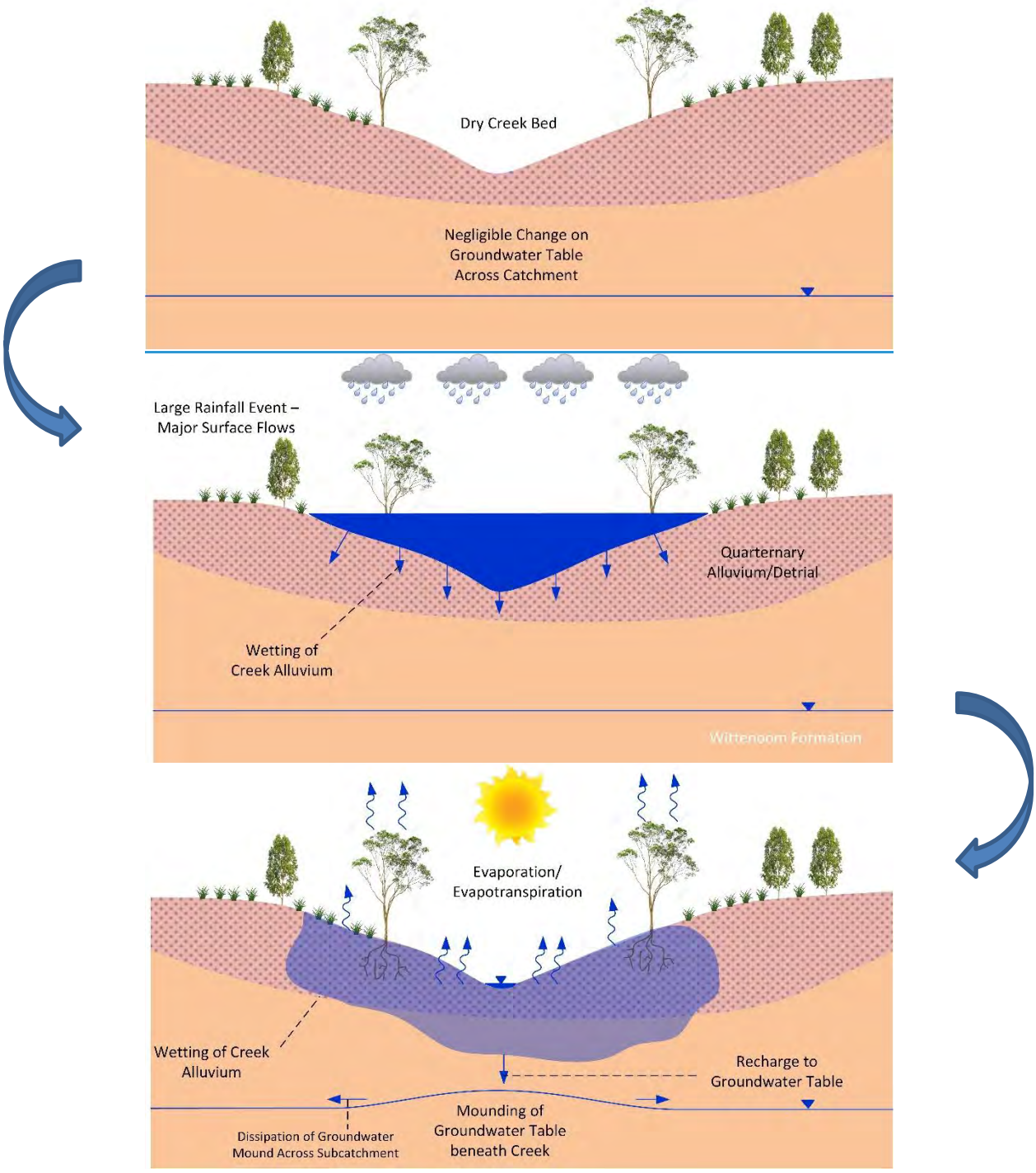


Plate 5: High Rainfall Surface Water and Groundwater Connection Schematic

4.4.4.5 Surface Water Pools

A desktop review of available aerial imagery has been undertaken to identify the locations of potential pools that may be relevant to the project, both inside and outside of the MDE. The review focused on the predicted drawdown area in addition to watercourses which intersect the proposed disturbance area. and cross referencing this against knowledge from existing site visits and hydrological studies to date and DWER pools GIS data.

The assessment focused on identifying expressions of water at surface that were observed to be present as more than standing water bodies following flow events; indicating some persistence. Where multiple features have been identified in close proximity, these have been considered a single 'system'

To begin, all the features that could be observed in a March 2017 image were captured. This image shows surface water features following rainfall in wet season. This dataset was then refined by cross checking against whichever image was captured the latest into the dry season for each location (with November being the final calendar month in which an image was considered as dry season). This included the following dates (November 2017, November 2005, September 2005, June 2017, May 2016, May 2015). Note, government aerials vary by month and year across the area and have a resolution that doesn't allow for clear identification of some pools within this area.

Pools that persisted later into the year, particularly those observed in towards November were considered most likely to be permanent pools and these are demonstrated in Figure 10. Of these pools, there are only three pools which were identified within the area of significant disturbance/impact, which may be impacted by a combination of groundwater drawdown and changes to stream flows. Impacts to pools is discussed in Section 4.4.6.3.

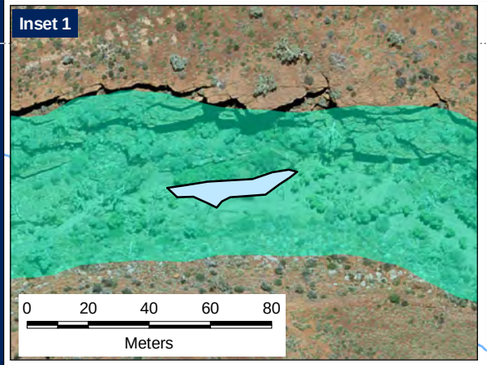
With increasing distance north, it is common to observe that the identified pools are in proximity to exposed bedrock in the creek bed. Pools located north towards Duck creek generally appear to have more persistence.

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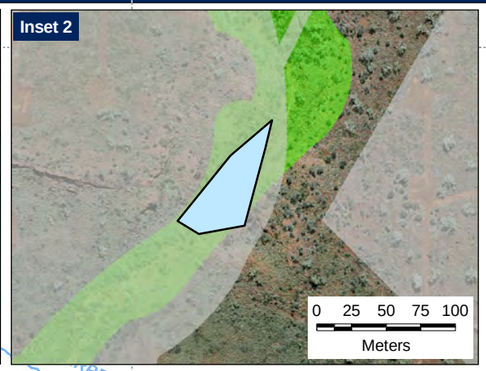
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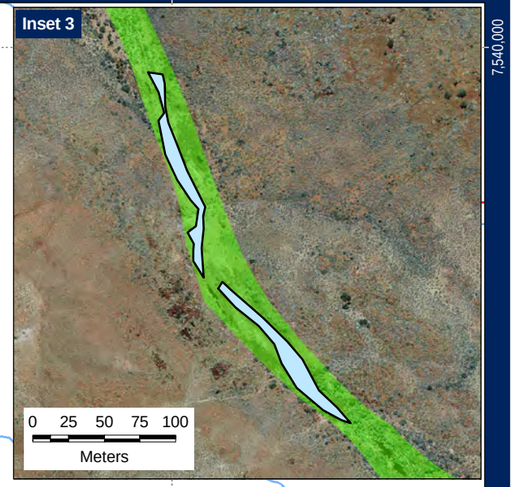
Inset 1



Inset 2



Inset 3



CAVES CREEK

RPENTINE CREEK

DUCK CREEK

Inset 1

Inset 2

Inset 3

PINARRA CREEK

BOOLGEEDA

480,000 500,000 520,000

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Pools
- Groundwater Dependent Ecosystem
- Potential Groundwater Dependent Ecosystem

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
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Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.055_r1

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Confidentiality: 1

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Figure 10
Surface Water Pools

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4.4.5 Potential Impacts

Proposal activities (typical of iron ore mines and groundwater abstraction) which have the potential to impact hydrological processes include:

- groundwater abstraction for mine dewatering (below water table mining) and water supply;
- injection or infiltration of excess water;
- controlled release of excess water into inactive mining voids or via surface discharge; and
- placement of infrastructure and landforms which interrupts surface water flow.

Potential impacts to hydrological processes include:

- Groundwater drawdown and alteration of hydrological processes as a result of mine dewatering and water supply abstraction;
- Groundwater mounding in areas of surplus water injection, infiltration or release of water into inactive mining voids;
- Impacts to surface water flow resulting from controlled surface discharge;
- Permanent modification to existing catchments and associated impacts to flow paths and inundation areas of surface water streamflows;
- Shadowing in areas of surface water sheetflow impacted by infrastructure or landform placement; and
- Altered hydrogeology and water balance associated with the creation of permanent and episodic mining void water bodies.

4.4.5.1 Groundwater Drawdown

Abstraction of groundwater for mine dewatering and water supply will potentially result in the reduction of available groundwater for other users. Fortescue has identified a number of species of stygofauna and groundwater dependent or potential groundwater dependent vegetation ecosystems (GDE) which have the potential to be impacted by changes in available groundwater.

Impacts associated with groundwater drawdown on stygofauna are addressed in Section 4.8.7 and impacts to GDE associated with changes to hydrological processes are addressed in Section 4.6.5.10

To understand the potential impacts of groundwater drawdown Fortescue commissioned Golder Associates to prepare a hydrogeological model of the Eliwana mine area for a number of mine dewatering and water supply scenarios. A preliminary mine plan with nominal pit locations were utilised to plan where dewatering and water supply bores could be reasonably located (Golder Associates, 2017c).

The majority of the resource in the MDE is above water table (AWT) and does not require dewatering. Of the resource below water table (BWT), a preliminary mine plan used for the impact and water balance assessment and indicates 7 pits where dewatering may be considered likely. The most significant dewatering effort will be required at Westend (approximately 150 m saturated thickness), Talisman 2 and MM4-6 (approximately 50 m of saturated thickness each). The impact assessment has incorporated a large degree of conservatism to account for variability in the mine plan as the Proposal develops.

Mine dewatering will be undertaken using a combination of in pit dewatering bores, dewatering bores located down gradient of the pit shell or directionally drilled dewatering bores. The specific mine dewatering method to be used will be dependent upon the ore body being mined, individual bore yields, and operational considerations.

4.4.5.2 Groundwater Mounding

Aquifer injection or infiltration of surplus mine dewatering water has the potential to result in alteration of groundwater levels which may impact subterranean fauna and/or result in water logging of vegetation.

4.4.5.3 Modification to Surface Hydrology

Modelling of the surface water impact scenario (Ultimate Scenario) has been undertaken and assessment of the impacts made for each sub-catchment. Details on the outcomes for each sub-catchment can be found in Appendix 3 and are described further below. The development of the Proposal has the potential to reduce the quantity of surface water flows to downstream ecosystems during operations and post closure.

4.4.5.4 Sheetflow Shadowing

Disruption of surface water systems has the potential to impact on areas dependent upon sheetflow (e.g. banded vegetation and cracking clay communities). No sheetflow dependent mulga communities occur within the MDE or in areas that may be impacted by changes to surface water flows.

4.4.5.5 Surface Water Pools

Groundwater drawdown has the potential to lower groundwater levels beneath or in the vicinity of groundwater fed pools. If water levels do not recover, these pools will dry out and begin to lose ecological function, including aquatic, flora and fauna values.

4.4.5.6 Mine Void Water Bodies

During operations, mine void water may be present in open pits following flood events. This water will be discharged to the downstream environment to allow mining to continue. Mine voids may also be used to temporarily store water during operations, however in these circumstances, it is unlikely that the water would then be discharged to the environment, but instead would be recycled through the mine operations.

At closure, the Proposal is likely to comprise both above water table and below water table pits (voids) that have not been backfilled. Some of these mine voids, owing to their location in a narrow drainage valley, may also intersect existing drainage lines and thus capture surface water flow during runoff events from significant catchments. Consequently, there may be a number of different types of water bodies present at closure, dependant on their position in the landscape (above or below watertable, above or within floodplain). The mine voids that may form water bodies are described as follows (Golder Associates, 2017d):

- **Surface water driven mine voids** – comprise above water table pits that will receive surface water run-off input from catchments that are significantly greater in area than the pit shell itself. They have no groundwater inflow but are located within the valley flood plain. This category of mine void is expected to be ephemeral but with potential for inter-annual flooding, depending on antecedent climatic conditions.
- **Groundwater driven mine void lakes** – comprise below water table mine voids that are principally supported by groundwater inflow and have negligible surface water input, that is, they are located above the valley floodplain. This category of mine void is expected to feature perennial water bodies within the post closure landscape, i.e. mine void lakes.
- **Groundwater – Surface water driven mine voids** – comprise below water table ore bodies that may receive some groundwater input as well as surface water input from catchments that are significantly greater in area than the pit shell itself. They have both groundwater inflow and are located within the valley floodplain. This category of mine void is expected to feature perennial water bodies within the post closure landscape.

The conceptual pre-mining and alternate post-closure mine void types are presented in Plate 6. Of the pit voids identified in the preliminary mine plan, eight (8) of have the potential to form permanent pit lakes following closure.

Of these eight voids, four are situated in the flood plain and could receive both groundwater and surface water inflow (Broadway West 3, Broadway East 1 and 2 and Talisman 2), whilst the others (including West End Pit) are located in an area where groundwater will be the main contribution to inflow.

The impact these mine void water bodies could have on hydrological processes if present on closure is discussed further in the next section and potential impacts to groundwater quality are discussed in Section 4.5.

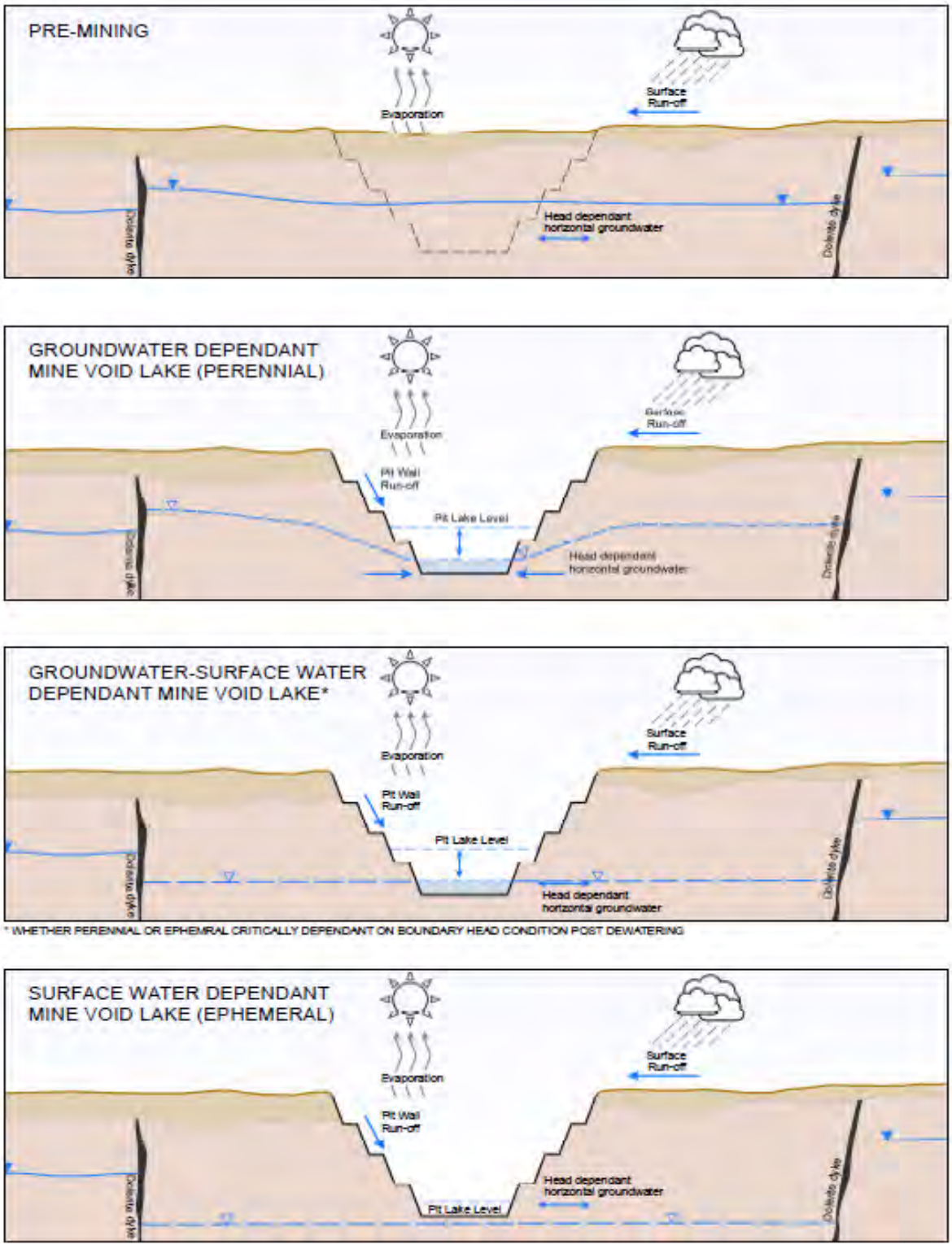


Plate 6: Conceptual Mine Void Closure Models (Golder Associates, 2017d)

4.4.6 Assessment of Impacts

The previous section outlined potential impacts to hydrological processes. This section provides quantitative or qualitative assessments changes to hydrological processes resulting from the Proposal.

As described in the Eliwana Mine Closure Plan EW-PL-EN-0001 (Appendix 2) closure management will vary from pit to pit in consideration of key stakeholder negotiated post-closure land uses and the mien development sequence employed during the life of the mine. In order to provide an assessment of potential closure impacts a conservative approach has been assumed whereby all mine voids remain open, with no closure management applied.

4.4.6.1 Impacts to Groundwater

The numerical FEFLOW model was used to predict the change to regional groundwater level caused by mine dewatering and abstraction for water supply. The model was subjected to a steady state calibration using the pre-mining water table described in the *Eliwana Mining Project - Hydrogeological Conceptual Model Report* (Golder Associates, 2017a).

To account for the uncertainty within the specific yield and eventual pit depths/scheduling, a series of scenarios were undertaken where the parameters were altered within their plausible ranges based on results of hydrogeological testing and other relevant experience from the Golder Associate senior staff. A summary of the sensitivity scenarios is available in the *Eliwana Mining Project – Groundwater Impact Assessment* (Appendix 7).

Six scenarios were considered for the impact assessment. The scenarios considered dewatering, water supply and closure predictions using the adopted range in specific yield (between 1 and 7 %) for the Wittenoom, Mineralised Marra Mamba and Mineralised Brockman aquifers as detailed below:

- Scenario 1 – Dewatering and Water Supply Modelling. 3% specific yield for Proposal aquifers (likely estimate) based on the preliminary mine plan
- Scenario 2 - Dewatering and Water Supply Modelling. 1% specific yield for Proposal aquifers (lower limit) based on the preliminary mine plan
- Scenario 3 - Dewatering and Water Supply Modelling. 7% specific yield for Proposal aquifers (upper limit) based on the preliminary mine plan
- Scenario 4 – Maximum Drawdown Impact Modelling. 1% specific yield based on an aggressive mine plan between 2018 and 2024
- Scenario 5 – Maximum Water Surplus Modelling. 7% specific yield based on an aggressive mine plan between 2018 and 2024

- Scenario 6 – Groundwater Recovery Modelling. 1% specific yield, using groundwater levels at the end of mining (2036) as predicted by Scenario 4 as initial heads and is simulated out to 2136 (100 years post closure).

Water Balance

The results of the first three scenarios have been used to simulate the annual water balance with respect to achieving the preliminary mine plan and water demand (Table 12). The modelled scenarios produce a range of water balance outcomes from short periods of supply surplus to extended period of supply deficit from dewatering requirements alone (Golder Associates, 2017d).

Table 12: Summary of Simulated Water Balance for all Scenarios by Rate (L/s) (Golder Associates, 2017d)

	Year	S019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Scenario		Water Balance (L/s)																	
	1	0					-10	-45 to -55										-100	
	2	0	-25			-50	-90 to -120												
	3	+100 to +140					+40	-20 to -85				+40		-50		-100		-145	

The total volume of dewatering and water supply for each scenario over the life of mine is presented in Table 13. Additional details of each modelled scenario are available in the *Eliwana Mining Project - Dewatering and Water Supply Assessment* (Appendix 6).

Table 13: Summary of Simulated Water Balance Volumes (Life of Mine period) (Golder Associates, 2017d)

Scenario	Total Demand (GL)	Total Dewatering (GL)	Water Supply (GL)	Deficit/Surplus (GL)*
1	92	71	22	+1
2		67	27	+2
3		91	0	-1

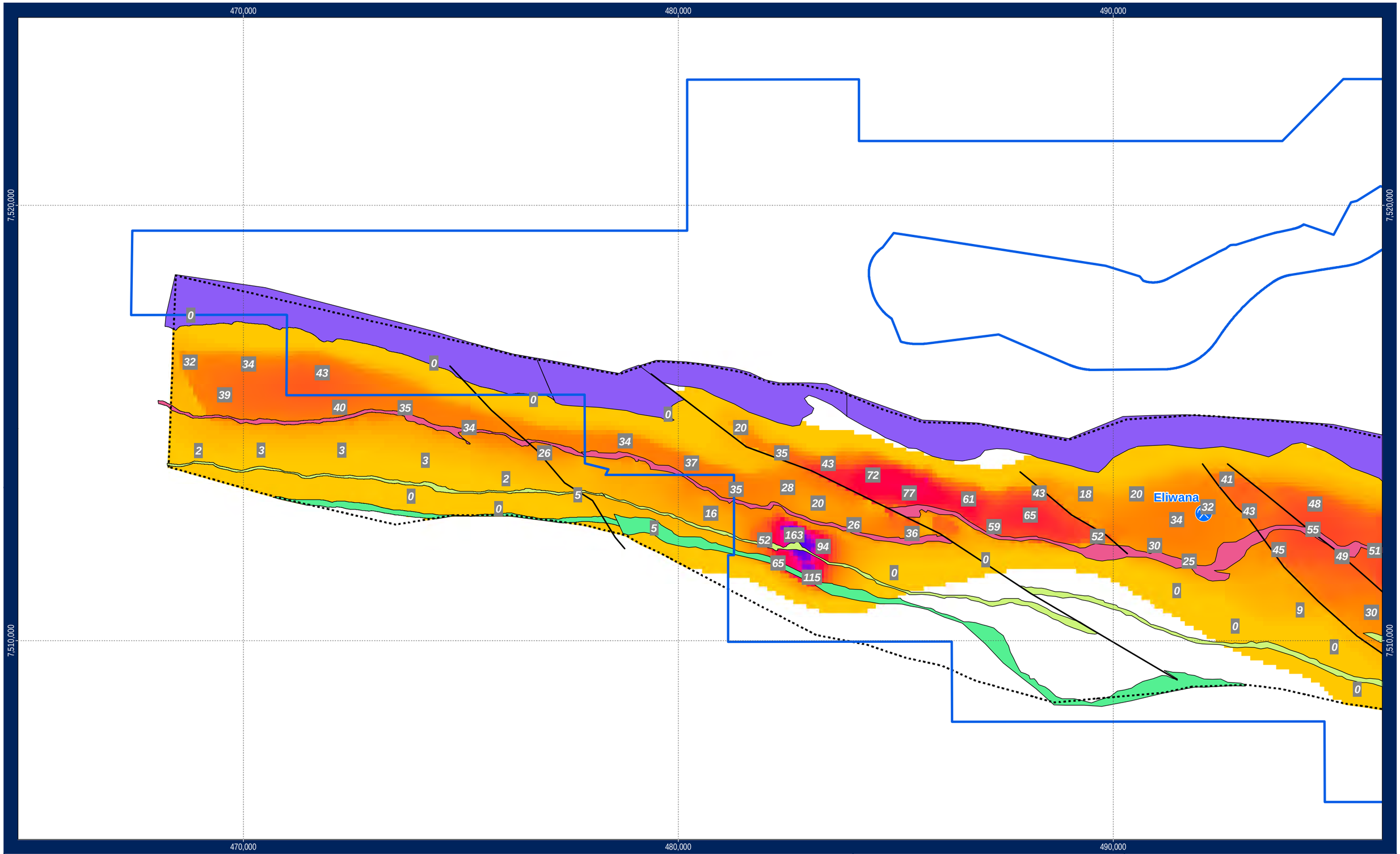
*This is an indicator of the error in the ability to manipulate the model with various pumping schedules and is not indicative of an actual Proposal surplus/deficit.

Maximum Predicted Groundwater Drawdown

Scenario 4 was utilised to estimate the maximum predicted groundwater level drawdown as a "worst case" simulation. The scenario assumed all below water table mining pits were dewatered simultaneously and the maximum amount of water required (taken from the largest water deficit scenario) from water supply bores abstracted to assess the impact of the water supply borefields in addition to mine dewatering.

The resulting ground level drawdown (at year 2024) is illustrated in Figure 11. To add further conservatism to the dewatering impact area the scenario used a low storage assumption (1%

specific yield). The figure presents the drawdown as a surface with a colour gradient where red indicates higher values of drawdown and orange indicates lower values. Drawdown values have been labelled in arbitrary locations to assist with interpreting the scale.



Fortescue Projects
Mine Development Envelope
Dolerite Dykes
Eliwana Model

Geology
Dolerite Sill
Jeerinah Formation
Mount McCrae Shale
Yandicoogina Shale

High : 166.667
Low : 0

Data Sources:
SRTM, GA.
All other data, FMG, 2017.

N

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Kilometres

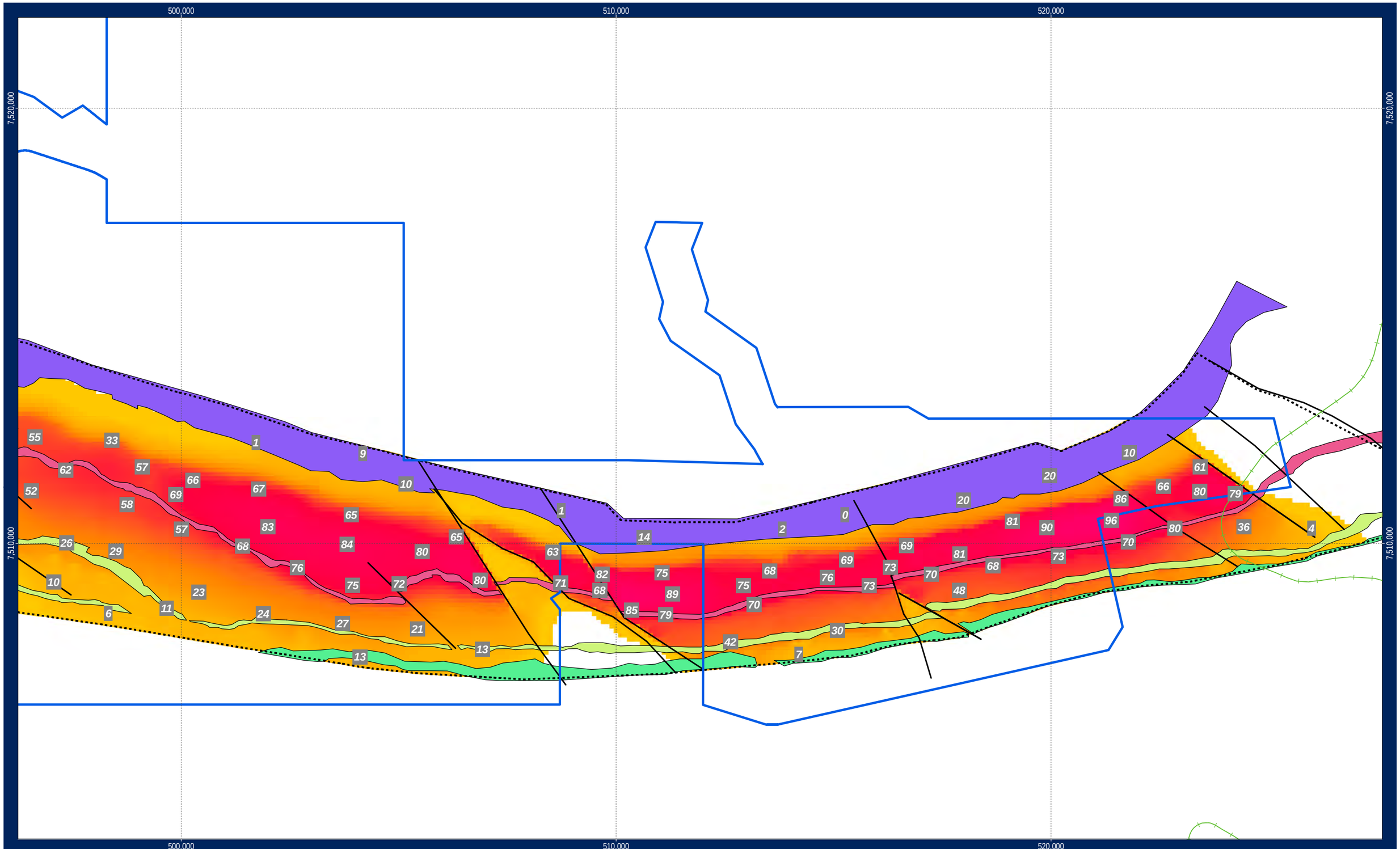
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Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:80,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.010a_r3

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Figure 11
Predicted Groundwater Drawdown
Sheet 1 of 2

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Rio Tinto Rail
Mine Development Envelope
Dolerite Dykes
Eliwana Model

Geology
- Dolerite Sill
- Jeerinah Formation
- Mount McCrae Shale
- Yandicoogina Shale

High : 166.667
Low : 0

Data Sources:
Rio Rail, RTIO.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

Requested By: J. Levett
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:80,000
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Figure 11
Predicted Groundwater Drawdown
Sheet 2 of 2

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Groundwater level drawdowns predicted for both dewatering and water supply typically extend across all of the groundwater sub catchments in which these activities are proposed. Consistent with the compartmentalised nature of the groundwater system across the MDE groundwater level drawdown contours do not extend beyond the low permeability geological units/structures which delineate each groundwater sub catchment. As a result, groundwater level drawdown predicted for the Proposal is contained within the model boundary (Golder Associates, 2017d).

Further details on Scenario 4 including graphs of the groundwater level drawdown at each monitoring point are provided in *Eliwana Mining Project – Groundwater Impact Assessment* (Appendix 7).

Maximum Predicted Groundwater Surplus

Scenario 5 was used to predict the maximum water surplus by using the simultaneous pit dewatering from Scenario 4 but assuming a 7% specific yield. The results of the scenario indicate that up to 49 GL of surplus groundwater may need to be managed throughout the initial 5 years of mining. This scenario equates to estimated rates of surplus water generation between 150 and 350 L/s.

A number of options to manage the surplus water are available and are summarised in Table 14.

Table 14: Surplus Water Release or Re-use Options (Golder Associates, 2017d)

Management Option	Site Specific Consideration
Relocation for use nearby	Eliwana represents a remote operation with negligible adjacent industries for use nearby. Other users in the area comprise pastoralists, with small demand, or other mining centres. The three nearest mining centres, RTIO's Brockman 4, Brockman 2 and Nammuldi Operations, all have surplus water balances with no perceived need for alternate sources.
In pit storage	In pit storage for later re-use is a viable option for surplus water management once mined out pits are established. There will be a number of above water table (AWT) pits where surplus water could be stored for either re-use or for infiltration back to the water table.
Aquifer reinjection	This option has potential along the valley floor between the Marra Mamba Iron Formation pits once dewatering of nearby pits has been facilitated.
Aquifer infiltration	This option could be used to as part of a managed aquifer recharge (MAR) approach to store excess dewater for later use. The likely target would be the Wittenoom Formation aquifer along the Eliwana valley.
Controlled discharge	Controlled discharge comprises the release of surplus water through a pipe line or overland diversion to a designated water course. The option has been successfully implemented at a number of mining operations within the Pilbara.
Uncontrolled discharge	Whilst a definition of uncontrolled discharge is not provided by the Department of Water, this option does not allow for effective mine planning and dewatering where the uncontrolled release of surplus water results in re-circulation to mine pits or impacts to infrastructure corridors. It is not considered a viable option within the limited tenure (area) available.

The viable surplus water management options considered for the proposal are in-pit storage, managed infiltration, aquifer reinjection and controlled discharge. In-pit storage requires a mining schedule where above water table pits are mined out early and available for water storage. Controlled discharge would be conducted within tributaries of the Boolgeeda catchment which both form part of the larger Ashburton River catchment. It is in Fortescue's best interest to manage any surplus water to the benefit of the long term water balance; controlled discharge of surplus water is therefore considered the least favourable of all surplus water management options.

Groundwater sub-catchments have been identified as potential options for injection or infiltration of surplus water, this is due to their proximity to mine pits and relatively deep groundwater table. An analytical assessment of the storage capacity of each sub-catchment has been undertaken is detailed in the *Eliwana Mining Project Groundwater Impact Assessment* (Golder Associates, 2017d). For ease of reference, this assessment uses the groundwater level in mAHD to name each sub-catchment. For instance, sub-catchment 457 is so named because groundwater is recorded at 457 mAHD. This analysis identified that Groundwater Sub-catchment 517-519 had the greatest capacity to store groundwater, with the potential to store 69 GL of water at 7% specific yield.

Groundwater Level Recovery Post-Closure

To estimate the potential post closure groundwater level recovery Scenario 6 of the model was completed. The scenario provides an estimate of aquifer recovery over a 100-year period post the completion of abstraction associated with mine dewatering and water supply.

The results of Scenario 6 indicate that the range in residual groundwater level drawdown between pre-mining levels and 100 years post closure could be between 1 and 37 m if no closure management was employed. A summary of the residual groundwater level drawdown after 100 years on a groundwater sub-catchment basis is contained in Table 15 (Golder Associates, 2017d).

Table 15: Post Closure Groundwater Level Recovery (Golder Associates, 2017d)

Groundwater Sub-Catchment (m)	Estimated Post Closure Groundwater Level (m AHD)	Predicted Residual Drawdown after 100 years (m)
393	383	10
457	455	2
459	458	1
474	464	10
502	484	18
510	485	25
517/519	494	25
500	476	24

Groundwater Sub-Catchment (m)	Estimated Post Closure Groundwater Level (m AHD)	Predicted Residual Drawdown after 100 years (m)
497	480	17
544	507	37
553	529	24

As discussed, each sub-catchment is named after its pre-development groundwater level in mAHD. Further details on Scenario 6 including graphs of the groundwater level recovery at each monitoring point are provided in *Eliwana Mining Project – Groundwater Impact Assessment* (Appendix 7).

Groundwater Mounding

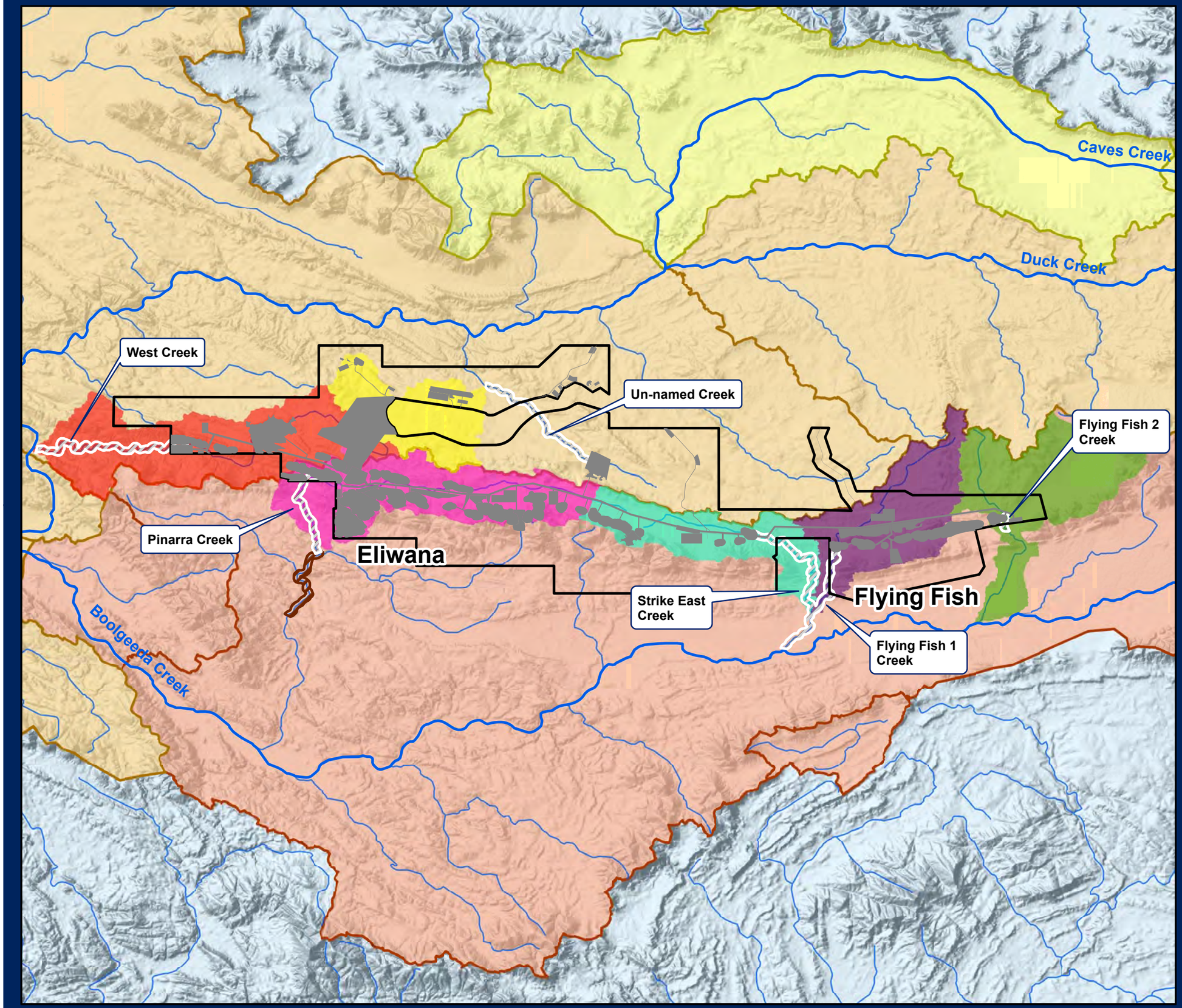
The proposed aquifer injection or infiltration of surplus groundwater has the potential to result in groundwater mounding. Fortescue will include trigger levels within the Groundwater Management Plan for acceptable mounding from groundwater re-injection/infiltration.

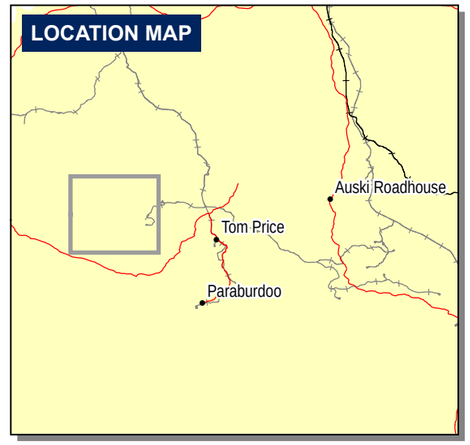
Further discussion of the potential impacts of groundwater mounding on subterranean fauna is contained in Section 4.8.7.2.

4.4.6.2 Impacts to Surface Hydrology

Through modelling of Baseline and Maximum Scenarios, areas likely to be impacted by the Proposal have been identified in order to understand impacts to the hydrologic regime and to enable investigation of potential indirect impacts to flora and vegetation. Areas located outside of the Proposal disturbance footprint with significant reductions to surface water flows are highlighted in Figure 12.

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LEGEND

N

- Watercourses
- Potential Impact Areas
- Excess Water Discharge Extent
- Mine Development Envelope
- Ground Disturbance

Catchments

- Duck Creek
- Boolgeeda Creek
- Caves Creek
- Strike East
- West Creek
- Flying Fish 1
- Flying Fish 2
- Pinarra Creek
- Infrastructure Area

0 1.75 3.5 7 10.5 14 Kilometers

Figure 12 - Potential Surface Water Impact Areas

Date: 22/08/2018
Size: A3L
Revision: 2
Drawn By: Ryan Warrington
Confidentiality: 1
Scale: 1:250,594
Coordinate System: GCS GDA 1994

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During operations, if large volumes of surface water are intercepted by pits during flood events, this water will be discharged back to the watercourse after the event via pumps and pipe infrastructure in accordance with the Fortescue Surface Water Management Plan and industry guidelines (such as the Department of Water's Water Quality Protection Guidelines for Mining and Mineral Processing Guidelines). Consequently, it is likely that the majority of intercepted surface water will be discharged to watercourses and there will not be a significant change of volume available to downstream ecosystems in these cases.

However, post mine closure, catchment changes may be permanent and reductions in flows are likely to persist. In this case, the greatest potential for impacts created by the mining activities are likely to be related to frequent events, as these provide a more regular source of flow and mine void inundation. The focus of the impact assessment has been on the 50% AEP event from the Surface Water Impact Assessment (Appendix 3). The assessment also includes broader consideration of larger events, but the impacts shown in these scenarios should be carefully considered against the relative frequency of the event.

It should be noted that the flood mapping shows maximum inundation. This inundation extent only occurs for a short duration at the peak of the flood, which is an important consideration given the location of the Proposal within the upper reaches of the local and regional catchments. Upper catchment flooding is associated with a shorter duration storm event due to relatively limited catchment size. Furthermore, areas located downstream that are impacted by reduction in stream flows will still receive runoff from direct rainfall and local catchment contribution.

Excess Water Discharge

Surface hydrology may also be impacted by the discharge of surplus mine dewatering. Fortescue commissioned Water Technology Pty Ltd to prepare the *Eliwana Mine Proposal Discharge Assessment* (Water Technology, 2017). Groundwater modelling predicted the worst-case scenario would result in 350 L/s of surplus water that would require controlled discharge. This rate of discharge is highly conservative, assuming an unlikely dewatering schedule, and it is considered improbable that discharge of this nature would persist for more than a few months at a time. As discussed in Section 4.4.6.1, it is in Fortescue's best interest to manage any surplus water to the benefit of the long term water balance. Discharge of surplus water is therefore considered the least favourable of all surplus water management options.

The controlled discharge of 350 L/s equates to 30.24 ML/day. As detailed in the groundwater modelling (Section 4.4.4.) this rate is a conservative estimate of the upper limit of the potential discharge rate. Although it is unlikely that such a rate would be sustained over an extended period, for modelling purposes this peak rate has been held constant in attempt to quantify the maximum possible extent of impacts (Water Technology, 2017).

Water Technology Pty Ltd developed a TUFLOW hydraulic model using predicted discharge rates, water balance parameters, local topography, evaporation rates, geological and infiltration information to determine assess the likely extent of the footprint of controlled discharge.

The discharge assessment was focused on understanding the distance downstream that discharge was expected to propagate under steady state conditions (i.e. prolonged discharge for an extended period of time). To represent steady state conditions, the creeks were modelled without streamflow, which is the state that which persists for the vast majority of the year. To model this steady state distance, the discharge has been modelled as a constant rate input, (based on maximum expected excess water delivery rate) with infiltration held constant over the model domain. The constant infiltration value was selected based on available literature to represent saturated conditions in the creek bed material (i.e. not dry conditions).

In unsaturated conditions, infiltration rate is significantly higher, in some cases it can be order or magnitude higher. Although the conditions will be unsaturated to begin with (outside of periods of streamflow), if discharge persists the creek bed will become saturated, and the rate at which discharge is lost to the creek bed converges to the infiltration rate for saturated soil conditions. By modelling the discharge with infiltration based on saturated conditions, the discharge will reach a point where the cumulative loss over the entire wetted area is equal to the rate of discharge, such that the extent will not move further and will be in steady state (when three is no streamflow).

In cases where there is streamflow, the rate of infiltration over the steady state discharge extent will not change (since the infiltration is already based on saturated conditions), however it is likely that the discharge will become entrained with the streamflow. Although the magnitude of the creek flow will vary based on the magnitude of rainfall, stream flows events will be in the order of cubic meters per second, compared to the discharge which is litres per second. Consequently, any discharged groundwater that is entrained in stream flows will be highly diluted and is expected to be indistinguishable. This is illustrated visually in Figure x, which shows the indicative dilution factor based on comparison of predicted peak flows from frequent rainfall event (1 in 2 year AEP) to discharge rate. This illustrates that even within the modelled discharge footprint, there is a high level of dilution (>40 times). With this level of dilution, there is not expected to be any observable impact outside of the modelled discharge footprint. In larger events there will be significantly higher levels of dilution. Consequently, only the extent of the location in the creek where discharge can be distinguished is considered relevant, as this represents the potential area where there could be some detectable changes from natural conditions. This impact will only be prominent when there is discharge occurring outside of streamflow conditions, as there will be observable water in an otherwise dry creek bed.

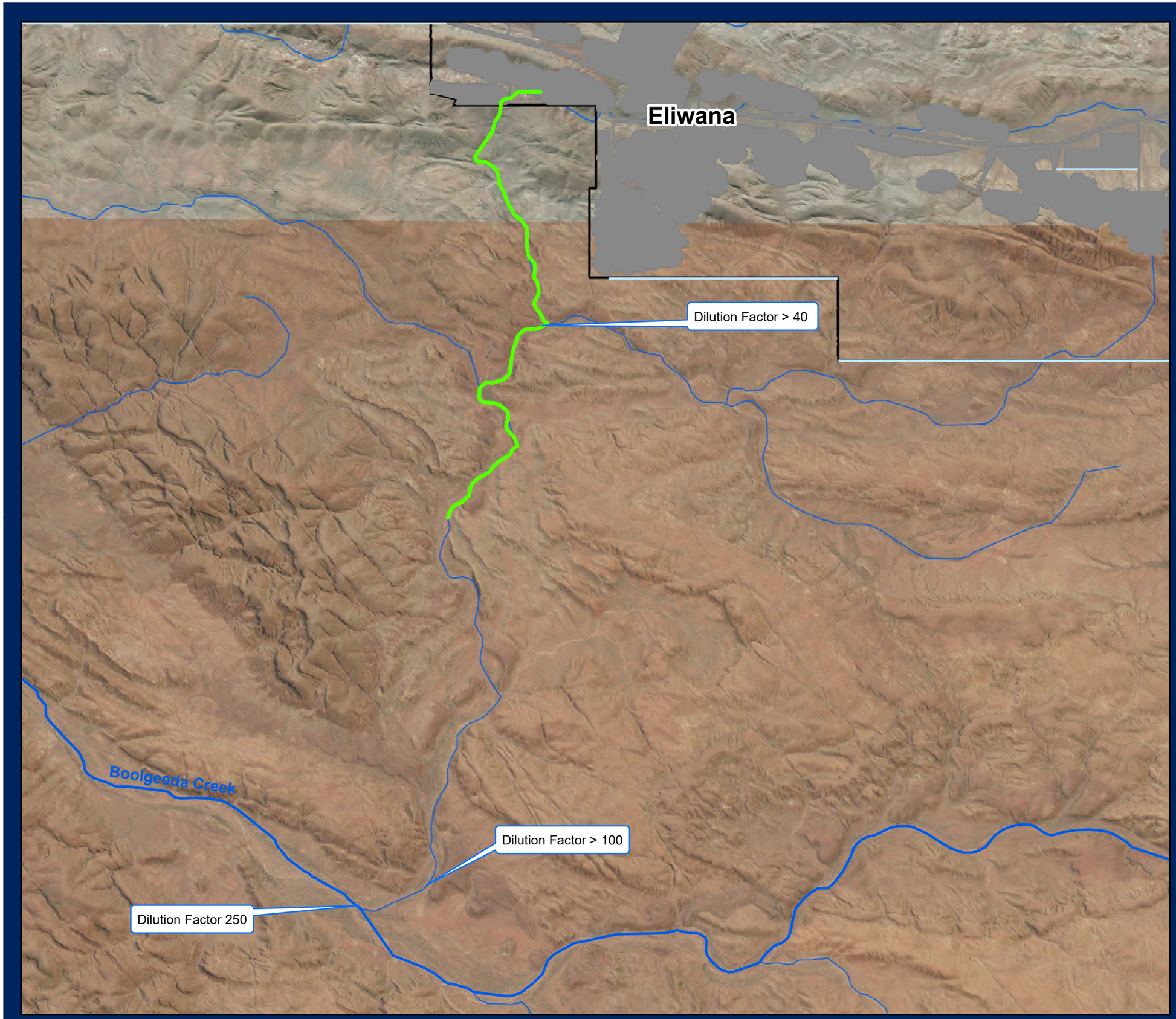
To capture any variations from the predicted steady state discharge extent predicted by modelling with published infiltration rates, additional modelling was undertaken with a more conservative loss rate. This infiltration loss rate was 50% lower than the value obtained from

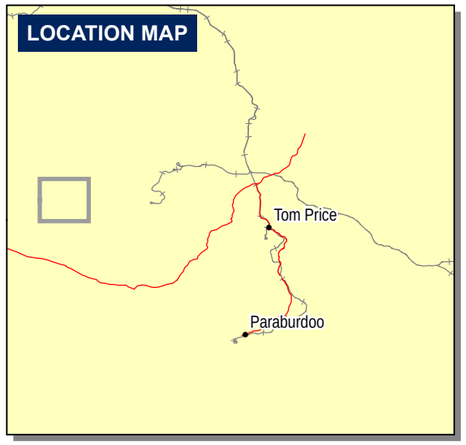
literature (used to derive initial steady state extent), which resulted in a significantly larger extent. By adopting this larger discharge extent using the more conservative loss rate, there is appropriate allowance for impacts due to any differences between modelled and real-world conditions.

Two discharge point options were considered for the discharge assessment. The assessment indicates that the extent of the discharge would be 13 km from the discharge point for Option 1 and 12.1 km from the discharge point for Option 2 (Figure 13) (Water Technology, 2017).

As discussed earlier it must be noted that discharge of surplus mine-dewatering is not a permanent feature of operations. Not all pits are below water table and there are significant periods where operations experience a water deficit, where additional groundwater abstraction is required.

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LEGEND

- Watercourses
- Modelled Discharge Extent
- Mine Development Envelope
- Ground Disturbance

N

0 0.5 1 2 3 4 Kilometers

Figure 13 - Excess Water Discharge Assessment

Date: 22/08/2018
Size: A3L
Revision: 2
Confidentiality: 1

Drawn By: Ryan Warrington
Scale: 1:82,876
Coordinate System: GCS GDA 1994

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Sheetflow Shadowing

The outcome of the baseline model identified that the MDE was channel flow dominated with minimal overland or sheetflow. Flora and vegetation surveys have not identified any habitats which rely on sheetflow (i.e. banded vegetation types or cracking clay flats) within the Mine Development Envelope (Biota, 2017). Fortescue considers the impact of sheetflow shadowing to be negligible across the Proposal.

Mine Void Water Bodies

As discussed in Section 4.4.5.6 preliminary analytical modelling (without closure management) of various post closure mining voids shows that mine void water may contain permanent water bodies post-closure (Golder Associates, 2017d). Eight mine voids may form permanent water bodies and four of these occur on the floodplain where they may interrupt or intercept surface water flow. The remaining four voids are groundwater driven as they occur above the floodplain.

Groundwater Driven Mine Void Water Bodies

The West End pit is planned to be mined to a depth approximately 150 m below the pre-mining water table. Sensitivity of the mine void water model was tested using hydraulic conductivity, groundwater level post mining, pit wall run-off and evaporation parameter variation.

All sensitivity scenarios resulted in the formation of a groundwater dependent mine void lake and the time to reach a steady state water level between 30 and >75 years. The predicted lake would act as a groundwater sink with the lake level between 0 and 50 m below the pre-mining groundwater level (Golder Associates, 2017d).

Groundwater - Surface Water Driven Mine Void Water Bodies

The majority of the below water table mine pits planned within the valley floor comprise groundwater-surface driven water mine voids following closure. This is due to the relative shallow depth of BWT mining, the compartmentalised nature of the groundwater sub-catchments and the potential to capture surface water. As described in Section 4.4.5.6 the mine voids within this category comprise Broadway West 3, Broadway East 1 and 2 and Talisman 2.

Without closure management these voids could either become perennial or ephemeral water bodies dependent upon whether the groundwater head is above or below the level of minimum mine bench. If the groundwater head is above the pit floor, then the void could become a perennial water body. However, if the groundwater head is equal or lower than the minimum bench level, the voids would be influenced by rainfall or surface water inflows only. These voids could form “swamp lands or marshes” at the bottom of the voids if a growth media, such as waste rock or eroded sediment is present inside the void.

Without closure management, mine voids in the floodplain could be inundated by surface water inflows with variation in depth and duration. The depth of inundation and the resultant outflows would vary dependent on the volume of water in the void prior to the inundation event and the shape of the pit voids.

For example, Broadway East 1 and 2 and Talisman may experience outflows during very rare or extreme rainfall events, within a sufficiently wet climatic period. In these instances, the volume of surface water flowing through the floodplain is so large, these voids will completely fill with water and will essentially restore surface water flow to the downstream areas whilst in flood.

For Broadway West 3, the upstream surface water catchment is sufficiently large enough to generate a volume of surface water that could completely fill the void with water and experience outflow on average every year during periods of flooding within the catchment. That is, surface water flows would be re-established downstream of Broadway West 3 on average every year. It should be noted that as typical for a Pilbara streamflow setting, these annual flows are ephemeral and outflow from Broadway West 3 would only occur during periods of flooding/streamflow.

Surface Water Driven Mine Void Water Bodies

Most of the mine voids are likely to terminate above the water table. These mine voids will capture surface water and incident rainfall only. They are likely to be ephemeral and will only host perennial mine void lakes if the rainfall run-off is sufficiently large and frequent (as driven by climatic conditions), and the hydraulic conductivity of the pit floor sufficiently low, such that the water reporting to the mine voids balances or exceeds the infiltration and evaporative losses (Golder Associates, 2017d).

Potential impacts to the quality of groundwater and surface water as a result of mine pit voids is discussed in Section 4.5.

Cumulative Impacts

Fortescue has not identified any water source protection areas, public drinking water source areas, National Parks, conservation estates or other users that will be impacted by the proposed dewatering based on the simulated extents of groundwater level drawdown.

Other groundwater users within the vicinity of the MDE comprise of pastoral land holders with small water demand for stock and other iron ore mining operations. All current open cut iron ore mines within the Brockman syncline currently operate with surplus water demands. These operations discharge surplus water to creek lines or use the water for alternate schemes such as the Nammuldi Agricultural Proposal (NAP) (Golder Associates, 2017d).

The extent of the groundwater and surface water impacts associated with the Proposal are expected to be limited to Fortescue's mining tenure with the exception of the option for discharge of surplus mine water to drainage lines.

The cumulative impacts within the Brockman Syncline bioregion include those associated with Rio Tinto Iron ore's operations at the Brockman 4, Brockman 2 and Nammuldi/Silvergrass mines.

The potential cumulative impacts related to groundwater comprise dewatering, the changes to landforms between pre and post mining that alter recharge regimes, disposal of surplus mine dewater during operations and the generation of mine void lakes on closure (Golder Associates, 2017d).

Given the Eliwana proposal, and the above approved impacts, the most likely cumulative impacts comprise:

- Cumulative dewatering of 'palaeo' groundwater from the Brockman syncline (whilst the drawdown cones from each operation are not anticipated to coincide, overall there will be a loss of stored groundwater across the syncline);
- The cumulative discharge of surplus water from Eliwana, if it was to occur, may mix with discharge from the Brockman 4 Operation to Boolgeeda Creek; and
- Generation of mine void lakes at Nammuldi and Eliwana. As neighbouring mines, the development of mine void lakes at Eliwana will extend the chain of pit lakes already planned to be developed at Rio Tinto's Nammuldi mine through to Eliwana along the local valley.

4.4.6.3 Impacts to Pools

As discussed in Section 4.4.5.5, three pools have been identified within the area impacted either by groundwater abstraction or surface water flows (Figure 10). These pools have not been characterised as either surface or groundwater dependent. However, as a result of changes to either groundwater and/or surface water settings, it is likely that these pools will dry up during operations. Given the level of groundwater drawdown experienced within the individual compartments, it is unlikely that these pools can be managed through supplementation.

Loss of these pools will result in a loss of the ecological function these pools perform, for instance, as habitat for a range of fauna species including aquatic invertebrates or for the maintenance of groundwater dependent vegetation (impacts to GDE vegetation from groundwater and surface water impacts discussed in Sections 4.6.5.9 and 4.6.5.10). The desktop review of surface water features across the MDE and surrounding areas noted that there were more pools and pool systems outside the area impacted by changes to groundwater

and surface water processes and these became more persistent (more likely to be permanent) further north near Duck Creek. Therefore, whilst the loss of these pools may represent a localised impact, there are no impacts to surface water pools more regionally from the proposal.

4.4.7 Mitigation

Fortescue has applied the mitigation hierarchy to the Proposal in relation to hydrological processes. Mitigation measures are summarised in Table 16.

Table 16: Summary of mitigation measures for hydrological processes

Category	Mitigation
Avoidance	The broad Proposal footprint avoids interaction with significant surface water features such as major rivers and major creeks where possible. Where possible, infrastructure and landforms will be placed to avoid interaction with minor surface water features. Where possible exhaust all alternative water reuse or storage options before controlled discharge is considered for surplus mine dewater.
Minimisation	Fortescue has developed geological and hydrogeological models of the MDE in order to allow impacts to be quantified. Fortescue has undertaken modelling of proposed groundwater drawdown associated with mine dewatering and water supply abstraction in order to allow impacts to be quantified. Fortescue has completed surface water modelling in order to allow impacts to be quantified. Minimise disturbance to existing hydrologic regime wherever possible through the implementation of the Fortescue Surface Water Management Plan. Divert significant surface water flows around pits and mining infrastructure where practicable to minimise impact on hydrologic regime.
Management	Implementation of the *Groundwater Management Plan 100-PL-EN-0029* Surface water management measures will be implemented in accordance with the *Surface Water Management Plan 100-PL-EN-1015.* Mine dewatering and water supply abstraction will be managed in accordance with approved Groundwater Operating Strategies. Design, review, revise and update closure landforms throughout the life of the mine to stabilise creeks and minimise groundwater table exposure where practical, in accordance with the *Eliwana Mine Closure Plan EW-PL-EN -0001*.
Research and Modelling	Monitoring of surface water flows to refine understanding of site hydrology Continue hydrological modelling to compare modelled groundwater prediction with actuals Monitoring of groundwater levels to refine understanding of site hydrogeology. Closure-related studies as described within the *Eliwana Mine Closure Plan EW-PL-EN -0001.*
Rehabilitation/Revegetation	Implement the stakeholder engagement and closure planning activities described in the *Eliwana Mine Closure Plan EW-PL-EN -0001.* Rehabilitate disturbed areas at the end of their serviceable or operational life, in accordance with the *Eliwana Mine Closure Plan EW-PL-EN -0001*. These activities will be undertaken progressively during the operating life of the mine.
Offsets	Fortescue will develop an offset strategy, including offsets for disturbance to significant hydrological aspects as required, in consultation with DBCA, EPA and DoEE.

4.4.7.1 Surface Water Management

Fortescue has previously developed the *Surface Water Management Plan 100-PL-EN-1015* (Fortescue, 2014) (Appendix 9) and implemented the Plan at existing operations across the Pilbara. A site-specific Surface Water Management Plan has been prepared for consideration during the assessment of this Proposal (Appendix 10).

The objectives of the Plan are to:

- Identify key environmental activities that have the potential to cause impacts to surface water across Fortescue's operations.
- Identify potential impacts to surface water caused by contamination, excessive erosion and downstream sedimentation resulting from Fortescue activities, and direct and indirect impacts on flora, fauna and vegetation during all stages of Fortescue's existing and proposed Pilbara operations.
- Provide guidance to facilitate robust and consistent use and design of drainage infrastructure.
- Provide guidance for site specific monitoring and reporting of water quality, flow and drainage infrastructure.
- Describe management actions that when implemented, will minimise environmental impacts on surface water.

The Plan addresses surface water management during all phases of the Proposal implementation (construction, operation and decommissioning).

4.4.7.2 Groundwater Management

Fortescue currently implements the *Groundwater Management Plan 100-PL-EN-1009* (Appendix 11) at its operations within the Pilbara. In addition, a site-specific groundwater management plan has been prepared for consideration during the assessment of this Proposal (Appendix 12).

The objective of the Plan is to:

- minimise direct and indirect impacts of Fortescue's groundwater management activities on groundwater quality and quantity in Fortescue Controlled Sites.

The Plan addresses management of groundwater during all phases of the Proposal implementation (construction, operation and decommissioning).

Additionally, where groundwater is to be abstracted it will be done so in accordance with a licence issued under the *Rights in Water and Irrigation Act 1914* and a *Groundwater Operating Strategy* approved by the Department of Water and Environment Regulation.

4.4.7.3 Rehabilitation and Closure

Fortescue develops site specific closure objectives and closure plans for its operations, to ensure that local issues can be resolved in consultation with key stakeholders and specific to the post-mining land use. At Eliwana, this will require feature (pit, waste dump etc.) specific closure strategies to be developed, reviewed and revised over the life of the mine, in consultation with key stakeholders, based on the latest mine plan.

The *Eliwana Mine Closure Plan EW-PL-EN-0001* (Appendix 2) has been developed consistent with the DMP and EPA *Guidelines for Preparing Mine Closure Plans* (2015). The Plan describes the process by which Fortescue will manage the hydrological regimes so that agreed environmental values are maintained post-closure.

The closure objectives of the Plan pertaining to hydrological processes include:

- pit lakes do not present a significant risk to human health or a significant ecological threat; and
- changes to hydrological regimes do not adversely impact downstream environmental or heritage values.

The Plan will be reviewed and revised regularly throughout the mine life, to incorporate the developing knowledge base and outcomes from studies and field trials.

A cycle of risk assessment, planning, implementation, monitoring, validation and adjustment/re-evaluation will be utilised to ensure risks are identified and management strategies are effective. The selection of mitigation strategies is part of the adaptive management process; that is, the mitigation strategy will be informed by ongoing monitoring, modelling and risk assessments. The mitigation strategies outlined in Table 17 available for use in one, or all, of the closure pit lake scenarios.

Table 17: List of Mitigation Strategies Available for Each Pit Lake Category

Mitigation Measures	1	2	3	4
Redesign mine void geometry to reduce potential negative impacts		✓	✓	
Remove deleterious material from wall rock by back excavating	✓	✓	✓	✓
Utilise full backfill for some mine voids to reduce risk		✓	✓	
Utilise partial backfill: • to reduce runoff from deleterious wall rock	✓	✓	✓	✓
• to reduce contact between deleterious wall rock and permanent mine void water (pit lake)		✓	✓	✓
• to reduce groundwater inflow			✓	✓
• with geochemically specific material (e.g. dolomite, organic matter) to induce neutralisation and precipitation of potentially elevated metals and oxyanions/metalloids			✓	✓

Mitigation Measures	1	2	3	4
• to reduce stratification		✓	✓	✓
• to reduce pit lake area and reduce evapoconcentration		✓		
• to reduce mine void depth and encourage outflow to reduce evapoconcentration		✓		
Increase depth of mine void to increase water storage volume so that potential for outflow is further reduced		✓		✓
Creek diversion where practicable, to reduce surface water inflow		✓		✓
Streamflow capture to control the salinisation and acidification of mine void water by constant dilution through seasonal outflow from the lake		✓		✓
Increase drawdown in a zero-recharge compartment in order to reduce groundwater inflow and prevent formation of permanent water			✓	✓
Passive wetland treatment systems and increase of environmental value	✓	✓	✓	✓

4.4.8 Predicted Outcome

Surface Water

During operations there is expected to be changes to the volume of water flowing through some creeks downstream of the proposed disturbance with the potential for some creeks to be captured and contained within the mine voids during operations and post-closure. There is also the potential for these creek inflows to create pit lakes.

On closure the land will be rehabilitated to ensure that indirect impacts resulting from any changes to the hydrological regimes are limited to local tributaries and Pinarra Creek.

Groundwater

The proposal is expected to result in the loss of stored water from the Brockman syncline however this is not anticipated to be significant as there are no other groundwater users identified for the area impacted by drawdown.

During operations surplus mine dewater may need to be discharged into nearby creek systems. The assessment has not identified any areas of significant environmental value that may be impacted by the discharge and this discharge is only required for some periods of operations for the life of the mine.

Following closure, mine pit voids may interact with the underlying groundwater and could impact on the recovery of groundwater within the aquifer, if no closure management was employed. Due to the compartmentalised nature of aquifers in the MDE, the impact is expected to be limited to the specific groundwater sub-catchments associated with the mine void. Residual groundwater level drawdown of between 1 and 37 m has been predicted for the groundwater sub-catchments of the MDE.

4.5 Inland Waters Environmental Quality

Inland waters environmental quality was identified as an environmental factor relevant to the Project in the Environmental Scoping Document (EPA, 2017). Inland Waters Environmental Quality refers to the quality of groundwater and surface water systems. Surface water and groundwater are valuable resources, many of which sustain both ecological and social functions. This chapter describes the quality of the surface water and groundwater systems intersected by the Proposal and should be read in conjunction with the associated sections on Hydrological Processes. The following sections provide an EIA for this factor.

4.5.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for inland waters environmental quality as follows:

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

4.5.2 Policy and Guidance

National

Water quality guidelines for the protection of marine and freshwater ecosystems have been released under the auspices of the National Water Quality Management Strategy (NWQMS) (ANZECC & ARMCANZ, 2000a). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies and are applied to five geographical regions across Australia and New Zealand. The NWQMS is supported by the Guidelines for Groundwater Protection in Australia (ANZECC & ARMCANZ, 2013), which outlines a framework for protecting groundwater in Australia. The guidelines require identification of beneficial uses for groundwater in aquifers, and policy to manage these issues.

A series of guidelines on national water quality management has also been released by the Natural Resource Management Ministerial Council (NRMMC) and, in some cases, in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State

Water resources policy and guidance in Western Australia relevant to the Proposal includes:

- *Preventing Acid and Metalliferous Drainage* (DIIS, 2016);
- *Water in Mining Guideline* (DoW, 2013a);
- *Pilbara Regional Water Plan* (DoW, 2010);
- *State Water Quality Management Strategy* (GWA, 2003);

Water Quality Protection Notes and Guidelines for mining and mineral processing applied by DWER and DMIRS including the WRC (Water and Rivers Commission) *Mining and Mineral Processing - Mine dewatering: Water Quality Protection Guidelines No. 11* (WRC, DME & DEP, 2000b).

The Government of Western Australia developed the *State Water Quality Management Strategy* in 2003 to supplement the National Water Quality Management Strategy with the objective "*to achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development".*

The *State Water Quality Management Strategy* proposes that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions can then require implementation of the Water Conservation Plan to an agreed schedule.

In 2000, the Water and Rivers Commission (now DWER) and Department of Minerals and Energy (now DMIRS) developed a series of Water Quality Protection Notes and Guidelines for mining and mineral processing. These guidelines address a range of mine site issues including dewatering, installation of groundwater monitoring wells, water quality monitoring, stormwater management and acid mine drainage.

In setting criteria for water quality impacts, the *Mining and Mineral Processing - Mine dewatering: Water Quality Protection Guidelines No. 11* (WRC, DME & DEP, 2000b) discusses mine dewatering receiving water quality criteria and notes that the appropriate discharge criteria would be set under the licensing provisions of the EP Act.

- The *Environmental Factor Guideline: Inland Waters Environmental Quality* (EPA, 2016d) provides an outline of how this factor is considered by the EPA in the EIA process. Relevant matters discussed in Guideline include the following:
- Definition of "inland waters environmental quality";
- The environmental objective for inland waters environmental quality;
- Considerations for EIA, including;
    - Application of the mitigation hierarchy to avoid or minimise impacts to inland water environmental quality, where possible;

- The environmental values of the inland waters;
- An assessment of the continuation of any pathways through which water quality may be impacted resulting in a risk assessment for the likelihood for any impacts;
- Potential impacts to water quality, the significance of any likely change to water quality and an assessment of cumulative impacts of any change;
- Water quality assessment using accredited methods and against recognised water quality criteria.

Fortescue has specifically considered this guidance in the following ways:

- Describes the baseline water quality and receiving environment;
- Identification of activities which may lead to impacts to inland waters;
- Presents the analyses results and data assessment undertaken to assess the source for any potential impacts to inland waters;
- An assessment of the impacts to inland waters using the surveys and analytical results, the connectivity of pathways and the significance and likelihood to impact inland waters; and
- Application of the mitigation hierarchy in elements of project design.

4.5.3 Studies and Surveys

Fortescue has conducted studies to develop a thorough understanding of the geological, hydrological, hydrogeological and geochemical environment of the Proposal site. The key findings of these reports are summarised in this chapter and are used to assess potential impacts to surface water and groundwater as a result of the Proposal. The most relevant studies include:

- Western Hub Stage 1 Subsurface Material Characterisation (Fortescue, 2017b); (Appendix 13)
- Western Hub Stage 1 Conceptual Site Model and Operational Risk Assessment (Fortescue, 2017c) (Appendix 14); and
- Western Hub Stage 1 Geochemistry Risk Assessment for Closure (Fortescue, 2017d) (Appendix 15).

4.5.4 Receiving Environment

An understanding of baseline groundwater and surface water quality is required so that an assessment of potential impacts can be undertaken. Baseline water quality has been

determined through sampling and comparison with ANZECC 95% of species limit of protection (SLP) as upstream mines and other land uses are likely to have had an impact on groundwater and surface water quality (ANZECC & ARMCANZ, 2000a). Site specific assessment criteria will be developed prior to operations commencing as the number of groundwater and surface water samples increases. Baseline groundwater and surface water data has been summarised from the Subsurface Materials Characterisation report (Fortescue, 2017b).

4.5.4.1 Preliminary Baseline Groundwater Quality

Fortescue has established a number of monitoring bores across the proposed mining areas at Eliwana and Flying Fish. A total of 39 groundwater samples have been collected from 23 bores variously installed into the Turee Creek Formation (shale), Mineralised Brockman Formation (banded iron formation - BIF) and the Mount Newman Member (weathered BIF), with the majority of samples (23) collected from the Bee Gorge (goethite and shale) and Paraburdoo Members (dolomite) of the Wittenoom Formation.

Groundwater in the Eliwana Mine area is of a calcium/magnesium-bicarbonate type while Flying Fish groundwater contains significant bicarbonate but is dominated by sodium/magnesium-chloride type water. Alkalinity is abundant with pH values all in the alkaline range and elevated hardness. Salinity across the project area ranges from approximately 400 - 2,500 µS/cm. Bores in the Turee Creek Formation (situated to the south of the project area), have the freshest groundwater with a salinity of ~500 µS/cm. Groundwater in the Eliwana area has a salinity of 900 – 1,000 µS/cm. The bores installed in the Flying Fish Mining area have higher salinity of between 1,900 – 2,500 µS/cm (Golder Associates, 2017d). The baseline groundwater quality ranges are presented in Table 18 for all groundwater bores.

Table 18: Range of Groundwater Parameters and Major Ion Concentrations (mg/L)

Range	Min	Max	Mean
pH	7.1	8.5	7.9
Electrical Conductivity µS/cm	404	2,480	1,330
Total Alkalinity as $CaCO_3$	7.0	405	288
Hardness as $CaCO_3$	112	905	488
Calcium	18	136	87
Potassium	6.0	26	13
Magnesium	16	138	65
Sodium	37	232	106
Chloride	70	503	210
Sulfate as SO_4	17	373	162
Total Nitrogen as N	<0.01	1.9	0.34
Silicon	7.0	34	12

Range	Min	Max	Mean
Arsenic	<0.001	0.001	<0.001
Boron	<0.05	0.74	0.37
Barium	<0.001	0.049	0.0066
Chromium	<0.001	0.001	<0.001
Cobalt	<0.001	0.002	<0.001
Copper	<0.001	0.02	0.0031
Manganese	<0.001	0.26	0.021
Nickel	<0.001	0.003	<0.001
Lead	<0.001	0.002	<0.001
Strontium	<0.001	0.48	0.22
Zinc	<0.005	0.055	0.013

Table adapted from Appendix 13 – Subsurface Materials Characterisation Report (Fortescue, 2017b)

Aluminium, antimony, beryllium, cadmium, iron, mercury, molybdenum, selenium, silver, tin and vanadium were tested for but are not shown in Table 18 as concentrations were below the limit of reporting (<LOR) in all 39 samples.

Arsenic, chromium, cobalt, nickel and lead occur in individual samples but are not frequently detected and have low concentrations just above the detection limits.

Barium, boron, copper, manganese, strontium and zinc are commonly detected in groundwater. The copper and zinc concentrations occur above the ANZECC 95% of SLP of 0.0014 mg/L and 0.008 mg/L, respectively. However, with the high hardness (>30 mg $CaCO_3$/L) the toxicity of these elements is reduced, and the limits of protection can be modified. Following this calculation for each water sample, two samples of copper and none of zinc occur above the ANZECC 95% of SLP hardness modified trigger value (HMTV).

4.5.4.2 Preliminary Baseline Surface Water Quality

A total of 14 surface water samples have been collected to determine baseline water quality (Table 19). Generally, surface water meets most ADWG (NHMRC, 2011). All pH values are in the alkaline range, salinity is considered “fresh” and most samples have elevated (>30 mg $CaCO_3$/L) hardness. Two samples contain one detection each of copper and zinc. For all samples aluminium and iron exceed the aesthetic taste limits with minor concentrations of boron, barium and manganese. All other elements that were tested occurred below the limit of reporting.

Table 19: Range of surface water major ion concentrations (mg/L)

Parameter	Min	Max	Mean
pH	7.3	8.1	7.62
Electrical Conductivity (µS/cm)	44	322	144
Total Alkalinity as $CaCO_3$	2.0	58	26
Hardness as $CaCO_3$	12	147	59
Calcium	3.0	42	18
Manganese	0.50	10	3.6
Sodium	2.0	17	7.6
Potassium	2.0	8	3.9
Chloride	4.0	28	26
Sulfate	2.0	25	11
Fluoride	<0.01	0.2	9.6
Nitrate + Nitrite as N	0.12	1.3	0.073
Ammonium as N	0.02	0.25	0.48
Aluminium	<0.01	0.44	0.16
Boron	<0.05	0.070	0.036
Barium	<0.001	0.016	0.0062
Copper	<0.001	0.0020	<0.001
Iron	<0.05	0.50	0.22
Manganese	<0.001	0.11	0.01
Phosphate as P	<0.01	0.20	0.02
Zinc	<0.005	0.073	0.0075

Table adapted from Appendix 13 – Subsurface Materials Characterisation Report (Fortescue, 2017b)

4.5.4.3 Nature of Waste Stored in Waste Structures

The characterisation of subsurface material has followed a staged approach with each stage of assessment providing more detailed analyses than the previous stage. The geochemical characterisation work has progressed as detailed below:

- The Preliminary stage included an assessment of the entire ore database of assay data.
- The Phase I ‘static test’ stage details a large volume of net acid generation oxidation testing to determine acid risk across the site.
- The Phase II stage detailing total and leachable element analyses were conducted.
- The Phase III test work is ongoing as it deals with short-term leach testing and long-term kinetic weathering potential.

This work has been combined into this single document to present a single point of reference for all geochemical assessment completed to date (Appendix 13). Following the geochemical study, a geochemical conceptual site model detailing the contaminant (source)-transport (pathway)-receptor (CTR) and contamination risk assessment was conducted (Appendix 14).

Acid Drainage Potential

The preliminary phase of characterisation assessed the assay database using calcium and total sulphur as proxies for neutralisation and acid generation, respectively. Based on the database, it is clear that are a larger number of acid consuming and neutralising assays in the waste material for each mining area and, in general, the risk of acid generation appears to be low. This preliminary assessment identified a potential risk from the presence of the Mount McRae Shale Formation and the West Angela Member shale subunits of the Wittenoom Formation and that the basal units of the mineralised material should be further investigated.

The phase I assessment conducted large-scale testing of the net acid generating potential of 1,000 samples of waste and ore material. The assumption that the majority of material has a low potential for acid generation and, consequently, is low risk, were confirmed. Even within the units identified as having the highest risk, Mount McRae Shale and West Angela Member shale, elevated sulphur occurs in individual samples and is not representative of the entirety of the material encountered. The acid risk is low and the volume of these materials excavated or exposed is low.

Full acid-base accounting was conducted in the Phase II stage of the test work. This more detailed testing allows the accuracy of assumptions to be tested and a classification system for waste to be refined and developed. The detailed acid-base accounting confirmed the assumptions made in the Preliminary and Phase I assessments.

- Calcium assays are an accurate proxy for predicting carbonate neutralising potential.
- Sulphur assays are an accurate proxy for predicting acid generating potential.
- Acid drainage is a risk from Mount McRae Shale, West Angela Member shale subunits and a minor risk from the basal Dales Gorge Member unit (D1).

Saline Drainage Potential

Phase II characterisation included water leach testing for soluble ions. The potential for saline drainage is based on a comparison of major soluble ions leached from waste rock samples compared to the local, natural groundwater salinity and composition. The water leached major ion concentrations from waste rock were compared to groundwater concentrations and were not found to be significantly different. As a result, there is not likely to be a risk to groundwater of saline drainage.

Metalliferous Drainage Potential

The Phase II characterisation included an acid digestion of the samples for total metal concentration and water leach testing for soluble elements. This testing found that while the acid risk from Mount McRae Shale and West Angela Member shale subunits is generally low, there is a high likelihood that any drainage from these units will neutral to alkaline and will contain elevated concentrations of metals.

It is expected that this material will leach arsenic, selenium and/or manganese, with the potential for minor chromium, copper and nickel at elevated concentrations. As arsenic is a potential carcinogen and selenium exhibits a tendency to bio-accumulate, the precautionary principal dictates that a conservative approach should be taken for these units.\

Waste Rock Physical Characteristics

Geologically derived waste (waste rock) at Eliwana originates from hard rock and sediment that is mined to facilitate access to the targeted iron ore deposits (overburden) and zones within the targeted deposit that have a low iron content or impurities (interburden). Excavation and disposal practices combine the waste rock, sometimes from multiple pits, resulting in a heterogeneous waste rock mix.

The physical characteristics of waste material generated from the geological units know from Eliwana are generally well known, being similar to other mine sites within the Pilbara, including Fortescues Solomon Mine. Table 20 lists the approximate volumes of waste rock and proportion of total volume that may be mined and lists whether the material is deleterious and / or erodible.

There are six dominant geological sources of waste rock (from largest to smallest): Dales Gorge Member, Joffre Member, Tertiary materials, Whaleback Shale Formation, Mount Newman Member and Wittenoom Formation. The approximate volumes of waste rock and proportion of total volume that may be mined and lists whether the material is deleterious and / or erodible.

Most of the material (~60%) is likely to be of moderate erodibility. Consequently, a relatively conservative approach to waste dump design will be required to manage erosion. Around 20% of the waste rock, however, is likely to be of low erodibility and suitable for rock armouring, should it be required.

A maximum of 8% of all waste rock is currently defined as deleterious. This estimate may reduce with more targeted definition of the waste rock units. The deleterious units will need to be encapsulated within benign material.

Table 20: Combined Geological Composition of Waste Rock

Geology		Volume	% of all waste	Erodibility*	Deleterious
Tertiary alluvial/colluvial and detrital		90Mt	16	High	No
Brockman Iron Formation	Joffre Member	110Mt	19	Low	No
	Whaleback Shale Member	40Mt	6	Moderate	No
	Dales Gorge Member	200Mt	3	Moderate	No
	D1	20Mt	1	Moderate	Yes
Mount McRae Shale		10Mt	9	Moderate	Yes
Wittenoom Formation		50Mt	6	High	No
	West Angeles Member[#]	40Mt	9	High	Yes
Marra Mamba Formation	Mount Newman Member	50Mt	<5	Low	No
Other minor contributors				-	No

*Potential to generate an erodible waste rock with respect to other waste material types in the Pilbara, based on general geological characteristics. Site specific test work required after blasting and material handling to validate categories and establish properties.

[#]Potential for dissolution or chemical hazard. Pit specific test work is required

Other Characterisation

From preliminary tailings characterisation, in general tailings material is not considered a risk for acid generation, saline or metalliferous drainage, however may result in minor chromium drainage.

In general, the mineralogy of material testing contained abundant goethite, hematite, quartz/silica and kaolinite, with secondary clays. No pyrite was detected above limits of reporting and there were two detections of neutralising minerals dolomite and calcite.

The self-heating and auto-ignition potential of organic shales have not been assessed at this stage of the project but will be investigated prior to disturbance, for health and safety concerns and reactivity when disposed of in the waste rock landform.

Weathering Potential

Detailed short-term, sequential leaching testing was conducted on waste material for the potential for elements to be present in drainage water from the mine under a range of conditions. The sequential leaching subjects the material to increasingly aggressive solutions which elements become mobile and what is unavailable to leach. This testing found that the vast majority of elements only become mobile under aggressive, very strong acid conditions, which are not likely to occur on site or in nature.

Kinetic testing for long-term weathering potential is currently being conducted.

4.5.5 Potential Impacts to Inland Waters

Potential impacts to inland waters environmental quality, not considering mitigation measures, include as listed in Table 21.

Table 21: Potential Water Quality Impacts

Issue	Areas of Concern	Activity
Reduced groundwater and surface water quality	Negative impact on waterways and wetlands of diffuse source pollution, including hydrocarbons.	Dewatering discharges where the water quality (temperature, heavy metals, carbonates) is a concern
Waste structures (including landfill, waste water and WRLs)	Appropriate siting of waste structures in a catchment (considering surface and groundwater systems, and sensitive receptors)	Direct discharge of wastewater to surface water systems. Clearing and stockpiling of waste rock that releases sediments to the environment.
	The nature of the materials stored in the waste structures, as there is the potential for erosion, oxidisation of acid forming materials, and metals and other elements to seep into groundwater and surface water systems	Waste disposal that produces leachate(s). Alteration of the land surface or dewatering of aquifers that exposes acid sulfate soils or creates acid rock drainage
	The availability of suitable material to encapsulate (and neutralise) waste that could cause contamination	New or changed land uses which lead to offsite discharge of wastes
	The design, monitoring and management of waste structure to avoid impacts, taking into account appropriate standards.	Any drainage construction directly impacting on waterways or which leads to the discharge of drainage water or deleterious sediments to waterways.
Creation of Mine Pit Lakes	Poor pit lake water quality through acid rock drainage, such as toxic concentrations of heavy metals or biological process, such as toxic algae.	Discharge of water to storage or evaporative basins, where there is potential for overflow or leakage

4.5.6 Assessment of Impacts

In order to assess the impact of waste materials and water sources a geochemical conceptual site model (CSM) is required to detail the interaction between waste rock landforms, mine voids, surface water, groundwater and geological characteristics.

4.5.6.1 Geochemical Conceptual Site Model

The *Subsurface Materials Characterisation Assessment* identified the rock material likely to pose the greatest risk of generating AMD. How and where this material is exposed during mining determines whether the material becomes a potential source of contamination. In

addition, the properties of surface water and groundwater discussed in the previous section are included to construct the contaminant-pathway-receptor model. The conceptual site model showing geology, mine voids and key transport pathways, is given in Plate 7.

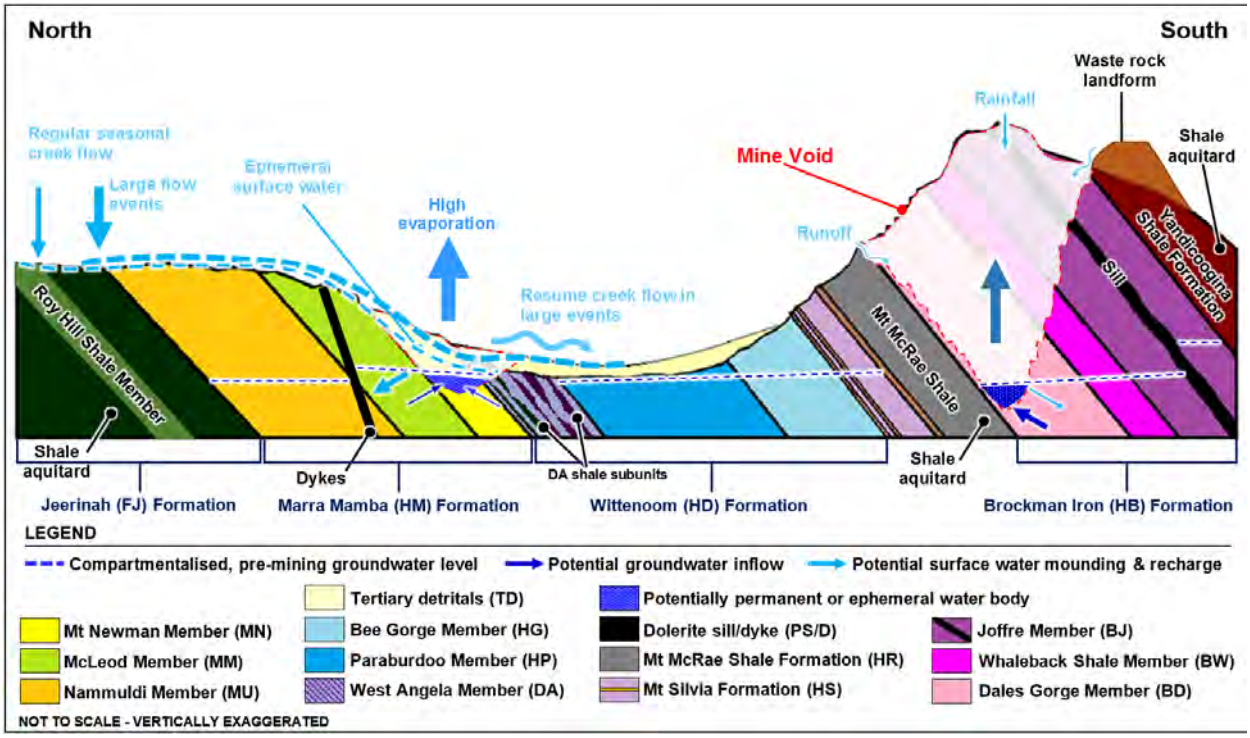


Plate 7: Geochemical Conceptual Site Model

The geochemical conceptual site model shows representative mine voids to the north and south of the Pinarra Creek valley. The southern mine voids are within the Brockman Iron (HB) Formation with mineralisation occurring in the Joffre (BJ) Whaleback Shale (BW) and Dales Gorge (BD) Member units. The northern mine voids are located in the Marra Mamba (HM) Formation and will be mining mineralisation in the Mount Newman (MN) Member. The conceptual site model also shows the differing water levels in the groundwater compartments that are bounded by shale units and dykes. The southern mine voids are below the water table and will form terminal sinks. Some of the northern mine voids are in connection with groundwater and surface water. The presence of Mount McRae Shale (HR) in the wall of southern mine voids may result in neutral, metalliferous drainage, while the presence of pyritic shale subunits of the West Angela (DA) Member represents a risk in the wall of the northern mine voids. Of particular note:

- There is sufficient neutralising and acid consuming material for construction and the encapsulation of any potentially AMD generating material.
- Pyritic shale units adjacent to mine voids are likely to undergo only negligible dewatering owing to mining activities as these units are highly impermeable and as a result are not considered to be a potential source.

- All mine voids will temporarily contain water from direct precipitation and runoff. The time period that water is present will depend on the size of the event and will be episodic, ephemeral or semi-permanent before infiltrating and evaporating. Salt build-up as a result is not expected to be high or to pose a risk of contamination in the event of a flushing episode. A small number of these mine voids will contain permanent water and develop pit lakes.

4.5.6.2 Appropriate Siting of Infrastructure and Landforms

Mine infrastructure, such as landfill facilities, mine voids, waste dumps, haul roads, conveyors and pipelines can impact water quality. The potential sources of impacts water quality include:

- Dust, erosion and sedimentation from earthworks and clearing activities; and
- Drainage of poor quality water from landforms.

Clearing and disturbance for mining and associated infrastructure can impact the water quality of downgradient creeks. Clearing activities are likely to result in dust and erosion of exposed surfaces. The increase in dust and sediments can be flushed into downgradient creeks and impact the turbidity of these creeks.

Drainage from and erosion of disturbed landform surfaces can impact the water quality of downgradient creeks. Dust and sediments from the disturbed landforms surfaces can drain into the creeks resulting in increased turbidity and sedimentation. This risk is potentially greatest where clearing and earthworks occur on steep slopes with erosive soils, or during construction of waste rock landforms.

The assessment of potential impacts from surface water outflows from mine voids is discussed further below.

4.5.6.3 Quality of Surface or Groundwater Associated with Waste Structures

Acidic drainage is unlikely to occur based on the low capacity of material to generate acid and the high neutralising potential of material. Any neutral or alkaline drainage may, however, contain elevated concentrations of the oxyanions arsenic and selenium as well as metals such as manganese, chromium, copper and nickel. Arsenic is a known carcinogen and selenium is known to bio-accumulate in sensitive aquatic ecosystems. If seepage from waste structures came into contact with a pathway there may be accumulation of these elements in ecosystems and a conservative approach to design and classification of material has been adopted.

4.5.6.4 Quality of Surface or Groundwater Associated with Mine Voids

The types of mine void water bodies that may occur following closure were discussed in Section 4.4.5.6. This includes surface water, groundwater and combined surface-groundwater driven mine void lakes during operations and potentially on closure.

The duration of water mine voids is defined as:

- Semi-permanent: any amount of water that exists for longer than a month up to 10 months.
- Permanent any water that exists for longer than 10 months. It is possible that "permanent" water may dry up given enough time with no further input, as *permanent* is a duration of time not a guarantee of perpetuity. Permanent mine void water will occur where mining is conducted below the pre-disturbance groundwater level and/or the mine void is located in a large surface water catchment.

As described in Section 4.4.7.3 closure management will vary from pit to pit, in consideration of key stakeholder negotiated post-closure land uses and the mine development sequence employed during the life of the operation. In order to provide an assessment of potential closure impacts a conservative approach has been assumed whereby all mine voids remain open, with no closure management applied.

Under this scenario, water quality in the permanent pit lakes that would form in Eagles Nest, M6, West End and West Side is likely to deteriorate as a result of evaporation and runoff from Mount McRae Shale Formation exposed in the wall rock and, over time, would contain high salinity and dissolved metals. The positioning of these pits in the landscape and the results of the groundwater recovery assessments suggest these four pit lakes would be terminal, evaporative sinks with no outflow and are not connected to any transport pathways or receptors. As such they are not considered to pose a risk to the downstream environment, surface water or groundwater.

Without closure management, Broadway East 1 and 2 and Talisman 2 could form permanent surface and groundwater fed pit lakes. The water quality in these voids would comprise fresh surface water and slightly more saline groundwater. The positioning of these pits in the landscape and the results of the groundwater recovery assessments suggest these pits would be evaporative sinks. Water quality would deteriorate over time as a result of evapoconcentration and potential exposure of West Angela Member shale in the footwall rock. Under these conditions, these mine voids would not be considered to pose a risk to the downstream environment as water is only released to the environment during very rare to extreme flood events. These events are unlikely to pose a risk of contamination from evapoconcentrated salts and metals as a result of the very large dilution factor present at the time of release, resulting in low concentrations of salts and metals within the creek flow.

Creek flows through Broadway West pit is likely to resume with or without closure management. Without management, creek flow is likely to resume during Frequent (occurring more than once every 10 years) to Rare (occurring between 10 and 50 years) volume rainfall events. Flow from this void will be brief and episodic, mimicking natural flood events. During the remainder of the year, Broadway West will host a mine void lake that will be surface water and groundwater driven. During the dry season there is the potential for the water quality to change. However, with constant influx of fresh surface water into the void, water quality is not likely to degrade to a level where it could have a detrimental effect on the environment.

4.5.6.5 Quality of Excess Water Disposal

There are two potential sources of water disposal to downstream environments during operations:

- Disposal of groundwater abstracted during mining to allow for dry mining conditions. Table 12 in Section 4.4.4.2 detailed periods during operations where there is a surplus of water.
- Discharge of water captured by mine voids during operations. This may occur after significant rainfall events.

Surface water quality is fresh and resembles rainfall, as flow is episodic and infiltrates quickly; as a result, most surface water flows do not entrain a large volume of dissolved salts. Water discharged from pits during mine operations will comprise mostly rainwater and surface water run-off. This water may be high in sediments, but is unlikely to be stored within pits long enough for any geochemical processes occur which may degrade the water quality. Sediment load is unlikely to be greater than the sediment load of surface water during flood events.

Groundwater in the Eliwana Mine area is fresh to brackish ranging from ~400 mg/L total dissolved solids in the Eliwana area, to ~1,500 mg/L in the Flying Fish Area. Water type in the Eliwana area is of a calcium/magnesium-bicarbonate type while Flying Fish groundwater contains significant bicarbonate is dominated by sodium/magnesium-chloride type water. Alkalinity is abundant with pH values all in the alkaline range and elevated hardness. It has been demonstrated that a minor increase in salinity of surface water flows, from rain water quality, due to surplus groundwater discharge down creek lines, generally has a positive impact to the ecosystem (Wetlands Research and Management, 2010) with fauna taxa increasing during dry periods.

It has been modelled (Section 4.4.6.2) that surplus discharge is unlikely to travel a significant distance downstream from the mine and will not reach Boolgeeda Creek during dry weather conditions. During rainfall events catchment flow will mix with discharge water and move downstream for increasing distances, depending on the magnitude and duration of the rainfall event. For an event that is likely to occur frequently (e.g. 1:2 probability or 50% chance of

occurrence), the volume of water from the Pinarra catchment alone will dilute surplus discharge water by approximately 40 times. Groundwater from the Eliwana area has an average TDS of less than 500 mg/L. During a small, high probability rain event dilution will result in creek water with a quality of less than 13 mg/L, which is an insignificant addition of salinity to surface water flows at the head of the catchment. With increasing distance down the creek, increasing dilution will result in the mix of surplus discharge water and surface water being indistinguishable from natural flow quality prior to reaching Boolgeeda Creek.

With these frequent events resulting in flushing a build-up of salts is not likely. Dilution from catchment runoff will be in the order of 250 times, if flow volume is large enough to reach Boolgeeda Creek. Accumulated salts are unlikely to have an impact on the Boolgeeda system at these predicted dilution conditions.

4.5.6.6 Hydrocarbon, Chemical and Wastewater Spills

Mine infrastructure, such as landfill facilities, workshops and the wastewater treatment plant can impact water quality. The sources of contamination to surface and groundwater include:

- operational leaks and spills; and
- release of untreated waste water from sewage treatment plants.

Hydrocarbons and chemicals when released to the environment may have toxic affects to native fauna. This can be either directly due to becoming coated with oil or ingestion of polluted water, or indirectly due to bioaccumulation of harmful chemicals in the food chain.

Fortescue keeps records of all hydrocarbon incidents and has effective management practices for the removal and remediation of hydrocarbon spills. Based on Fortescue's previous operational experience, hydrocarbon, chemical and wastewater contamination is not considered to be a high risk and no significant impacts are expected.

4.5.7 Mitigation

Fortescue has applied the mitigation hierarchy (BBOP, 2012) to the Proposal in relation to inland waters environmental quality. Mitigation measures include:

Avoidance

- The Proposal avoids interaction with significant surface water features such as major rivers and major creeks where practicable;
- Where possible, infrastructure and landforms will be placed to avoid interaction with major surface water features.

- Where practicable and cost-effective mining voids may be redesigned, to avoid exposing deleterious material in walls.
- Do not use deleterious rock material for construction or expose such material during infrastructure installation.
- Mount McRae Shale and West Angela units will not be used as construction material.

Disposal of surplus mine dewater is considered as a last resort option after all other potential uses, including storage in pits or re-injection have been investigated.

Minimisation of waste landform impacts

- Fortescue will ensure that appropriate handling and storage procedures are in place to avoid impacts to water quality associated with chemical or hydrocarbon spills;
- Fortescue will undertake water quality testing of mine void water to verify quality of discharge of water into the creeklines;
- Fortescue will continue the detailed geochemical assessment of waste rock to facilitate segregation and appropriate disposal of deleterious materials within WRLs;
- The remaining management procedures detailed in Fortescue's *AMD Management Plan* to be conducted prior to and during construction and operations:
    - Ongoing water quality and waste rock monitoring;
    - Establish baseline trigger values - will be completed when sufficient monitoring has established a robust dataset of water quality samples;
    - Waste rock landform planning;
- WRLs will be designed to encapsulate or otherwise manage deleterious material using mitigation measures to minimise the risk of acid and / or metalliferous drainage generation.
- Closure landforms will be designed to be acceptably stable in order to minimise impacts to water quality associated with erosion and sedimentation;
- Carbonaceous shale material should be sent for self-heating and auto-ignition risk assessment testing prior to operations commencing. The potential for spontaneous combustion will also affect drill and blast activities and will be addressed in health and safety plans.

Modelling and Research

- Ongoing waste characterisation to collect additional samples in areas and rock units which require greater certainty;
- Continuously update the geological model as the resource is further defined and more extensive information about the distribution and volumes of waste types is collected;

- Closure-related studies as described within the *Eliwana Mine Closure Plan EW-PL-EN -0001*.
- Adaptive management of pit lakes as outlined in Section 2.3 of the *Closure-related Management Plan EW-PL-EN-0002.*

Rehabilitation/Revegetation

- Fortescue will progressively rehabilitate disturbed areas at the end of their serviceable or operational life where appropriate;
- To ensure water quality achieves the closure objectives, conduct rehabilitation in accordance with the *Eliwana Mine Closure Plan EW-PL-EN-0001* (Appendix 2)

4.5.8 Predicted Outcome

After the application of management and mitigation measures, the Proposal is expected to result in the following outcomes in relation to inland waters environmental quality.

Likely residual impacts as a result of the Proposal include:

- Minimal impacts to surface water quality are expected from erosion and sedimentation caused from clearing and construction of mine structures;
- The quality of water discharged to creeklines from mine dewatering activities is not considered to be deleterious to the health of creekline ecosystems;
- The discharge of mine void water during operations into the creeks is not expected to significantly impact water quality. The water will be tested to confirm the suitability for discharge and/or treated to render the water suitable for discharge;
- The creation of permanent pit lakes is expected at closure. Closure strategies will be progressively developed and reviewed throughout the mine life to ensure that the closure objectives relating to water quality can be met on closure;
- Impacts from hydrocarbon and chemical spills are not expected to impact surface water or groundwater quality.

The Proposal is not expected to result in significant adverse impacts to inland waters environmental quality from the implementation of the Proposal. The mitigation measures described will ensure minimisation of water quality impacts. In considering the outcome as described, the Proposal is expected to meet the EPA objective for inland waters environmental quality to maintain the quality of groundwater and surface water so that environmental values are protected.

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4.6 Flora and Vegetation

Flora and vegetation was identified as an environmental factor relevant to the Proposal in the Environmental Scoping Document (EPA, 2017). The following sections provide an environmental impact assessment for this factor.

4.6.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for flora and vegetation as follows:

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

4.6.2 Policy and Guidance

The following policy and guidance is relevant to this factor:

Environmental Factor Guideline: Flora and Vegetation (EPA, 2016e)[1]**.**

This guideline provides an outline of how flora and vegetation is considered by the EPA in the environmental impact assessment (EIA) process. Relevant matters discussed in guideline include the following:

- description of EIA considerations, including:
  - application of the mitigation hierarchy
  - the flora and vegetation affected by the proposal
  - the potential impacts and the activities that will cause them
  - surveys and analyses required
  - the significance of the flora and vegetation, and the risk to the flora and vegetation
  - the current state of knowledge of flora and vegetation and the level of confidence underpinning the predicted residual impacts
- describes issues commonly encountered by the EPA during EIA of this factor
- provides a summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

[1] Note, this guidance supersedes EPA Position Statements 2 and 3.

Technical Guidance – Flora and Vegetation Surveys for Environmental Impact (EPA, 2016f)[2]**.**

This guidance is intended to ensure adequate flora and vegetation data of an appropriate standard are obtained and used in EIA, specifically providing advice on:

- survey preparation and desktop study;
- determining the type of survey required;
- sampling techniques and survey design; and
- data analysis and reporting.

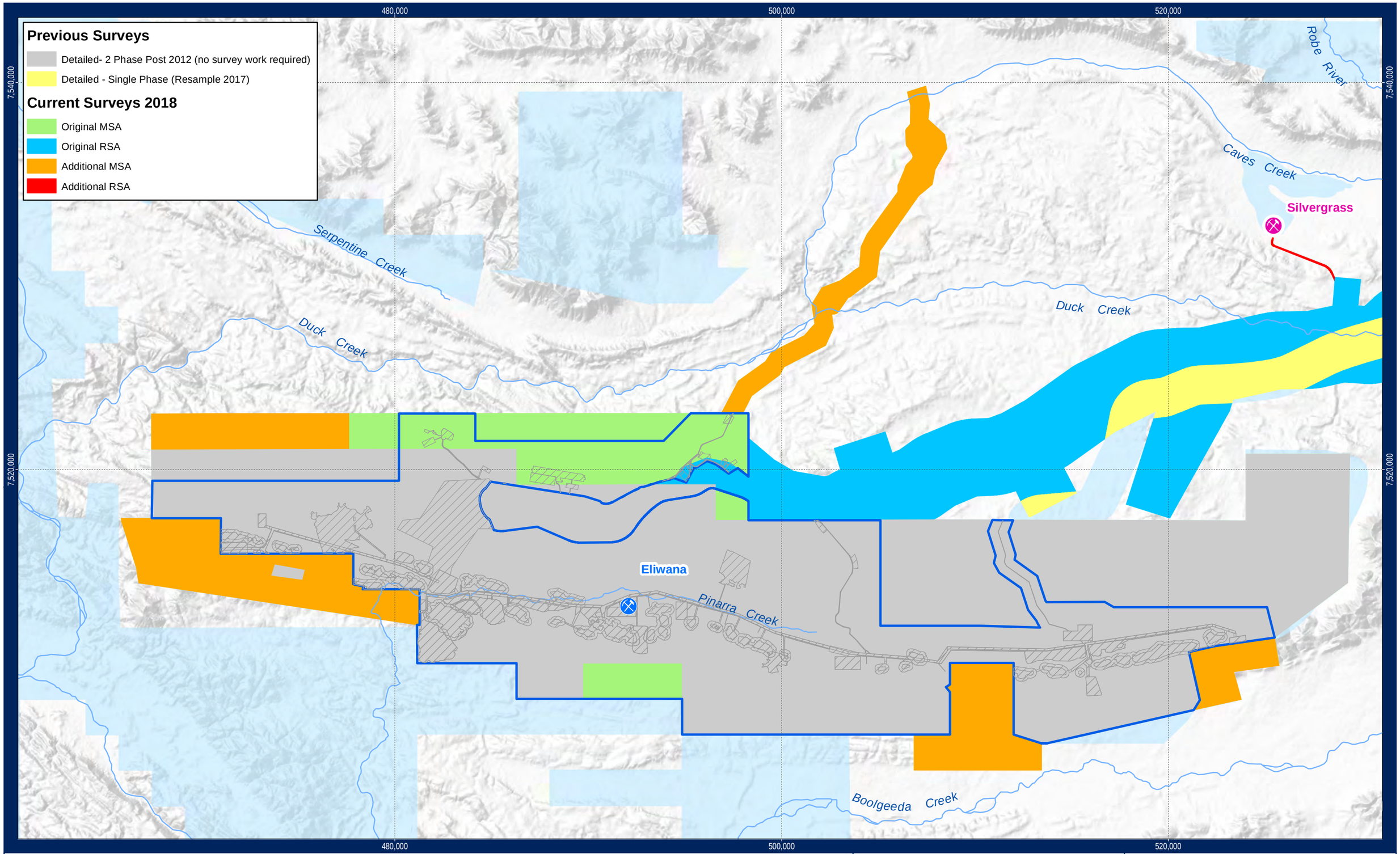
4.6.3 Surveys and Studies

Fortescue has conducted extensive mineral exploration activities in the area and significant survey effort was undertaken to support historic exploration activities and the current Proposal. The most relevant previous surveys relating to flora and vegetation include:

- Eliwana and Flying Fish Level 2 Flora and Vegetation Survey (Ecoscape, 2015)
- Western Hub Rail Link Level 2 Flora and Vegetation Survey (Ecoscape, 2014)
- Eliwana Consolidated Detailed Flora and Vegetation Survey (Biota, 2017) (Appendix 16)

Biota's 2017 survey and report consolidates all data from within a defined survey boundary (Figure 14). This report incorporates information and data from twenty-two (22) botanical surveys that overlap with the survey area and a further thirteen (13) surveys that occur within 30 km of the survey area. The Consolidated Survey area includes the MDE and the RDE (not subject to this environmental review).

[2] Note, this guidance supersedes EPA Guidance Statement 51.



Fortescue Projects
Rio Tinto Mines
Indicative Mine Footprints
Mine Development Envelope

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M. Dowling
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:180,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.017_r3

Date: 20-Aug-18
Size: A3L
Revision: 1
Confidentiality: 1

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Figure 14
Flora Survey Extent

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The New Force in Iron Ore

The Consolidated Survey incorporates all data from previous surveys and includes additional work in areas previously not surveyed, or areas where botanical surveys were either yet to be completed, or data was considered incomplete (re-survey). In total, the consolidation of previous surveys and additional surveys in 2017 resulted in:

- The surveying of 994 quadrats across the entire survey area of which 135 were new quadrats established in 2017. Of the 994 quadrats, 332 occur within the MDE, the remaining 662 quadrats occur in the RDE.
- The surveying of 154 relevés across the entire survey area, of which 45 were new relevés established in 2017. Of the 154 relevés, 68 occur within the MDE.

The Consolidated Survey represents a very detailed and comprehensive flora and vegetation assessment within the MDE that far exceeds the requirements of the published technical guidance for flora and vegetation surveys[3].

4.6.4 Receiving Environment

This section discusses the botanical environment within the MDE and within a regional context. This includes:

- A regional area, considered as the wider Pilbara IBRA bioregion
- A local area, defined by the MDE

4.6.4.1 Regional Vegetation Units

Vegetation units have been described on a regional scale by Beard (1975). These vegetation units are broad scale descriptors and closely align with topography and landform. Beard vegetation units mapped within the MDE are representative of the broad vegetation descriptions identified in the land system mapping described in Section 2.4.2. Beard vegetation units within the MDE are displayed in Figure 15 and are listed in Table 22.

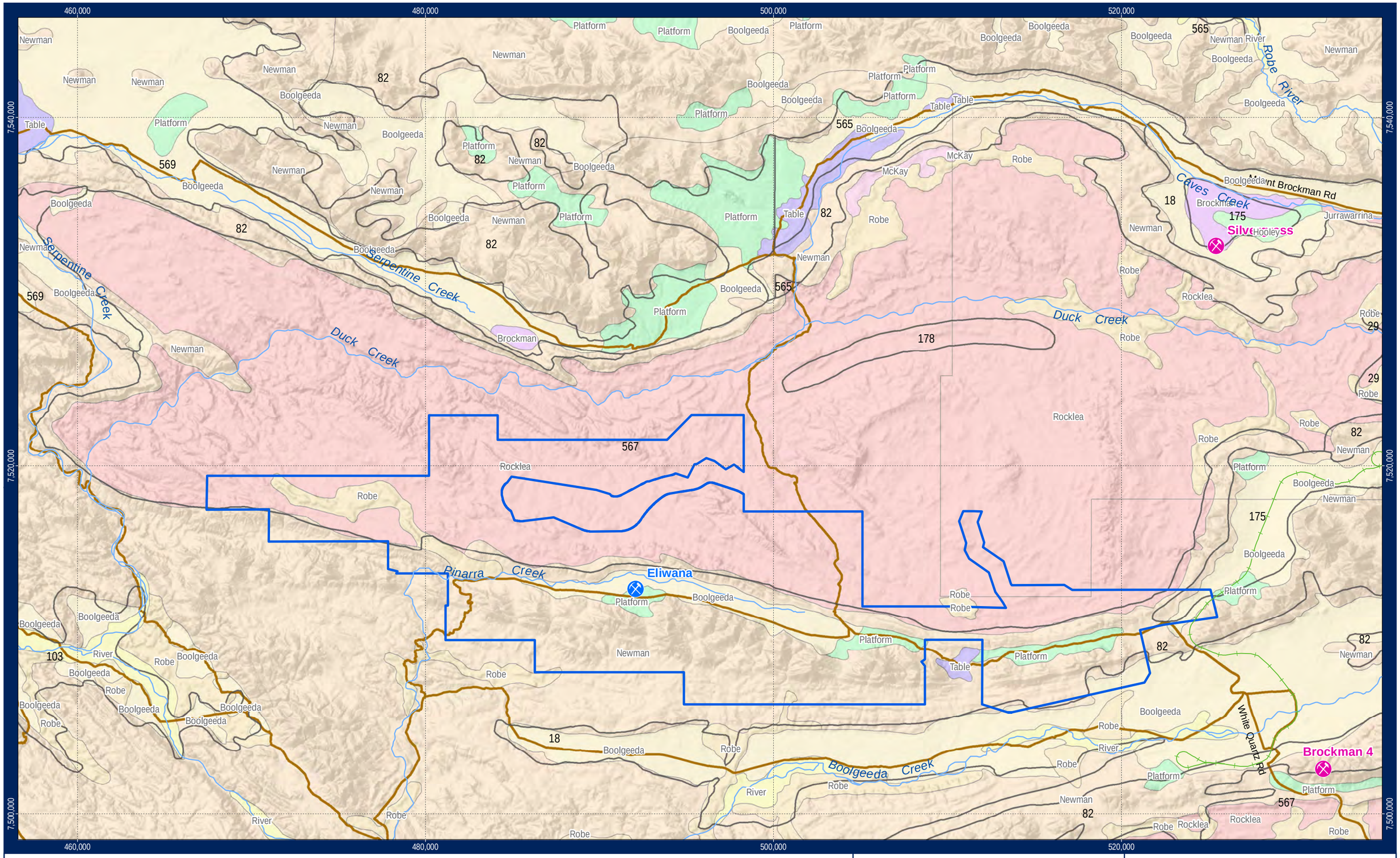
Table 22: Beard Vegetation Associations within the MDE

Association	Description
18	Mulga (‘*Acacia aneura*’) open shrubland
82	Snappy Gum (*Eucalyptus leucophloia*) low woodland over *Triodia wiseana* hummock grassland
175	*Astrebla pectinata* open tussock grassland

[3] Note, the extent of the MDE has changed since the Consolidated Survey report was prepared. Calculations of the extent of vegetation communities and flora species within the MDE in this Document will not be consistent with those reported in the Consolidated Survey report.

Association	Description
567	Mulga (‘*Acacia aneura’*) and *Acacia pyrifolia*10 open shrubland over soft spinifex (*Triodia epactia/pungens*) and *T. basedowii* hummock grassland

Vegetation units 82 and 567 are the most common vegetation units, representing 98% of the MDE. As demonstrated in Figure 15, these two vegetation units correlate extremely closely to the Newman and Rocklea land systems which make up the majority of the MDE.



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Figure 15
Beard Vegetation Units

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4.6.4.2 Vegetation Communities

A total of 37 vegetation communities have been mapped within the MDE as described in Table 23 and depicted in Figure 16.

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Table 23: Vegetation Communities of the Mine Development Envelope. Communities in bold possibly represent a Priority Ecological Community

Community	Description	Areal Extent (ha)	MDE Extent (ha)
AanAprERfTeTw	*Acacia 'aneura'*, *A. pruinocarpa* low open woodland over *Eremophila forrestii subsp. forrestii* mid sparse shrubland over *Triodia epactia*, *Triodia wiseana* low open hummock grassland	79.5	52.3
AanAprTw	*Acacia 'aneura'*, *A. pruinocarpa* mid open woodland over *Triodia wiseana* mid open hummock grassland	75.9	46
AanExAatAbCHfTe	*Acacia 'aneura'*, *Eucalyptus xerothermica* mid open woodland over *Acacia atkinsiana*, *A. bivenosa* mid sparse shrubland over *Chrysopogon fallax* mid sparse tussock grassland over *Triodia epactia* mid hummock grassland	144.8	10.3
AanTwTe	*Acacia 'aneura'* low woodland over *Triodia wiseana*, *T. epactia* low sparse hummock grassland	258.4	35.7
AbTwTe	*Acacia bivenosa* mid sparse shrubland over *Triodia wiseana* or *T. epactia* mid open hummock grassland	199.7	105.6
AeTwTe	*Acacia exigua*, *A. marramamba* and /or *A. bivenosa* mid sparse shrubland over *Triodia wiseana*, *T. epactia* low open hummock grassland	2,398.4	2,085.3
AiTw	*Acacia inaequilatera* tall sparse shrubland over *Triodia wiseana* low open hummock grassland	6,074.1	86.2
AiTw/ElTa	MOSAIC: *Acacia inaequilatera* tall sparse shrubland over *Triodia wiseana* low open hummock grassland / *Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Triodia angusta*, *T. longiceps*, *T. wiseana* low open hummock grassland	8,549.6	3,015.9
AmTw	*Acacia maitlandii* mid sparse shrubland over *Triodia wiseana* low open hummock grassland	847.6	13
AtruTbt	*Acacia trudgeniana* tall isolated shrubs over *Triodia basitricha*, *T. wiseana* low open hummock grassland	187.1	187.1
AxAanAtERcTw	*Acacia xiphophylla*, *A. 'aneura'* low woodland over *Acacia tetragonophylla* tall sparse shrubland over *Eremophila cuneifolia*, *E. forrestii subsp. forrestii*, *Senna stricta* mid sparse shrubland over *Triodia wiseana*, *T epactia* mid open hummock grassland	232.3	75.5
CdAiTwTbt	*Corymbia deserticola subsp. deserticola* low isolated trees over *Acacia inaequilatera*, *A. exigua*, *Senna glutinosa subsp. glutinosa* mid sparse shrubland over *Triodia wiseana*, *T. basitricha* low open hummock grassland	541	36.6
ChAarAadTw	*Corymbia hamersleyana*, *Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Acacia arida*, *Grevillea wickhamii* mid sparse shrubland over *Acacia adoxa var. adoxa* low sparse shrubland over *Triodia wiseana* mid hummock grassland	3349.1	413.2
ChAbTw	*Corymbia hamersleyana*, *Eucalyptus leucophloia subsp. leucophloia* mid open woodland over *Acacia bivenosa*, *A. synchronicia*, *A. ancistrocarpa* mid-tall sparse shrubland over *Triodia wiseana* low sparse hummock grassland	1,421.8	312.5

Community	Description	Areal Extent (ha)	MDE Extent (ha)
ChAcAbCEc	*Corymbia hamersleyana*, *Acacia citrinoviridis* low open woodland-low woodland over *Acacia bivenosa* mid-tall sparse shrubland over **Cenchrus ciliaris*, **C. setiger* low open tussock-tussock grassland	196.4	71.2
ChAiTw	*Corymbia hamersleyana* and/ or *E. leucophloia subsp. leucophloia* low open woodland over *Acacia inaequilatera* and/ or *A. bivenosa* mid sparse shrubland over *Triodia wiseana* low open hummock grassland	2,252.5	902.3
ChAiTw/ElAbTlo	Mosaic: *Corymbia hamersleyana* and/ or *Eucalyptus leucophloia subsp. leucophloia* low isolated trees over *Acacia inaequilatera* and/ or *A. bivenosa* mid-tall sparse shrubland over *Triodia wiseana* low hummock grassland / *Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Acacia bivenosa* mid open shrubland over *Triodia longiceps*, *T. wiseana* low open hummock grassland	26,026.2	14,731.9
EcAcEuaTe	*Eucalyptus camaldulensis subsp. refulgens*, *E. victrix* mid woodland over *Acacia citrinoviridis*, *Melaleuca glomerata* tall open shrubland over *Eulalia aurea* mid sparse tussock grassland over *Triodia epactia* low sparse hummock grassland	328.3	5.5
EgAatTe	*Eucalyptus gamophylla* mid sparse mallee shrubland over *Acacia atkinsiana*, *A. bivenosa*, *A. exigua* tall sparse shrubland over *Triodia epactia*, *T. wiseana* mid hummock grassland	2,960.8	2,200.9
ElAarTwTspr	*Eucalyptus leucophloia subsp. leucophloia* mid isolated trees *Acacia arida* mid open shrubland over *Triodia wiseana*, T. sp. Robe River (M.E. Trudgen et al. MET 12367) mid hummock grassland	2,622.6	1530.7
ElAatTw	Eucalyptus leucophloia subsp. leucophloia low open woodland over Acacia atkinsiana, A. exigua tall sparse shrubland over Triodia wiseana low sparse hummock grassland	474.2	398.3
ElAbTlo	*Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Acacia bivenosa* mid open shrubland over *Triodia longiceps*, *T. wiseana* low open hummock grassland	884.3	884.6
ElAcAarTwTspr	***Eucalyptus leucophloia subsp. leucophloia* isolated low trees-low open woodland over *Acacia citrinoviridis*, *A. pruinocarpa* low open woodland over *Acacia arida*, *A. maitlandii* mid sparse-mid open shrubland over *Triodia wiseana*, *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) low hummock grassland**	**561.8**	**550.5**
ElAcTwTspr	*Eucalyptus leucophloia subsp. leucophloia* low isolated trees over *Acacia citrinoviridis*, *A. pruinocarpa* tall open-sparse shrubland over *Triodia wiseana*, *T.* sp. Robe River (M.E. Trudgen et al MET 12367) mid open hummock grassland	146.6	146.6
ElAkTbt	*Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Acacia kempeana* mid sparse shrubland over *Triodia basitricha* low hummock grassland	265.4	265.4

Community	Description	Areal Extent (ha)	MDE Extent (ha)
ElAkTe	*Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Acacia kempeana* mid sparse shrubland over *Triodia epactia* or *T. wiseana* low hummock grassland	564.8	311
ElAmTw	*Eucalyptus leucophloia subsp. leucophloia* and/ or *Corymbia hamersleyana* mid open woodland over *Acacia maitlandii* mid sparse shrubland over *Triodia wiseana* low hummock grassland	16,751	15169.6
ElAmTw/ElAarTwTspr	Mosaic: *Eucalyptus leucophloia subsp. leucophloia* and/ or *Corymbia hamersleyana* mid open woodland over *Acacia maitlandii* mid sparse shrubland over *Triodia wiseana* low hummock grassland / *Eucalyptus leucophloia subsp. leucophloia* mid isolated trees *Acacia arida* mid open shrubland over *Triodia wiseana*, *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) mid hummock grassland	2,135.1	101.6
ElApTspr	***Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Acacia pruinocarpa* tall sparse shrubland over *Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) low hummock grassland**	**34.3**	**19.3**
ElEgAmTw	*Eucalyptus leucophloia subsp. leucophloia* and/ or *Corymbia hamersleyana* mid open woodland over *E. gamophylla* mid open mallee woodland over *Acacia maitlandii*, *Petalostylis labicheoides*, *A. pyrifolia* tall sparse shrubland over *Triodia wiseana* low hummock grassland	438.6	393
ElTa	*Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Triodia angusta*, *T. longiceps*, *T. wiseana* low open hummock grassland	7,555.4	336.1
EvAcCcERIt	*Eucalyptus victrix* low-mid open woodland over *Acacia citrinoviridis* and/ or *Melaleuca glomerata* tall open shrubland over **Cenchrus ciliaris*, *Eriachne tenuiculmis* mid open tussock grassland	566	298.4
EvAcMgErIt	*Eucalyptus victrix* low-mid open woodland over *Acacia citrinoviridis*, *Melaleuca glomerata* tall sparse shrubland over *Eriachne tenuiculmis* mid sparse tussock grassland	357.9	103.1
ExAcTHtTe	*Eucalyptus xerothermica* low open woodland over *Acacia citrinoviridis*, *A. bivenosa*, *A. pyrifolia* tall sparse shrubland over *Themeda triandra*, *Chrysopogon fallax* mid tussock grassland over *Triodia epactia* mid hummock grassland	557.7	384.4
ExEsAbTw	*Eucalyptus xerothermica*, *E. socialis subsp. eucentrica* low open mallee woodland over *Acacia bivenosa*, *A. synchronicia* tall sparse shrubland over *Triodia wiseana* low hummock grassland	1,345.8	552
ExEsAbTw/ElTa	Mosaic: *Eucalyptus xerothermica*, *E. socialis subsp. eucentrica* low open mallee woodland over *Acacia bivenosa*, *A. synchronicia* tall sparse shrubland over *Triodia wiseana* low hummock grassland / *Eucalyptus leucophloia subsp. leucophloia* low open woodland over *Triodia angusta*, *T. longiceps*, *T. wiseana* low open hummock grassland	656.2	65.3
SENgTw	*Senna glutinosa subsp. glutinosa* mid isolated shrubs over *Triodia wiseana* low open hummock grassland	690.8	673.7

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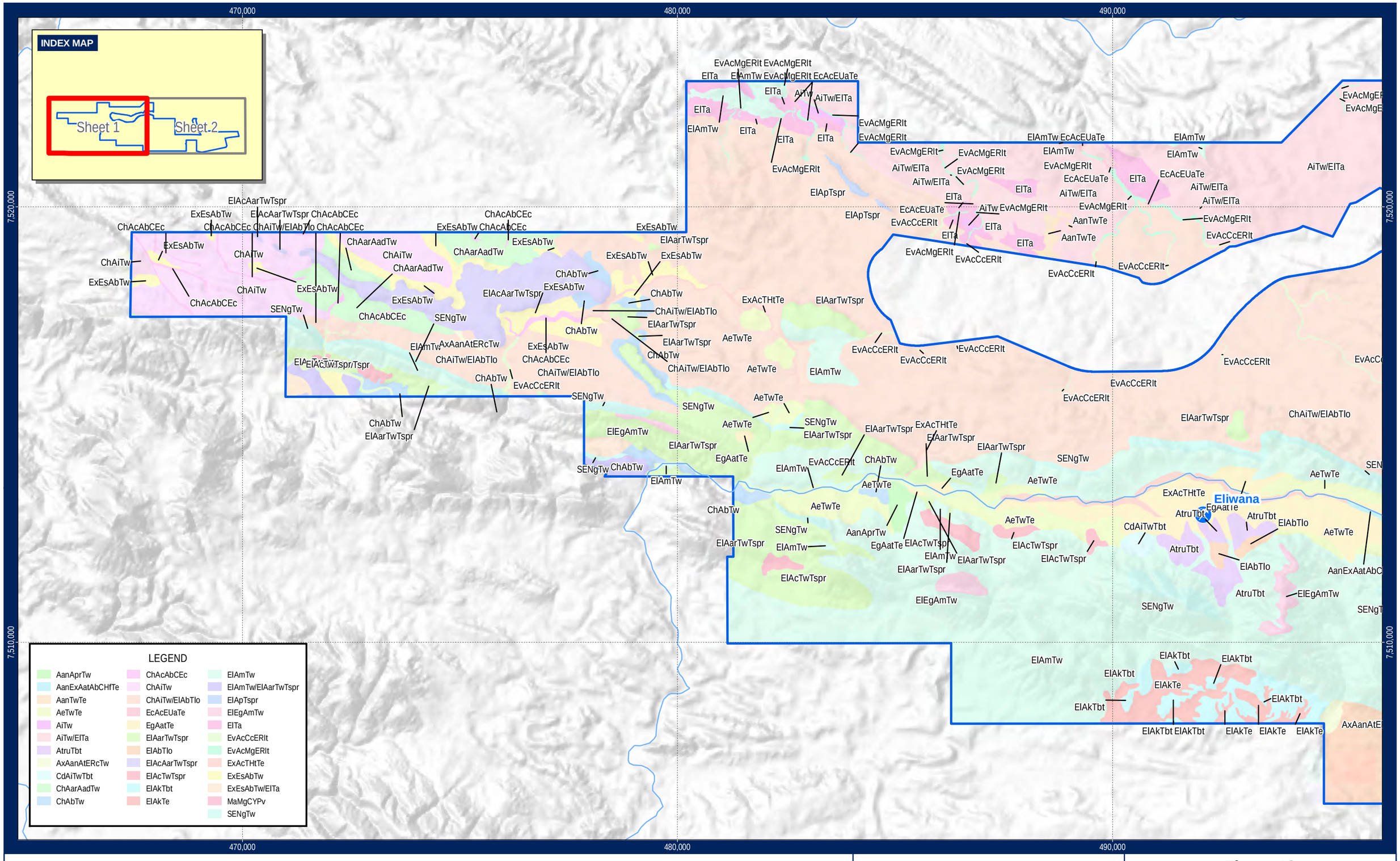
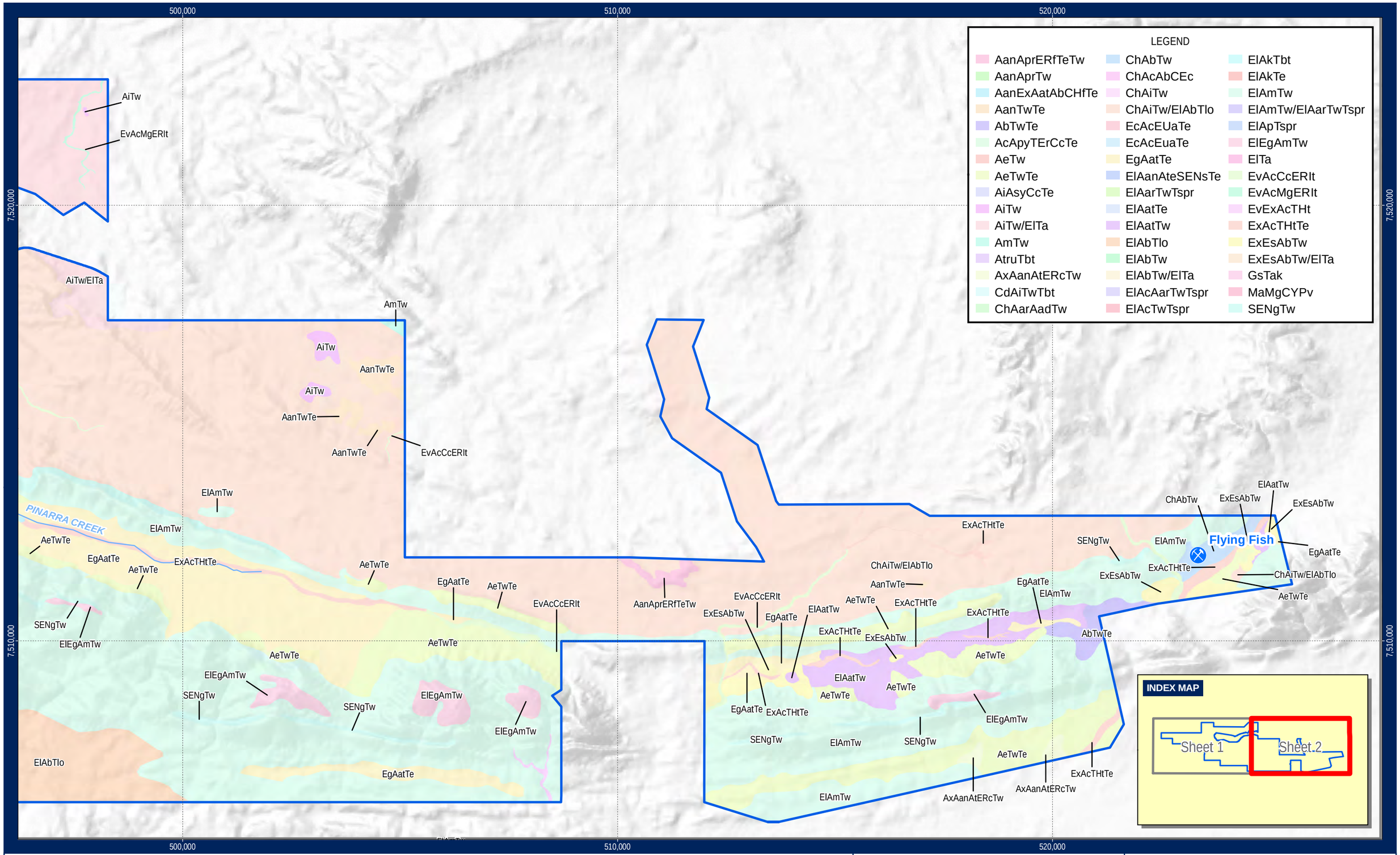


Figure 16
Mapped Vegetation Communities
Sheet 1 of 2

Fortescue Metals Group Ltd
The New Force in Iron Ore



Fortescue Projects
Major Drainage
Mine Development Envelope

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

Requested By: M. Dowling
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:80,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.019c_r2

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Revision: 1
Confidentiality: 1

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Figure 16
Mapped Vegetation Communities
Sheet 2 of 2

Fortescue Metals Group Ltd
The New Force in Iron Ore

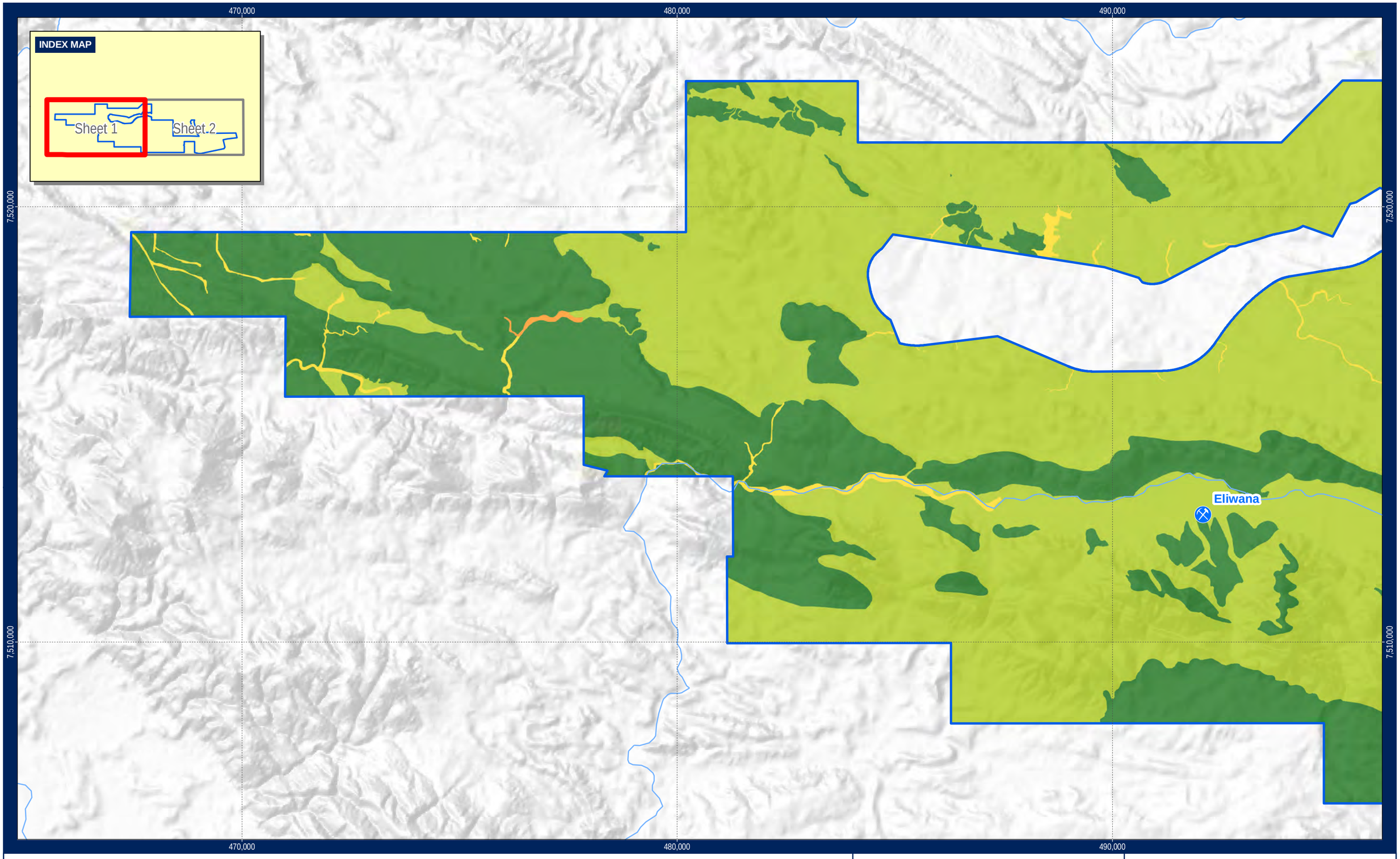
4.6.4.3 Vegetation Condition

Vegetation within the MDE has been ranked according to its condition. The majority of vegetation is considered to be in Excellent to Good condition, particularly vegetation on hills and stony plains, which are not often grazed by cattle (van Vreeswyk, et al., 2004). Grazing pressures on lower lying areas such as mulga, clay pans and major drainage lines tended to be in poorer condition with higher abundance of weed species. Table 24 and Figure 17 shows the areas of vegetation by condition.

Table 24: Vegetation condition within the MDE

Condition	Landform	Extent in MDE
Excellent	Major Drainage Lines Minor Drainage Lines Clay Plains and Stony Plains Stony Hill Slopes, Hill Crests and Foothills	14,097
Very good	Major Drainage Lines Minor Drainage Lines Clay Plains and Stony Plains Stony Hill Slopes, Hill Crests and Foothills	29,326
Good	Major Drainage Lines Minor Drainage Lines Clay Plains and Stony Plains Stony Hill Slopes, Hill Crests and Foothills	359
Poor	Major Drainage Lines Minor Drainage Lines	21

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Fortescue Projects
Major Drainage
Mine Development Envelope

Condition
Excellent
Very Good
Good
Poor

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

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Document Name: 750EW_MP_EN_0010.020b_r2

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Size: A3L
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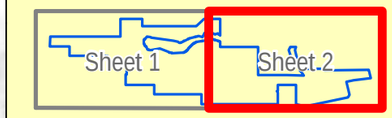
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Figure 17
Vegetation Condition
Sheet 1 of 2

Fortescue Metals Group Ltd
The New Force in Iron Ore

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

INDEX MAP



PINARRA CREEK

Flying Fish

Fortescue Projects
Major Drainage
Mine Development Envelope

Condition
- Excellent
- Very Good
- Good
- Poor

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

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Figure 17
Vegetation Condition
Sheet 2 of 2

Fortescue Metals Group Ltd
The New Force in Iron Ore

4.6.4.4 Threatened and Priority Ecological Community

Vegetation communities in Western Australia are described as Threatened Ecological Communities (TEC) if they have been endorsed by the Western Australian Minister for Environment following recommendations made by the Threatened Species Scientific Committee. TECs that are listed to be of State conservation significance in Western Australia are considered to be Environmentally Sensitive Areas (ESA) under Part V of the EP Act.

Possible threatened ecological communities that do not meet survey criteria are added to the Priority Ecological Community (PEC) list under Priority 1, 2 or 3. Ecological communities that are adequately known, are rare but not threatened, or meet criteria for "Near Threatened", or that have been recently removed from the threatened list, are placed in Priority 4. Conservation dependent ecological communities are placed in Priority 5.

Two vegetation communities that may be representative of the PEC *Triodia sp. Robe River assemblages of mesas of the West Pilbara* have been recorded within the MDE. This Priority 3 PEC is described as:

"…typically restricted to mesas and cordillo landforms where the plant assemblages are dominated by or contain *Triodia* sp. Robe River and are indicative of inverted landscapes; that is, where *Triodia* sp. Robe River occurs in combination with species that are considered 'out-of-context' from their normal habitat. The community is a combination of *Triodia* sp. Robe River with *Acacia pruinocarpa*, *A. citrinoviridis* on slopes or peaks of mesas. These two Acacias are generally found associated with Pilbara creeklines, and their occurrence is probably indicative of the genesis of the mesa surfaces in wetlands, then erosion of the landscape and 'inversion of the landscape' such that the mesa slopes and peaks that were previously low in the landscape become high points" (Department of Biodiversity, Conservation and Attractions, 2017).

The two communities within the MDE that are considered to represent this PEC are:

- ElAcAarTwTspr;
- ElApTspr

These communities were considered by Biota (2017) to be possibly representative of the PEC as a result of the presence of *T*. sp. Robe Rover as the dominant hummock grass understorey species, in combination with *A. citrinoviridis* and *A. pruinocarpa* and have been located on mesa landforms. A total of 591.1 ha of these two communities have been mapped (Figure 18). Vegetation units were only considered equivalent to the Triodia sp. Robe River assemblages of mesas PEC if they were recorded from mesa landforms. Vegetetation unit ElAcTwTspr (occurring on hills), previously considered to be a PEC by Ecoscape (2015) and vegetation unit ElAarTwTspr (on low foothills) were therefore excluded. Fire age of site, soil and rock type are all

recorded and taken into consideration when making a determination of each vegetation association including determinations of PEC.

Vegetation units were only considered equivalent to the *Triodia* sp. Robe River assemblages of mesas PEC if they were recorded from mesa landforms, which according the DBCA's description of the PEC, is a key determinant on whether a recorded community can be considered representative of the PEC.

For this reason, Biota (2017) vegetation units ElAcTwTspr (recorded as occurring on hills) and ElAarTwTspr (recorded as occurring on low foothills) have therefore been excluded as being representative of the PEC. Fire age of site, soil and rock type were all recorded by Biota and taken into consideration when making a determination on each vegetation association. These Biota (2017) communities had previously been considered to be representative of the PEC by Ecoscape (original vegetation codes AcTwEl (Ecoscape, 2015) and ElAcTr (Ecoscape, 2012a)) but have since been excluded as they do not occur on mesa formations.

480,000
500,000
520,000
7,540,000
7,520,000
Robe River
Silvergrass
Eliwana
Pinarra Creek
Boolgeeda Creek

Fortescue Projects
Rio Tinto Mines
Major Drainage
Mine Development Envelope

Communities Mapped as PEC
ElAcAarTwTspr
ElApTspr

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N
0 2 4 6 8 10
Kilometres

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Figure 18
Communities Mapped as PEC

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The New Force in Iron Ore

4.6.4.5 Regionally Significant Vegetation

Biota has described three vegetation communities within the MDE that may have local significance:

- AtruTbt (187.1 ha within the MDE);
- CdAiTwTbt (36.6 ha within the MDE); and
- ElAkTbt (265.4 ha within the MDE).

These communities feature a hummock grassland dominated by the Priority 3 species *Triodia basitricha*. However, other than the presence of *T. basitricha*, the vegetation would otherwise be considered common and the communities do not occur on restricted landforms. Vegetation community CdAiTwTbt does not occur within the proposed footprint and a further 504.3 ha occurs outside of the MDE. Biota (2011) also notes that *T. basitricha* was mistaken with the more common species *T. melvillei* for many years, and as a result, vegetation with hummock grasslands dominated by *T. basitricha* are more widespread than is currently known.

4.6.4.6 Sheetflow Dependent Vegetation

According to the results of the Consolidated Survey, no stands of mulga-dominated sheetflow vegetation occur within the MDE (Biota, 2017).

4.6.4.7 Groundwater Dependent and Potentially Groundwater Dependent Vegetation

Groundwater Dependent Ecosystems (GDE) are considered to have higher significance in the Pilbara landscape largely due their higher biomass and therefore their greater fauna habitat value within an otherwise arid landscape. GDE vegetation is also often habitat for SRE invertebrate species and where surface water is present, becomes a refuge for aquatic of flora and fauna species, or those with part of their life cycle dependent on the presence of surface water bodies.

GDE vegetation is often characterised by the presence of key indicator species such as Cadjeput (*Melaleuca argentea*) or River Red Gum (*Eucalyptus camaldulensis*). These species obtain the majority of their water requirements from groundwater.

Other vegetation communities may potentially be dependent on groundwater depending on the depth to groundwater in the local area. In particular, the presence of *Eucalyptus victrix* as dominant overstorey species may indicate that a vegetation community may potentially be dependent on groundwater. A discussion on *E. victrix* follows.

From an assessment of water level ranges of Pilbara riparian species, it was found that the mean minimum groundwater level depth of *E. victrix* was greater than that for *E. camaldulensis*,

providing support for the view that *E. victrix* is found in slightly drier areas than *E. camaldulensis* and may not be as responsive to water table fluctuations (Loomes, 2010).

This is supported by a number of studies which find that *E. victrix* is considered to be a facultative phreatophyte (Batini, 2009) (Froend, 2009), that is, *E. victrix* uses soil water derived from surface water drainage into the unsaturated zone but may obtain some of their water requirements from groundwater where it is available, particularly large mature trees.

Water inputs from flooding appears to be important for sustaining *E. victrix* communities in most environments, regardless of the groundwater level. Regular flood events are required to recharge soil moisture in the vadose zone and provide enough soil water to sustain *E. victrix* during lengthy periods of drought that can last many months to years (Astron, 2016).

Therefore, based on available literature Fortescue considers that the presence of *E. victrix* as a dominant overstorey species is indicative of a potential use of groundwater, depending on site-based conditions, including depth to groundwater and the surface hydrological regime.

Small occurrences of Groundwater Dependent Vegetation type EcAcEUaTe have been mapped within the MDE. This vegetation type is dominated by *E. camaldulensis*, which as described above as an indicator species for groundwater dependency. A total of 10.8 ha of this GDE vegetation type occurs within the MDE.

Two vegetation communities that are considered Potentially Groundwater Dependent Vegetation within the MDE have been mapped (EvAcCcERIt and EvAcMgERIt) within the MDE. Both EvAcCcERIt and EvAcMgERIt are dominated by *E. victrix* which as described above may be potentially obtaining some of its water requirements from groundwater depending on depth to groundwater. 298.4 ha of EvAcCcERIt and 103.2 ha of EvAcMgERIt have been mapped within the MDE.

All GDE and Potential GDE vegetation communities are shown in Figure 19.

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

SERPENTINE CREEK
DUCK CREEK
CAVES CREEK
ROBE RIVER
PINARRA CREEK
BOOLGEEDA CREEK
BOOLGEEDA CREEK

Silvergrass
Eliwana

LEGEND

- Fortescue Projects
- Rio Tinto Mines
- Major Drainage
- Mine Development Envelope
- Groundwater Dependent Ecosystem
- Potential Groundwater Dependent Ecosystem

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

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Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
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Coordinate System: GDA 1994 MGA Zone 50
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Confidentiality: 1

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Figure 19
Groundwater Dependent Vegetation

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The New Force in Iron Ore

4.6.4.8 Flora Taxa

A total of 769 native taxa from 223 genera and 67 families have been recorded from the entire survey area. Of these, 555 taxa from 180 genera occur within the MDE, dominated by *Acacia*, *Senna*, *Sida* and *Euphorbia* species (Biota, 2017). The survey results suggest the MDE has a similar level of species diversity to other studies conducted in the region, including surveys at Rio Tinto's Brockman Mine, although when the entire survey area is considered, the level of speciation is greater. This is not surprising, given the length of the survey area stretches from the boundary of Karijini National Park to approximately 140 km west near the confluence of Boolgeeda and Duck Creek, encompassing a wide variety landforms and habitats. Fortescue therefore considers that the flora of the MDE demonstrates a high level of biodiversity but no greater than the surrounding areas.

4.6.4.9 Flora of Conservation Significance

A total of 32 species of priority flora have been identified within the survey area. Of these, 17 species occur within the MDE (Figure 20). The priority flora located within the MDE is shown in Table 25.

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460,000 480,000 500,000 520,000

7,540,000

7,520,000

CAVES CREEK

SERPENTINE CREEK

DUCK CREEK

Eliwana

PINARRA CREEK

BOOLGEEDA CREEK

Legend

Significant Flora

Species

- Acacia bromilowiana
- Dicladanthera glabra
- Eragrostis surreyana
- Eremophila magnifica subsp. magnifica
- Eremophila magnifica subsp. velutina
- Goodenia nuda
- Grevillea saxicola
- Gymnanthera cunninghamii
- Hibiscus sp. Mt Brockman (E. Thoma ET 1354)
- Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)
- Ipomoea racemigera
- Isotropis parviflora
- Pentalepis trichodesmoides subsp. hispida
- Pleurocarpaea gracilis
- Ptilotus mollis
- Rhynchosia bungarensis
- Sida sp. Hamersley Range (K. Newbey 10692)
- Terminalia supranitifolia
- Triodia basitricha
- Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)
- Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)

460,000 480,000 500,000 520,000

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8
Kilometres

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Figure 20
Priority Flora Species

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The New Force in Iron Ore

Table 25: Priority flora species within the MDE

Species	Number of Individuals in MDE	Number of Known Individuals	Number of Populations in MDE	Number of Known Populations	Number of Records from Naturemap
Priority 1					
Sida sp. Hamersley Range (K. Newbey 10692)	~103	~760*	2	30	25
Vittadinia sp. Coondewanna Flats	~2	~39	1	8	13
Priority 2					
Ipomoea racemigera	2	~189	1	13	6
Isotropis parviflora	1	28	1	3	27
Pentalepis trichodesmoides subsp. hispida	36	310	9	25	11
Priority 3					
Eragrostis surreyana	2	65	1	3	10
Eremophila magnifica subsp. velutina	~283	~454	18	29	29
Grevillea saxicola	1	339	1	13	37
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	~1,428	~7,888	51	199	45
Pleurocarpaea gracilis	22	~334*	1	13	11
Triodia basitricha	~59,226	~85,922*	6	31	20
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	~17,743	~223,867*	40	125	48

Species	Number of Individuals in MDE	Number of Known Individuals	Number of Populations in MDE	Number of Known Populations	Number of Records from Naturemap
Priority 4					
Acacia bromilowiana	~170	~353	5	12	40
Eremophila magnifica subs magnifica	~258	~1,181	21	61	38
Goodenia nuda	~106	~9,735*	4	331	112
Ptilotus mollis	322	2,073	6	21	36
Rhynchosia bungarensis	22	2,584*	9	130	194

Notes:

* Species counts with an asterix include records where local abundance has not been recorded. For instance, Fortescue is aware of 293 recorded locations of *Rhynchosia bungarensis* in its database, but only 218 have local abundance data.

~ some species growth habits result in difficulty in recording accurate numbers in the field eg. *Triodia basitricha*, *Triodia sp*. Robe River. For these species, the percentage cover of the species within the quadrat is often recorded. For instance, *Triodia basitricha* may occupy 15% of a 50 x 50 m quadrat. Fortescue has estimated 1 plant per square meter to estimate local abundance where percentage cover has been recorded. In this example, 15% of the quadrat is equal to an estimated 375 individual plants.



Plate 8: *Acacia bromilowiana*



Plate 9: *Eremophila magnifica subsp. magnifica*



Plate 10: *Indigofera* sp. Bungaroo Creek



Plate 11: *Sida* sp. Hamersley Range

4.6.4.10 Other Significant Flora

According to EPA guidance (EPA, 2016f), flora species may be considered significant if they are considered possible new species, have atypical characteristics or are range extensions. A number of species, recorded within the MDE that may be considered significant, are discussed below. Locations of these other significant flora species are shown in Figure 21.

Undescribed or Unresolved Taxa

The following species collected within the MDE require further work to determine their taxonomic status:

Acacia pyrifolia – there are many varieties of this species, which is treated as a species complex by Biota consultant until further taxonomic work is undertaken. *A. pyrifolia* is not conservation significant.

Amaranthus aff. undulatus (round leaves, short tepals) – A form with affinity to *A. undulatus* was recorded from the study area. *A. undulatus* is not conservation significant.

Corchorus parviflorus – a distinct form of this species was recorded from the study area, but has also been recorded between Brockman and Pannawonica (Biota, 2017).

Cymbopogon procerus/ambiguus – although not considered to be present in the Pilbara, specimens of *Cymbopogon* that key out to *C. procerus* continue to be collected from the Pilbara. However, until further clarification, the specimens recorded in the study area are considered to be *C. ambiguus*, which is widespread across Western Australia.

Solanum aff. horridum – A sterile specimen with affinity to *S. horridum* was collected from the study area. This entity has also been recorded from near Yandi (Biota, 2017). *S. horridum* is widespread across the Pilbara.

Vittadena sp. Coondewanna Flats – currently considered a separate species to *V. pustula* due to the absence of pustules on the face of the cypsela, however Fortescue is aware that the WA Herbarium intends to review both species. *V. pustula* is a Priority 3 species recorded from the Pilbara, Central Ranges, Murchison and Great Victoria Desert IBRA bioregions.

Acacia aff. maitlandii – specimens similar to *A. maitlandii* have been previously recorded within the MDE, but require genetic study to determine their taxonomic status. *A. maitlandii* is not conservation significant and has been recorded over a wide area through the Pilbara, Gascoyne, Murchison and desert regions of Western Australia.

Taxonomic Forms

These species are not recognised as separate species but have different growth forms compared to the vouchered specimens lodged with the WA Herbarium. They are widespread and frequently recorded in the Pilbara and are not considered conservation significant.

- *Acacia bivenosa*
- *Eriachne mucronata*
- *Fimbristylis dichotoma*
- *Gossypium australe*
- *Senna artemisioides subsp. oligophylla* (form with thinly sericeous leaves)
- *Portulaca intraterranea/oleracea*

Range Extensions

Harnieria kempeana subsp. muelleri –a range extension 23 km to the north.

Isotropis parviflora (Priority 2) – a range extension 102 km to the south-west.

Hibiscus sturtii var grandiflorus – a range extension 160 km to the west.

Mnesithea formosa – a range extension of 50km to the west.

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LEGEND

Taxanomic Forms Species

- Acacia bivenosa (141)
- Eriachne mucronata (133)
- Fimbristylis dichotoma (18)
- Gossypium australe (35)
- Gossypium australe (Burrup Peninsula form) (31)
- Gossypium australe (Whim Creek form) (8)
- Portulaca oleracea/intraterranea (5)
- Senna artemisioides subsp. oligophylla (101)

CAVES CREEK

SERPENTINE CREEK

DUCK CREEK

Eliwana

PINARRA CREEK

BOOLGEEDA C

480,000 500,000 520,000

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
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Date: 20-Aug-18
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Confidentiality: 1

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Figure 21
Taxonomic Forms Species
Conservation Significant Flora

Fortescue Metals Group Ltd
The New Force in Iron Ore

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LEGEND

Range Extensions

- Harnieria kempeana subsp. muelleri (1)
- Hibiscus sturtii var. grandiflorus (4)
- Isotropis parviflora (1)
- Mnesithea formosa (3)

CAVES CREEK

SERPENTINE CREEK

DUCK CREEK

Eliwana

PINARRA CREEK

BOOLGEEDA C

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LEGEND

- Fortescue Projects
- Major Drainage
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- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8
Kilometres

Requested By: M.Dowling
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Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.054c_r1

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Confidentiality: 1

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Figure 21
Range Extensions
Conservation Significant Flora

Fortescue Metals Group Ltd
The New Force in Iron Ore

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7,540,000

7,520,000

LEGEND

Undescribed or Unresolved Taxa

- Acacia maitlandii (129)
- Acacia pyrifolia (13)
- Amaranthus aff. undulatus (round leaves, short tepals) (1)
- Amaranthus undulatus (15)
- Corchorus parviflorus (14)
- Cymbopogon ambiguus (118)
- Solanum horridum (31)
- Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684) (1)

CAVES CREEK

SERPENTINE CREEK

DUCK CREEK

Eliwana

PINARRA CREEK

BOOLGEEDA C

480,000 500,000 520,000

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
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Coordinate System: GDA 1994 MGA Zone 50
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Date: 20-Aug-18
Size: A3L
Revision: 0
Confidentiality: 1

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Figure 21
Undescribed/Unresolved Taxa
Conservation Significant Flora

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4.6.4.11 Introduced Flora

A total of 14 species of introduced flora have been recorded from the MDE (Biota, 2017) (Figure 22). None of the species are listed as Weeds of National Significance, although several species are listed as environmental weeds. Introduced flora species are:

- **Aerva javanica* (Kapok Bush)
- **Argemone ochroleuca subsp. ochroleuca* (Mexican Poppy)
- **Bidens bipinnata* (Beggartick)
- **Bothriochloa pertusa* (Indian Bluegrass)
- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Datura leichhardtii* (Native Thornapple)
- **Euphorbia hirta* (Asthma Plant)
- **Flaveria trinervia* (Speedy Weed)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Setaria verticillata* (Whorled Pigeon Grass)
- **Solanum nigrum* (Blackberry Nightshade)
- **Sonchus oleraceus* (Common Sowthistle)
- **Vachellia farnesiana* (Mimosa Bush)

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Introduced Flora

- *Aerva javanica (4)*
- *Argemone ochroleuca (2)*
- *Argemone ochroleuca subsp. ochroleuca (11)*
- *Bidens bipinnata (9)*
- *Cenchrus ciliaris (31)*
- *Cenchrus setiger (1)*
- *Datura leichhardtii (3)*
- *Flaveria trinervia (23)*
- *Malvastrum americanum (28)*
- *Portulaca pilosa (3)*
- *Setaria verticillata (10)*
- *Vachellia farnesiana (16)*

SERPENTINE CREEK

DUCK CREEK

CAVES CR

Eliwana

PINARRA CREEK

BOOLGEEDA CREEK

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
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Figure 22
Weed Species in
Mine Development Envelope

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The New Force in Iron Ore

4.6.5 Assessment of Impacts to Flora and Vegetation

This section describes, quantifies and assesses the impacts to the flora and vegetation within the MDE caused by the Proposal. Potential impacts are:

- Direct loss of vegetation at local and regional level
- Direct loss of conservation significant vegetation
- Direct loss of Conservation Significant Flora
- Degradation of vegetation due to indirect impacts such as:
    - Fragmentation, leading to edge effects
    - Dust deposition
    - Altered fire regimes
    - Chemical, hydrocarbon spills, leaks from containment structures or Acidic or Metalliferous Drainage (AMD)
    - Changes to surface hydrology
    - Groundwater abstraction

4.6.5.1 Direct Loss of Vegetation at Local and Regional Level

Development of the proposal will result in the clearing of approximately 7,900 ha of native vegetation. Of the 37 vegetation communities mapped within the MDE, 29 will experience some direct loss from clearing or other indirect impacts and a further two vegetation communities will experience some indirect impact. All vegetation communities impacted by the proposal are shown in Table 26.

Table 26: Indicative disturbance by vegetation community. Communities in bold may represent at PEC.

Community	Areal extent (ha)	Proposed Disturbance (ha)	Indirect Impacts (ha)*	% remaining
AanAprTw	75.9	41.9		45
AanExAatAbCHfTe	144.8	7.1		95.1
AanTwTe	258.4	17.9		93.1
AbTwTe	199.7	35.9		82
AeTwTe	2,398.4	459.6		80.8
AiTw	6,074.1	0.8		99.9
AiTw/ElTa	8,549.6	235.5		97.2
AtruTbt	187.1	131.5		29.7

Community	Areal extent (ha)	Proposed Disturbance (ha)	Indirect Impacts (ha)*	% remaining
CdAiTwTbt	541	23.3		95.7
ChAarAadTw	3,349.1	13.5		99.6
ChAbTw	1,421.8	92.9		93.5
ChAcAbCEc	196.4	23.3		88.2
ChAiTw/ElAbTlo	26,026.2	1,407.1		94.6
EcAcEuaTe	328.3	0	15.3	100
EgAatTe	2,960.8	804		72.8
ElAarTwTspr	2,622.6	980.4		62.6
ElAatTw	474.2	243.3		48.7
ElAbTlo	884.3	10.8		98.8
ElAcAarTwTspr	**561.8**	**28.1**		**95**
ElAcTwTspr	146.6	108.9		25.7
ElAmTw	16,751	1,511.8		91
ElAmTw/ElAarTwTspr	2,135.1	116.7		94.5
ElApTspr	**34.3**	**13.3**		**61.2**
ElEgAmTw	438.6	30.1		93.1
ElTa	7,649.9	106.4		98.6
EvAcCcERlt	566	149.1	91.7	73.7
EvAcMgERlt	357.9	0.2	21.2	99.9
ExAcTHtTe	557.7	121.7		78.2
ExEsAbTw	1,345.8	209.1		84.4
ExEsAbTw/ElTa	656.2	52.2		92
MaMgCYPv	51.2	0	19.6	100
SENgTw	690.8	79.8		88.4

* Indirect impacts to vegetation have been estimated based on changes to baseline surface water runoff and groundwater drawdown. The indirect impacts to these vegetation units could range from no visible impact to significant impact. It is likely that most of the vegetation impacted indirectly would still function as the representative vegetation units, however some structural changes may occur (vegetation height or density). It should also be noted that 166.2 ha of riparian vegetation may be impact through indirect impacts that has not been subject to vegetation mapping. Estimations of these vegetation types have been made in Section 4.6.5.9 based on an extrapolation of mapping.

EPA Position Statement No. 2 discusses a threshold level of clearing of 30%, that is, clearing of vegetation communities to less than 30% of its original extent, below which species loss appears to accelerate exponentially at an ecosystem level. Fortescue notes that this Position Statement is no longer available on the EPA's website. In the absence of any other guidance on vegetation clearing from the EPA, Fortescue has adopted the 30% threshold to determine impacts from vegetation loss resulting from clearing.

All but two of the 37 of vegetation communities mapped within the MDE that will experience some direct disturbance will remain above the 30% guidance threshold as discussed in EPA Position Statement No. 2. (Table 26). The two communities that will be cleared below 30% are AtruTbt and ElAcTwTspr.

Vegetation community AtruTbt is described as *Acacia trudgeniana* tall isolated shrubs over *Triodia basitricha*, *T. wiseana* low open hummock grassland. Following implementation of the proposal, approximately 29.7% of this vegetation community will remain, marginally below the 30% threshold level.

It is estimated that approximately 25.7% of vegetation community ElAcTwTspr will remain after the implementation of the proposal. However, Fortescue notes that vegetation community AcTr, mapped by Ecoscape (Ecoscape, 2015) is analogous to ElAcTwTspr (Biota, 2017). A total of 34 ha of vegetation type AcTr, mapped to the west and north-west of the MDE has been located. Therefore, the areal extent of both these communities is 180.6 ha and the proposed clearing represents 60% of both communities. As a result, the clearing will not breach the 30% threshold.

Fortescue also notes that none of the Land Systems discussed in Section 2.4.4 are listed in Table 3 of the EPA's *Advice on Cumulative Environmental Impacts in the Pilbara* (EPA, 2014) as being at risk from development while under pressures from land degradation.

4.6.5.2 Direct Loss of Good to Excellent Vegetation

The Pilbara IBRA bioregion is largely undisturbed, with natural characteristics such as stony mantles, and extensive level plains with a tall shrub stratum that protect it from inappropriate land use practices (van Vreeswyk, et al., 2004). As a result, extensive areas of the Pilbara remain much as they were arrival of European settlers and vegetation in these areas is ranked as being in good to excellent condition. Of the 7,900 ha of vegetation to be cleared, 7,879 ha (99.7%) is in good to excellent condition. This loss of vegetation has a high impact to biodiversity on a local scale, but less impact on a regional scale, with vast areas of vegetation in good to excellent condition remaining intact.

4.6.5.3 Direct Loss of Conservation Significant Vegetation

As described in Section 4.6.4.4, two communities (ElAcAarTwTspr and ElApTspr) within the MDE may potentially represent the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* PEC. The combined areal extent of these three communities is 596.1 ha. This represents a significant increase in the extent of the PEC, which according to publicly available data, has a current extent of just 66 ha.

This PEC is described by DBCA (2017) as "…plant assemblages (underline added) are dominated by or contain *Triodia* sp. Robe River…that is, where *Triodia* sp. Robe River occurs in

combination with species that are considered 'out-of-context' from their normal habitat. The community is a combination of *Triodia* sp. Robe River with *Acacia pruinocarpa*, *A. citrinoviridis* on slopes or peaks of mesas…" According to publicly available data, 66 ha of this PEC has been mapped by DBCA.

This description allows that the PEC may be represented by more than one type of plant assemblage, and Fortescue notes that Biota (2017) identified two separate communities that may be representative of the PEC (See Section 4.6.4). Fortescue has also mapped other potential occurrences of this PEC in the wider area to the south and west of the MDE. As a result, Fortescue consider that there may be up to 2,093 ha of the PEC within approximately 70 km of the MDE, consisting of:

- A total of 1,497 ha of vegetation type ElAcTw (Astron, 2013) from the area immediately south of the MDE. This vegetation type was described as:

  Eucalyptus leucophloia subsp. *leucophloia* isolated low trees to low open woodland over *Acacia citrinoviridis* and *A. pruinocarpa* low open woodland over *Acacia arida* and *A. maitlandii* mid sparse to mid open shrubland over *Triodia wiseana* and *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) low hummock grassland.

  In particular, it was noted that individuals of *Triodia* sp. Robe River were frequently recorded in this vegetation unit, typically at the top or on the edge and upper slopes of the mesa and cordillo landforms (Astron, 2013).

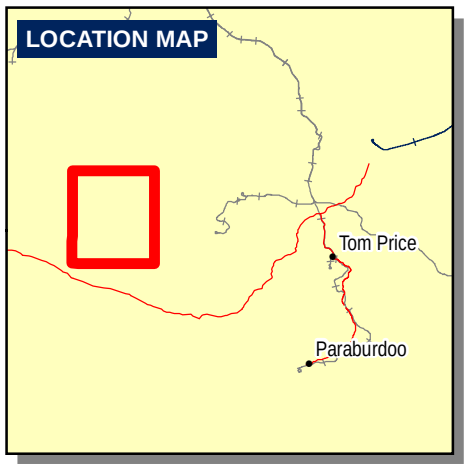
- The 596.1 ha ElAcAarTwTspr and ElApTspr mapped during the 2017 survey (Biota, 2017) noted above.

The areal extent of all communities that may be representative of the PEC are shown in Figure 23.

460,000 470,000 480,000 490,000

7,530,000 7,520,000 7,510,000 7,500,000 7,490,000

Eliwana



LEGEND

- Major Drainage
- Mine Development Envelope

Communities Mapped as PEC

- ElAcAarTwTspr
- ElAcTw
- ElApTspr
- PEC

Data Sources:
Drainage, SRTM, Geoscience Aus.

N

0 2 4 6 8
Kilometres

Figure 23
Communities Mapped as PEC

Requested By: M. Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:150,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.045_r2

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When considered at its total extent, the PEC is extensive in the region, certainly far greater than the 66 ha mapped by DBCA. Considering the large areas of potential PEC that have been identified by vegetation surveys in the region, Fortescue considers that the loss of 41.4 ha, or just 2%, of the potential extent of the PEC does not pose a risk to its conservation.

Given the potentially large extent of the PEC, that various communities representative of the PEC has been recorded over a wide area and that it has been recorded more extensively outside the MDE, Fortescue consider that the conservation of the PEC is not at risk from this Proposal.

4.6.5.4 Direct Loss of Conservation Significant Flora

The potential direct loss of conservation significant flora based on the proposed footprint shown in Table 27. Of the 17 priority flora species within the MDE, 9 species will be directly impacted by the Proposal.

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Table 27: Potential Loss of Priority Flora within the proposed footprint

Species	Total no. individuals	No. individuals in MDE	No. Individuals proposed disturbance	No. populations proposed disturbance	% loss individuals in MDE	% loss total individuals
Acacia bromilowiana	~353	~170	~60	3	~35.2	~17
Eremophila magnifica subsp. magnifica	~1,181	~258	36	10	13.9	3
Eremophila magnifica subsp. velutina	~454	~283	~60	4	~21.2	~13.2
Goodenia nuda	~9,735*	~106	~41	1	38.7	0.4
Indigofera sp. Bungaroo Creek	~7,888	~1,428	~519	26	36.3	6.6
Ptilotus mollis	2,073	322	193	3	60	9.3
Rhynchosia bungarensis	2,584*	22	18	6	81.8	0.6
Triodia basitricha	~85,922*	~59,226	~32,700	1	~55.2	~38.1
Triodia sp. Robe River	~223,867*	~17,743	5,744	24	32.3	~2.5

Notes:

* Species counts with an asterix include records where local abundance was not recorded. For instance, Fortescue has 293 recorded locations of *Rhynchosia bungarensis* in its database, but only 218 have local abundance data.

~ some species growth habits result in difficulty in recording accurate numbers in the field eg. *Triodia basitricha*, Triodia sp. Robe River. For these species, the percentage cover of the species within the quadrat is often recorded. For instance, *Triodia basitricha* may occupy 15% of a 50 x 50 m quadrat. Fortescue has estimated 1 plant per square meter to estimate local abundance where percentage cover has been recorded. In this example, 15% of the quadrat is equal to an estimated 375 individual plants.

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As demonstrated in Table 27 above, the impact to priority flora species as a result of the proposal is not significant on a regional scale. Specific species that may experience impacts on a local scale are discussed below.

Triodia basitricha

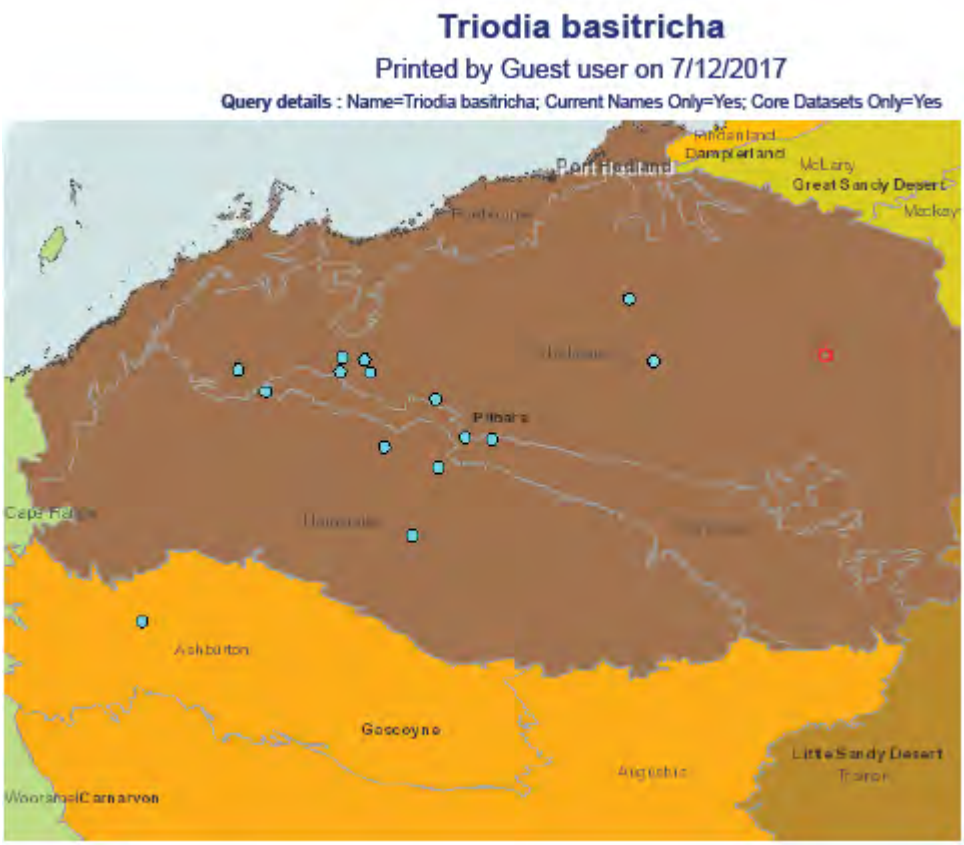
The Priority 3 species *Triodia basitricha*, will experience a 55% loss on a local scale (within the MDE). This figure is an estimate considering accurate counts of individuals is not possible due to the species hummock growth habit and that it is extensive where it occurs. Fortescue also note that Biota (2017) estimated that based on an average cover of 20% per quadrat, and an equivalent 800 individuals per hectare, there may be up to 836,000 *T. basitricha* individuals within the area surveyed in 2017. Fortescue has not included this estimate in Tables 28 and 30 above and have instead included a conservative estimate based on 1 plant per square metre and then calculated the number of individuals from the percentage cover recorded during quadrat surveys.

Fortescue also notes that this species would be disturbed through the implementation of Fortescue's Solomon Sustaining Production Proposal (Fortescue, 2015). The Solomon Sustaining Production PER estimated a total loss of approximately 26,300 individuals. Therefore, the cumulative loss between this proposal and the Solomon Proposal is approximately 59,000 individuals. As discussed during the assessment of the Solomon proposal, accurate counts of any *Triodia* species is not possible due to its growth habit and most records of *T. basitricha* do not include counts of individuals, but rather an estimate of the percentage cover within the quadrat. Fortescue's assessment of impacts to *T. basitricha* for the Solomon proposal recommended that impacts should be estimated based on number of populations and at that time, Fortescue was aware of nine locations where the species has been recorded (Fortescue, 2015). As demonstrated in Figure 24 below, Naturemap now has 20 locations for this species and these are spread across all three IBRA sub-bioregions as well as an additional record in the Gascoyne, with the distance between the most eastern and western populations approximately 500km (DPAW, 2007-).

Furthermore, Biota (2017) estimated that based on an average cover of 20% per quadrat, and an equivalent 800 individuals per hectare, there may be up to 836,000 *T. basitricha* individuals within the survey area, suggesting that the impacts to this species from both mine and rail proposals will not be significant.

With such an enormous range of occurrence, and the potential for there to be many millions of individuals across the Pilbara, based on Biota's estimations of abundance, there is unlikely to be any risk to the conservation of this species from the proposal, despite the cumulative disturbance posed by both this proposal and the Solomon Proposal.

Figure 24: ***Triodia basitricha*** **locations (DPAW, 2007-)**



Triodia **sp. Robe River**

This species distribution is closely aligned with the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* PEC, but has been recorded in similar vegetation not occurring on mesas. Given over 220,000 *T. sp*. Robe River individuals have been recorded in the region, impacts to this species on a local and regional scale will be negligible.

4.6.5.5 Fragmentation

Fragmentation of vegetation occurs when pockets of vegetation become isolated through clearing for infrastructure (Coffin, 2007) (Karlson, et al., 2014). These islands of vegetation can become degraded through 'edge effects' where cleared areas become vectors for weeds, changes to surface drainage and dust deposition. For some flora species within these vegetation fragments, the distance between vegetation may be too great for pollination or seed dispersal. These vegetation fragments can degrade over time to the point where they are no longer suitable for some species of flora and fauna. There will be fragments of vegetation created within the MDE during construction and operation of the Proposal and some of these fragments are likely to be small and may not continue to be representative of their original community structure. The indirect impacts to flora and vegetation from fragmentation is unquantifiable as, fragmentation by itself does not preclude the flora and vegetation from existing. Fragmentation is a gateway to

secondary impacts such as weeds, reduced seed dispersal and dust. Re-establishment of ecological linkage through progressive rehabilitation and at mine closure will attempt to mitigate the impacts of fragmentation on vegetation, as outlined in Section 4.6.6.

4.6.5.6 Dust Deposition

Dust deposition on foliage can impact on a plants ability to photosynthesise, or control water loss through transpiration. One published study indicates that vegetation health is not impacted by dust deposition until relatively high levels of dust are experienced, that is, greater than 7g/m^2/month (Doley, 2006). Dust deposition can occur through movement of vehicles, blasting, earth moving and ore processing. The indirect impacts to flora and vegetation from dust deposition is difficult to quantify in isolation. As discussed in section 4.6.5.5, dust deposition can operate in combination with other environmental changes such as weeds, fragmentation or surface water to degrade vegetation. Management of dust is discussed in Section 4.6.6.

4.6.5.7 Altered Fire Regimes

Most wildfires in the Pilbara burn out of control over very large areas. Without anthropogenic management, frequent hot, uncontrolled bushfires can change vegetation structure, which in turn can lead to flora species that are better adapted to fires outcompeting species that require less frequent, or cooler fires. Frequent fires also lead to an increase of some weeds species, which can result in the vegetation becoming more bushfire prone. Fortescue considers that the risk of increased fire as a result of the proposal is low. Management of fire is discussed in Section 4.6.6.

4.6.5.8 Chemical Spills, Leaks and Leachate

Contamination of soil by chemical and hydrocarbon spills can impede plant growth or kill vegetation. Drainage from waste rock dumps and tailings storage facilities may contain harmful acidic, saline or metalliferous leachates, which may also cause a decline in vegetation health. Similarly, leakage from tailings pipelines can smother vegetation with very fine silts and accidental release of saline water into the environment can cause vegetation deaths. Fortescue consider the risk of impacts to vegetation from contamination and pollution to be low. Management of these impacts is discussed in Section 4.6.6. AMD risks are discussed in Section 4.5.6.4.

4.6.5.9 Altered Surface Hydrology

Pilbara creeks are typically ephemeral and with the exception of pools and groundwater-fed springs, are dry for the majority of the year. Pilbara soils typically have high initial infiltration rates where the moisture content of catchment soils is low. Significant streamflow usually occurs where moisture content of catchment soils is high, which is caused by significant rainfall in the

days or weeks preceding a storm event. There are typically two different types of climatic events which cause flood response in the Pilbara, namely cyclonic activity/tropical low-pressure systems and localised diurnal thunderstorms.

Hydrology of the mine development envelope is discussed in Section 4.4. The results of the surface hydrology model described in Section 4.4, which predicts changes in surface water flows are used to predict impacts to riparian vegetation in this section (Fortescue, 2017a). It should be noted that the model does not include any surface water diversion that may be constructed to allow water to continue to flow downstream. Surface water diversions around key infrastructure and pits will be constructed where practicable during operations, however, these have not yet been designed for construction.

In this section, the identified riparian vegetation communities are MaMgCYPv, EcAcEuaTe, EvAcCcErIt and EvAcMgERIt, noting that MaMgCYPv, EcAcEuaTe are also groundwater dependent (see Section 4.6.4.7). MaMgCYPv does not occur within the MDE but is found downstream of the MDE in major drainage areas. Note, there are no sheetflow vegetation communities within the MDE. Impacts to these communities are either as a result of:

- Fragmentation of riparian vegetation in between infrastructure, open pits and constructed landforms.
- Riparian vegetation downstream of the proposed disturbance that may receive less run-on from higher in the catchment.

Of the four riparian communities, only EvAcCcERIt will be impacted by fragmentation, resulting in remnants that will remain after the proposed disturbance. These remnants will only receive incident rainfall as surface water flows are truncated from upstream. These remnants will likely experience changes in vegetation structure and species composition as a result of receiving significantly reduced surface water flows, leading to a decline in vegetation health followed by a loss of biomass, before the community recalibrates to the reduced water availability and establishes a new equilibrium.

Areas of vegetation downstream of all mining disturbance will experience truncated surface water flows due to the restriction in surface water flow from higher in the catchment. The exception to this may be during extremely rare rainfall events where some open pits may overflow.

Section 4.4.4.3 and 4.4.5.3 described the surface water modelling undertaken to determine the potential changes to surface water flow resulting from the Proposal. In particularly, this model was based on a maximum expected impact. The assessment of impacts to vegetation as a result of changes to surface water flow described below are therefore considered maximum impacts.

As a result of the proposed disturbance, six local creeks are likely to experience a reduction in surface water flow. These are

- West Creek;
- Pinarra Creek;
- Strike East Creek;
- Flying Fish 1 Creek;
- Flying Fish 2; and.
- Un-named creek downstream of a potential TSF location. Impacts to this creek will only occur if the TSF is built in this location.

These areas downstream of the proposed disturbance that may experience reduced surface water flows are shown in Figure 12. Strike East Creek and Flying Fish 1 Creek converge downstream of the proposed disturbance.

The surface hydrology model predicts that the reduction in flood volume and extent of reduced surface water flows downstream of the proposed disturbance in West Creek may extend 12 km downstream. West Creek joins Duck Creek at this point, reducing the shadow effect of the upstream disturbance. The effects are greatest closest to the mine void and dissipate further down the reach as other small tributaries add water volume. Under an annual exceedance probability of 50%, flood levels are estimated to be reduced by 0.5m to 1m for the first 1.5 km downstream of the mine void. This equates to a reduction of between 100% (Dry) to 50% of the pre disturbance flood levels. From this point there are small stretches (50m – 300m) that experience 0.5m – 1m reduced flood levels down the reach. A reduction in flood level by 0.25m to 0.5m is the most likely scenario for the majority of West Creek, which reduces further as the confluence with Duck creek is approached. The reduction in flood level is likely to result in changes to vegetation structure and species abundance, particularly closer to the disturbance, with a decline in overall vegetation health in this area until a new equilibrium is established. Approximately 94.2 ha of riparian vegetation will be indirectly impacted by reduced volumes of surface water (Table 28).

Vegetation community MaMgCYPv in West Creek will also experience a significant decline in groundwater (see discussion later in this section). It is also noted that the majority of vegetation downstream of the proposed disturbance is vegetation community EcAcEuaTe, which is considered to be groundwater dependent. Groundwater drawdown will not extend as far as this vegetation unit in West Creek and therefore it will not be impacted by groundwater drawdown. Tall *E. camaldulensis* trees in EcAcEuaTe are likely to be sustained by groundwater, independent of reduced surface water flows. Therefore, changes to vegetation structure may be limited to understorey shrub layer species in vegetation community EcAcEuaTe in West Creek.

Pinarra Creek catchment contains more open pits than any of the other local catchments and as a result, has the largest extent of change. Indirect impacts to vegetation from reduced surface water flows are likely to occur up to 6.5 km downstream of the disturbance potentially impacting

60.7 ha of riparian vegetation (Table 28). Under an annual exceedance probability of 50%, flood levels are estimated to be reduced by 0.5m to 1m for the first 2 km downstream of the disturbance. This equates to between 100% (dry) to 50% of the pre-disturbance flood levels. The remaining 4.5 km of the affected reach are likely to experience reduction of between 1m to 0.1m, with the impacts reducing with distance from the impact. It is expected that vegetation type EvAcCcErIt will experience changes in vegetation structure and species composition as a result of the hydrological changes upstream, this is expected to extend no more than 4.5 km downstream of the open pits.

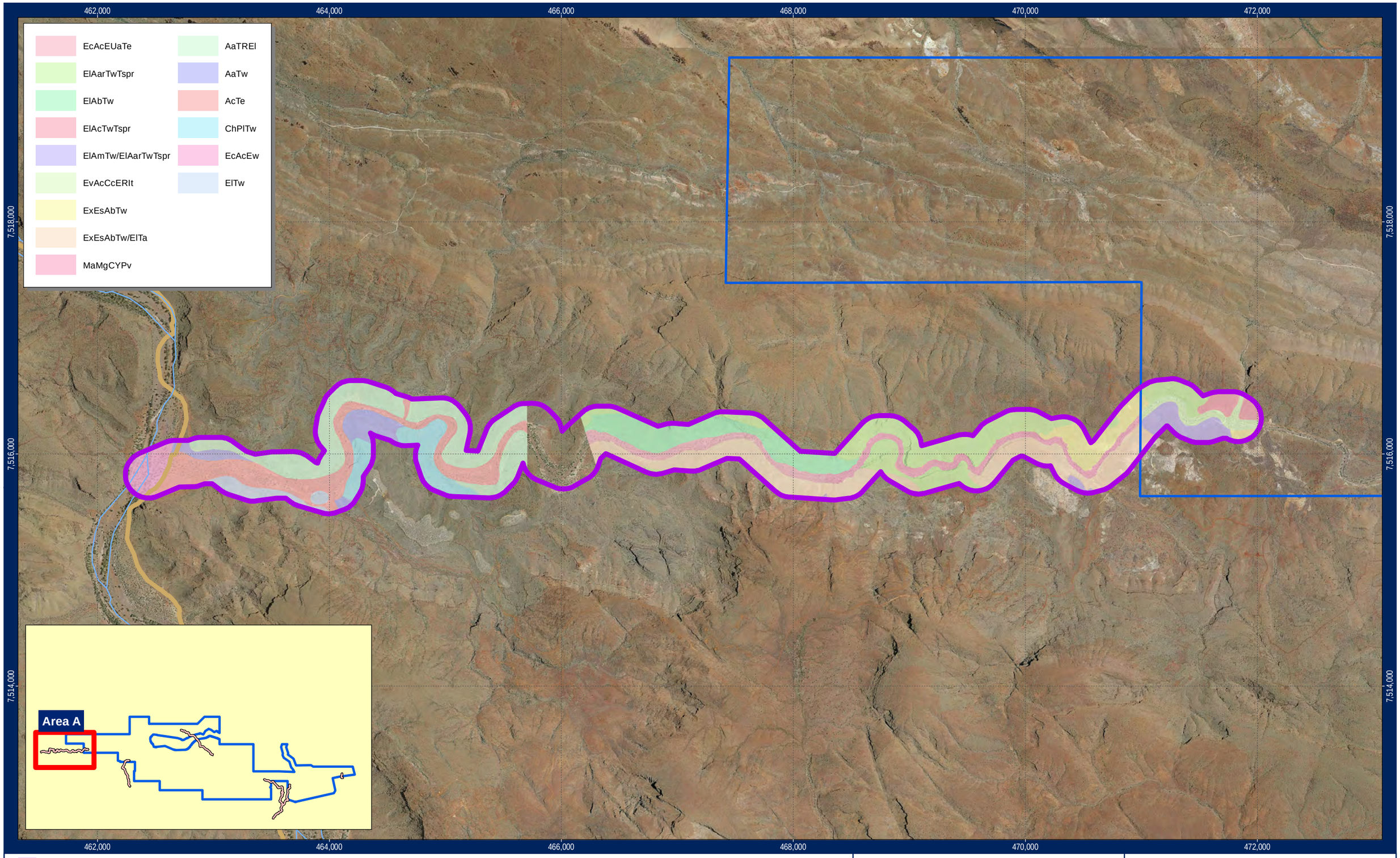
Strike East Creek and Flying Fish 1 Creek converge at a point 4km south of the proposed disturbance. Both creeks have proposed open pits which will intercept surface water flows. Impacts to surface water flows on Strike East Creek are relatively low with reductions under an annual exceedance probability of 50% of 1m to 0.5m predicted to occur up to 500m downstream of the disturbance. The remaining 8km of the reach until the confluence with Flying Fish 1, will experience reductions ranging between 0.5m to 0.1m, with the latter level being more common the further from the disturbance.

For Flying Fish 1 Creek, under an annual exceedance probability of 50%, there is predicted reduction of 1m to 0.5m for approximately 4km downstream of the disturbance. For the remainder of the reach a reduction of 0.5m to 0.25m is most likely.

Where the two creeks converge the upstream pit developments result in water level depth reductions of less than 0.5 m in the annual exceedance probability of 50%. These depth reductions don't translate to major flood extent reductions, with flow widths in the ultimate scenario being typically at least 75% of that of the baseline scenario. Therefore, vegetation types EvAcCcErIt and EvAcMgERIt will experience a reduction in flow volumes downstream of the proposed disturbance, but these impacts are minor in Strike East Creek and downstream of the point where the two creeks converge. Changes in vegetation structure and composition will be confined to areas immediately downstream of the proposed open pits. Approximately 143.4 ha of riparian vegetation may be impacted from some level of reduced surface water volumes from both Strike East Creek and Flying Fish 1 Creek.

Flying Fish 2 Creek may experience minor flood reductions of between 0.25m to 0.1m. Approximately 15.6 ha of vegetation may be impacted to some extent as a result of the reduce water volumes.

All areas of riparian vegetation that may be subject to reduced surface water flow are shown in Figure 25 (Maps 1 – 5).



Shadow Areas
Mine Development Envelope

Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 200 400 600 800 1,000
Meters

Requested By: M. Dowling
Drawn By: C. Whyte
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.048a_r1

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Figure 25
Impacts to Surface Water Flows
Area A

Fortescue Metals Group Ltd
The New Force in Iron Ore

476,000 478,000 480,000 482,000 484,000

7,514,000 7,512,000 7,510,000

ChAbTw
ChAiTw/ElAbTlo
ElAarTwTspr
ElAmTw
ElAmTw/ElAarTwTspr
EvAcCcERIt
ChAmTe
EcrAcPr
ElAcTw
EvAcCc

Area B

Shadow Areas
Mine Development Envelope

Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 200 400 600 800 1,000
Meters

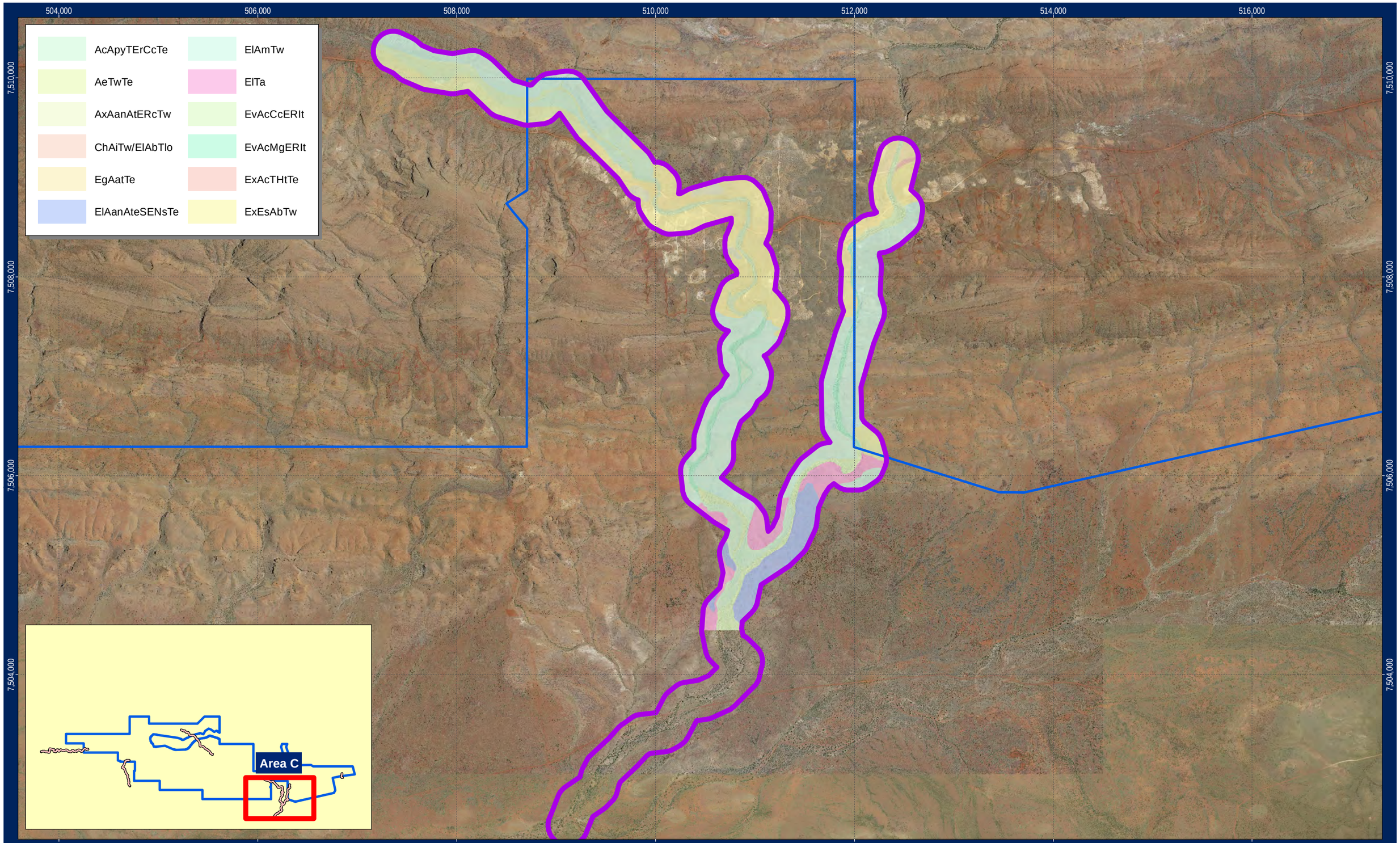
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Approved By: P. Mastalir
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Size: A3L
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Confidentiality: 1

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Figure 25
Impacts to Surface Water Flow
Area B

Fortescue Metals Group Ltd
The New Force in Iron Ore



Shadow Areas
Mine Development Envelope

Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

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Meters

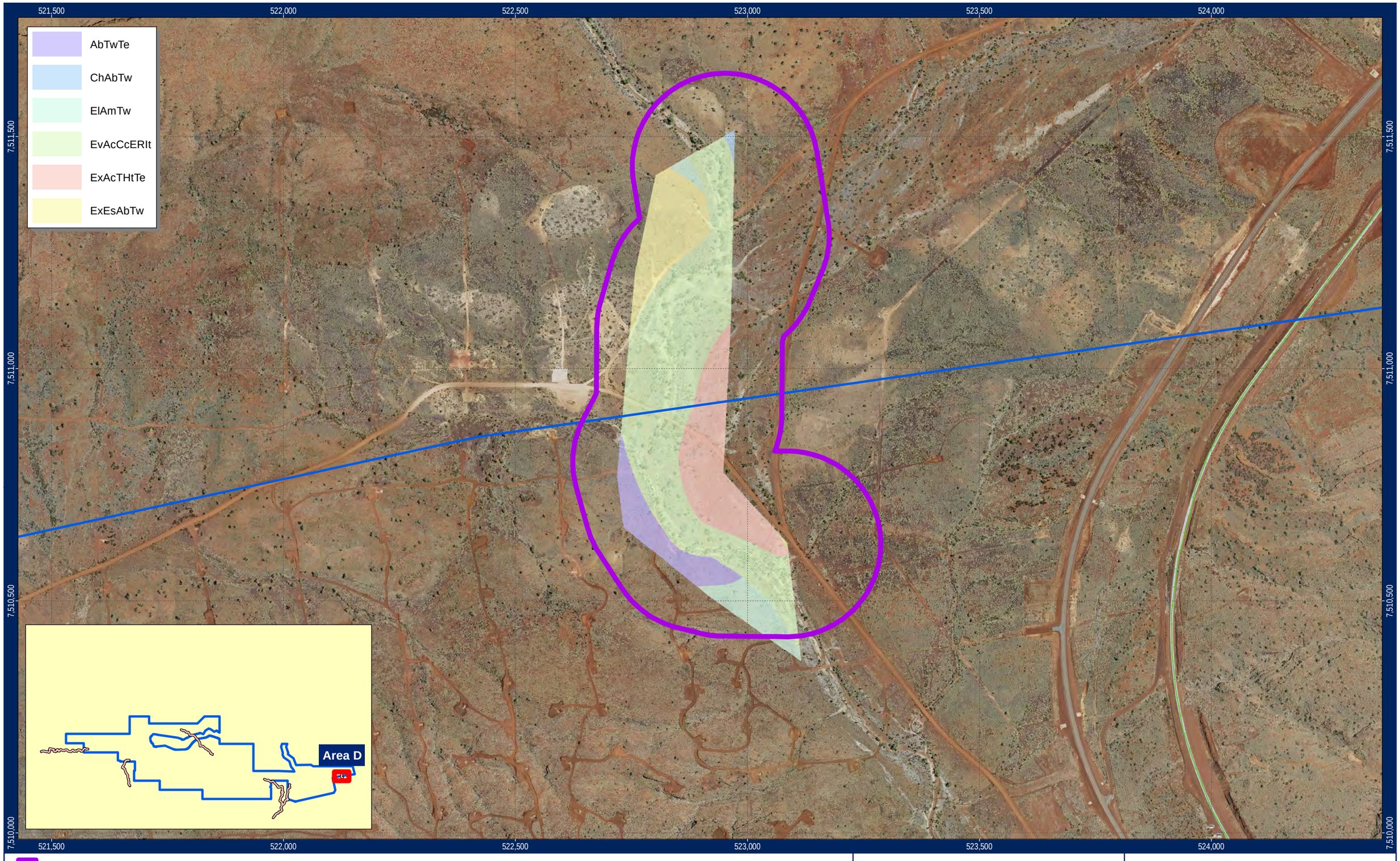
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Drawn By: C. Whyte
Revised By: scostello
Approved By: P. Mastalir
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Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.048c_r1

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Size: A3L
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Figure 25
Impacts to Surface Water Flow
Area C

Fortescue Metals Group Ltd
The New Force in Iron Ore



Shadow Areas
Mine Development Envelope

Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N
0 50 100 150 200 250
Meters

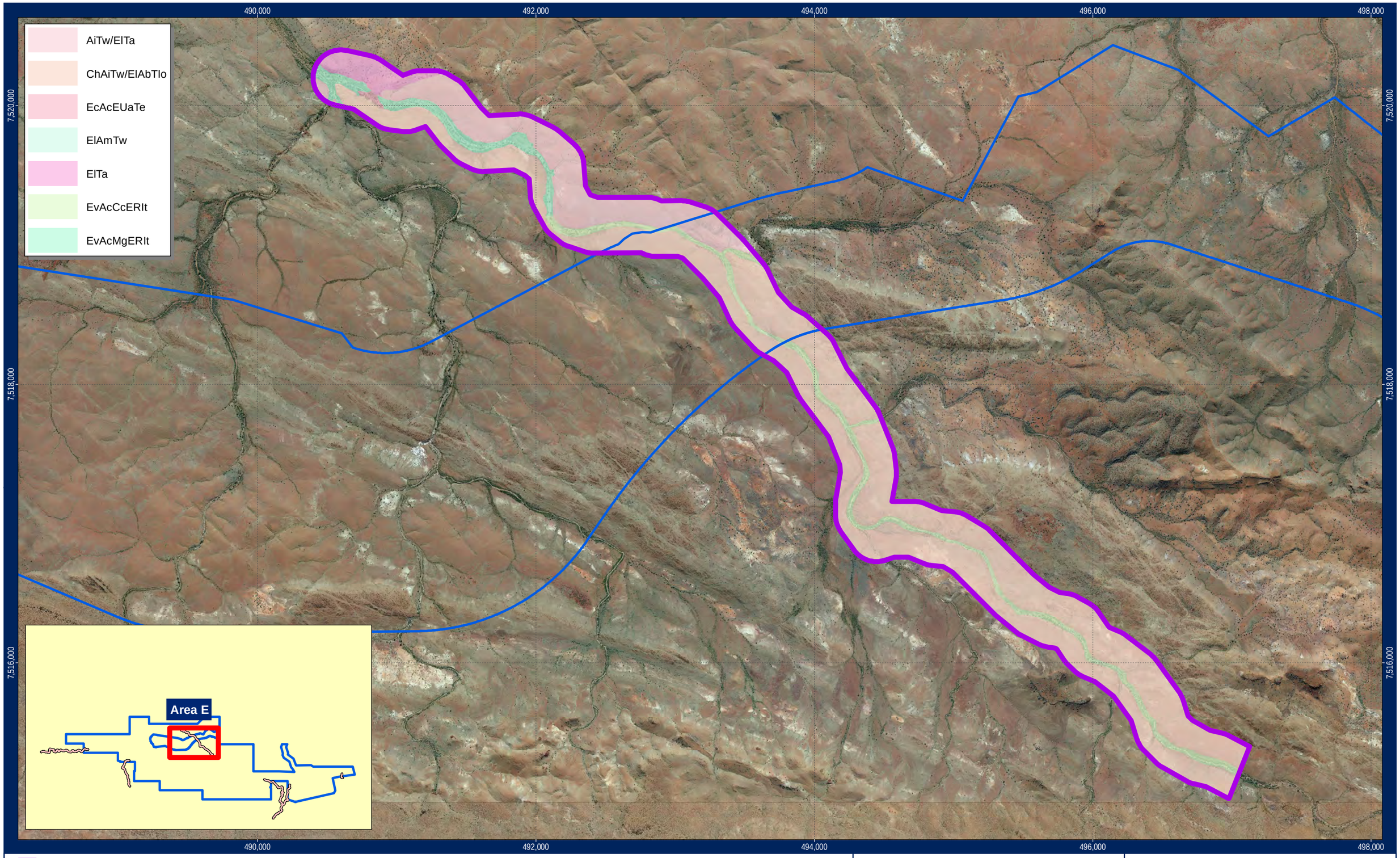
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Drawn By: C. Whyte
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Approved By: P. Mastalir
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Document Name: 750EW_MP_EN_0010.048d_r1

Date: 21-Aug-18
Size: A3L
Revision: 2
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Figure 25
Impacts to Surface Water Flow
Area D

Fortescue Metals Group Ltd
The New Force in Iron Ore



Shadow Areas
Mine Development Envelope

Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N
0 200 400 600 800 1,000
Meters

Requested By: M. Dowling
Drawn By: C. Whyte
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:25,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.048e_r1

Date: 21-Aug-18
Size: A3L
Revision: 2
Confidentiality: 1

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Figure 25
Impacts to Surface Water Flow
Area E

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The New Force in Iron Ore

Table 28: Indirect impacts to vegetation from changes to surface water

Creek name	Mapped Veg type	Estimated veg type*	Indirect impact (ha)
West Creek	MaMgCYPv (19.6 ha) and EcAcEuaTe (15.3 ha)	EcAcEuaTe (59.4 ha)	94.3
Pinarra Creek	EvAcCcErIt (19.9 ha)	EvAcCcErIt (40.8 ha)	60.7
Strike East and Flying Fish 1	EvAcCcErIt (56.2 ha) and EvAcMgERIt (21.2 ha)	EvAcCcErIt (66 ha)	143.4
Flying Fish 2	EvAcCcErIt (15.6 ha)	Nil	15.6
TOTAL	**147.8 (ha)**	**166.2 (ha)**	**314 (ha)**

* vegetation mapping did not cover the entire reaches of some of the creeks that were impacted by surface water shadowing from disturbance. In this case, the vegetation type was extrapolated and estimated to be the same as what was mapped at the boundary of the mapping. High-resolution aerial imagery was consulted in these estimates.

Finally, there will be some minor impacts to surface water flow as a result of the construction of infrastructure near the proposed OPF, accommodation camps, ore stockpiles and train loadout infrastructure in the northern part of the MDE. These changes are minor, and it is likely that surface water will be diverted around infrastructure for safety and asset protection purposes. These areas are also high in the catchment and there are not significant surface water flows in these areas.

Indirect Impacts to Conservation Significant Flora

In addition to the impacts to riparian vegetation described above, several Priority flora species have been recorded from within these creeklines. It is likely that the number of individuals recorded from these populations is influenced by the higher volume of surface water and/or soil moisture in these creeklines compared to other populations of the same species elsewhere in the landscape. Whilst it is not possible to quantify a loss of individuals from a reduction in available water, a reduction in seasonal surface water flows in the creeklines discussed above may result in a decline in the number of these individuals within these populations, although they will continue to receive incident rainfall. Table 29 below lists those species located in these creeklines and the number of individuals recorded from those locations. The table also demonstrates the individuals at these locations as a percentage of the total number of individuals in the MDE (refer to Table 25 – Number of Individuals in MDE).

Table 29: Priority Flora within areas subject to a reduction in surface water flow

Location	Species (status)	Individuals at Location	% of MDE individuals
West Creek	*Dicladanthera glabra* (P2)	20	10
	Indigofera sp. Bungaroo Creek (P3)	120	5
	Pleurocarpa gracilis (P3)	6	5
	Sida sp. Hamersley Range (P1)	120	31
	Rhynchosia bungarensis (P4)	50	18
	Terminalia supranitifolia (P3)	6	100

Location	Species (status)	Individuals at Location	% of MDE individuals
Pinarra Creek	*Indigofera* sp. Bungaroo Creek (P3)	473	21
	Ipomoea racemigera (P2)	1	33
	Rhynchosia bungarensis (P4)	15	5
Strike East and Flying Fish	*Indigofera* sp. Bungaroo Creek (P3)	45	2
Flying Fish 2	*Rhynchosia bungarensis* (P4)	1	0.3

Of the species listed in Table 29 above, the only species where indirect impacts from changes to surface water flow may have a significant impact is *Terminalia supranitifolia* (Priority 3). This population is the only population recorded from the MDE, although Fortescue is aware of approximately 140 other individuals (approximately 8 populations) outside of the MDE. The indirect impacts to the remainder of the Priority species is not significant, even when considered cumulatively with direct disturbance to individuals discussed in Section 4.6.5.4.

Indirect Impacts from Excess Water Discharge.

As described in Tables 13 and 14 and Section 4.4.6.2, there will be periods during the life of the mine where the volume of water abstracted for dry mining will exceed the water demand for the Proposal. It is proposed that this excess water will be discharged to the environment down a creek as illustrated in Figure 13. As discussed in Section 4.4.6.2, the extent of the wetting front for discharge is approximately 12.1 km downstream from the discharge point (Pinarra Creek).

This strategy has been employed at many operations in the Pilbara. Noting that there are also periods of the life of the mine where there will be a water deficit, it is more likely that vegetation within the proposed discharge channel will experience short term periods of continual flow followed by periods where surface flows will revert to natural regimes. If discharge were to occur over extended periods, the vegetation in the creek may experience one of two scenarios:

- Additional water supply may increase plant available water resulting in increased vegetation vigour and recruitment; or
- Formation of permanent water in some parts of the creek may lead to reduced vigour in plants that are sensitive to saturated soil conditions.

Given the riparian vegetation in the creek is adapted to annual inundation from surface water flows and that discharge is unlikely to occur for extended periods, it is considered that the discharge of water to the creek as is proposed in this proposal will have a not have a significant negative impact on the health of the vegetation in the creek.

It is also noted that the creek into which excess water will be discharged is likely to experience a reduction in annual surface water flows as described earlier in this sub-section. The discharge of water during periods of excess water supply may balance the impacts from reduced surface water flow during operations.

As a result, it is expected that the sporadic discharge of excess water down Pinarra Creek is unlikely to significantly alter the vegetation within Pinarra Creek downstream of the discharge point. Impacts to vegetation within Pinarra Creek are more likely to result from reductions in surface water flow over time as described above.

4.6.5.10 Impacts from Groundwater Drawdown

The impacts of groundwater abstraction with regards to hydrological processes is discussed in Section 4.4 and impacts to stygofauna discussed in Section 4.8. This section discusses how abstraction of groundwater has the potential to impact vegetation that may be dependent on groundwater (GDE and Potential GDE).

Mine dewatering is required to enable mining of ore below the water table. The drawdown from mine dewatering in the MDE has been characterised in Hydrological Processes (Section 4.4). As discussed in Section 4.4 the spatial extent of drawdown is limited by the compartmentalised nature of the aquifers in the MDE, which are divided by low permeability dolerite dykes and shale-rich stratigraphic units.

As discussed earlier, vegetation communities recorded within the MDE with potential for groundwater dependence are:

- EcAcEuaTe: Groundwater dependent vegetation dominated by *E. camaldulensis*.
- EvAcCcErIt and EvAcMgERIt: Potential groundwater dependent vegetation dominated by *E. victrix*.

MaMgCYPv (Groundwater dependent vegetation dominated by *Melaleuca argentea)* has been recorded immediately outside the MDE in areas that may be impacted by groundwater drawdown.

The potential extent of groundwater drawdown at its maximum extent is shown in Figure 26. As discussed in Section 4.4, the model predictions for the extent of groundwater drawdown assumes the unlikely “worst-case” event where all pits are dewatered concurrently and aquifer storage parameters are set to their lowest likely value (1% Specific Yield).

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460,000 480,000 500,000 520,000

7,540,000

7,520,000

INSET 1 - See Map 1

INSET 2 - See Map 2

See Inset 1

See Inset 2

CAVES CREEK

PENTINE CREEK

DUCK CREEK

PINARRA CREEK

BOOLGEEDA CREEK

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Eliwana Model
- Groundwater Dependent Ecosystem
- Potential Groundwater Dependent Ecosystem
- Dyke

High : 166.667

Low : 0

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

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Kilometres

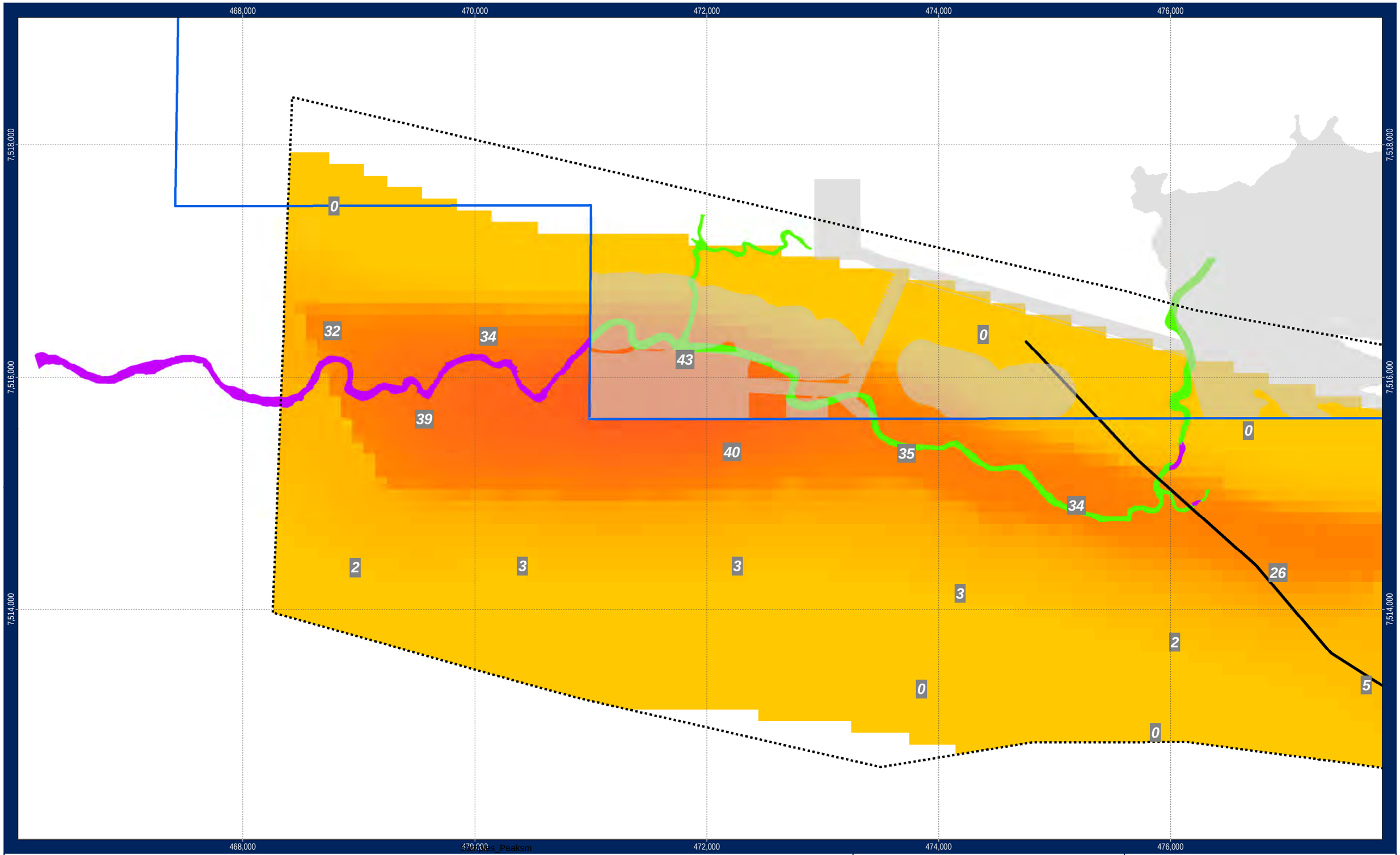
Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:200,000
Coordinate System: GDA 1994 MGA Zone 50
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Date: 21-Aug-18
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Revision: 0
Confidentiality: 1

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Figure 26
Impacts from
Ground Water Drawdown

Fortescue Metals Group Ltd
The New Force in Iron Ore



LEGEND

- Mine Development Envelope
- Indicative Mine Footprints
- Eliwana Model
- Groundwater Dependent Ecosystem
- Potential Groundwater Dependent Ecosystem
- Dyke

Samples_Peaksm

High : 166.667

Low : 0

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

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Kilometres

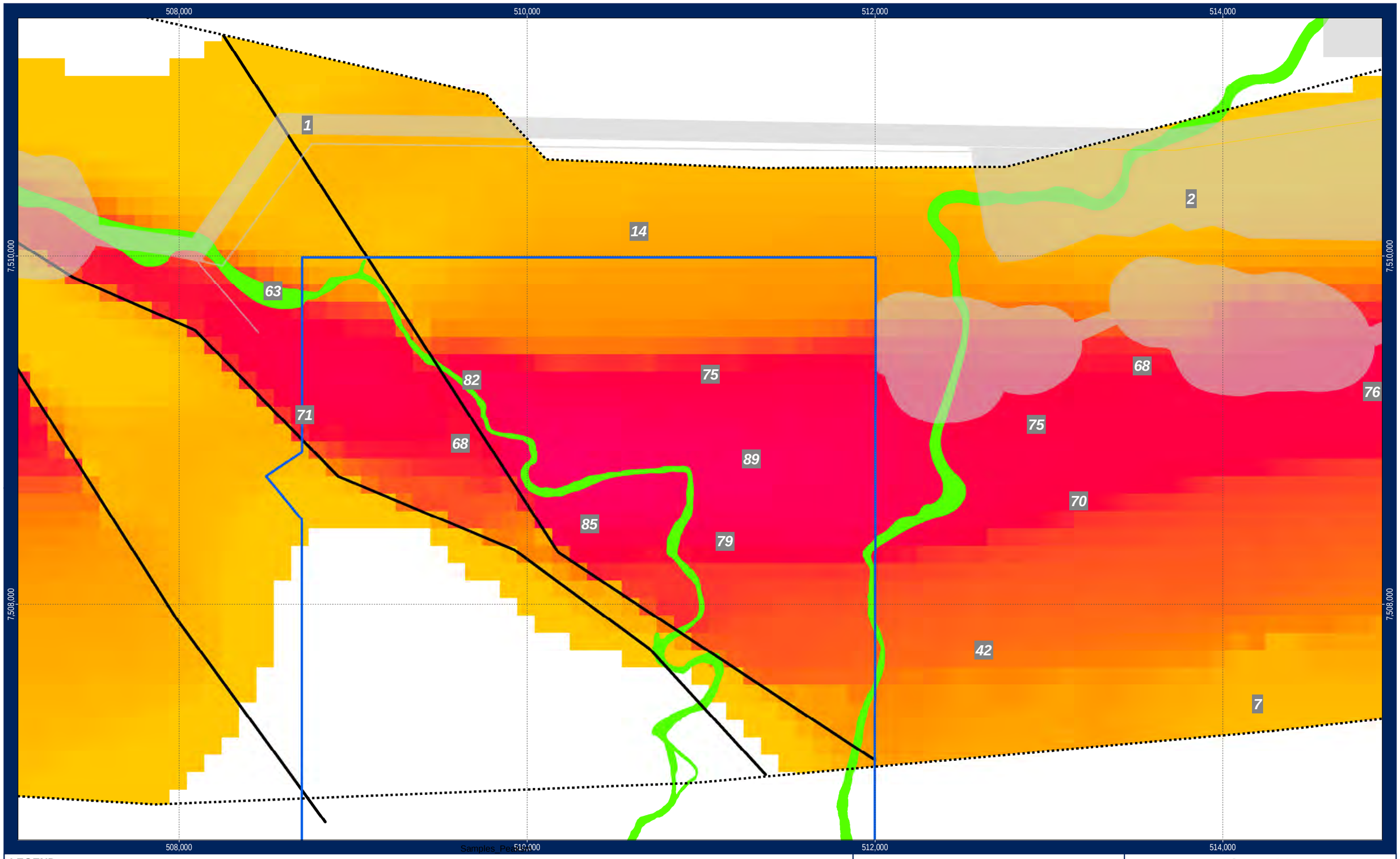
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Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.028a_r2

Date: 21-Aug-18
Size: A3L
Revision: 0
Confidentiality: 1

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Figure 26
Impacts from
Ground Water Drawdown - Map 1

Fortescue Metals Group Ltd
The New Force in Iron Ore



LEGEND

- Mine Development Envelope
- Indicative Mine Footprints
- Eliwana Model
- Potential Groundwater Dependent Ecosystem
- Dyke

High : 166.667

Low : 0

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 250 500 750 1,000
Meters

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:20,000
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Document Name: 750EW_MP_EN_0010.028b_r2

Date: 21-Aug-18
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Figure 26
Impacts from
Ground Water Drawdown - Map 2

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Key factors to the impact to vegetation as a result of groundwater drawdown is:

- The species present within the defined GDE or Potential GDE and their likelihood for groundwater dependence;
- The initial depth to groundwater;
- The amount to which groundwater levels decline as a result of dewatering; and
- The rate of decline.

As discussed in Section 4.6.4.7, the key indicator species for groundwater dependence are *Melaleuca argentea*, *Eucalyptus camaldulensis* and *E. victrix,* with *E. victrix* having the potential for groundwater dependence based on all available literature.

Reliance of vegetation on groundwater decreases with increasing depth to water table (Eamus, et al., 2006) (DoW, 2009). Contribution of groundwater to whole plant water use is thought to be relatively small where the water table lies beyond 10m below ground level. Beyond 20m depth, the probability of groundwater as a significant resource is considered to be very low in most instances (Zencich, et al., 2002). In the Pilbara, groundwater dependency is mostly restricted to areas where groundwater is less than 10m from the surface (Barron & Emelyanova, 2015).

The magnitude of groundwater level change will influence the impact on groundwater dependent vegetation. As a generalisation, where groundwater is close to the surface and vegetation root systems are concentrated over shallow groundwater, these communities will be more sensitive to groundwater decline than vegetation established in areas where depth to groundwater is much greater, as deep-rooted vegetation are less likely to draw significant volumes for their water requirements from the capillary zone.

Estimates of groundwater changes that can be tolerated by plants is poorly reported. Fortescue understands that where groundwater declines of less than 2m occurs, plants are likely capable of adapting, but a change of more than 2m may increase plant stress (Marcam Environmental, 1998) (Froend, et al., 2004) (Naumberg, et al., 2005) (Braimbridge, 2010).

Rate of drawdown also impacts the ability of vegetation to cope with declining groundwater levels. Relatively little is known on the ability of groundwater dependent species to grow roots in response to groundwater decline. What little has been published suggests that root growth will not keep pace with groundwater declines of more than 1cm per day (Kranjcec, et al., 1998) (Scott, et al., 1999) (Horton & Clark, 2001) (Canham, 2001). This suggests rapid drawdowns in the order of 1m over several months would pose a high risk to groundwater dependent vegetation.

However, groundwater dependent species in the Pilbara are capable of withstanding periods of drought, with coping mechanisms such as adjustments in leaf area and root growth and are likely to be able to cope with short term changes in groundwater. Longer term changes in groundwater

levels are likely to result in more visible responses in vegetation health which may become apparent months to years after the initial impact.

Based on the information available, Fortescue has adopted the following thresholds to determine impacts from groundwater drawdown:

- A decline of more than 2 metres in areas where groundwater is greater than 5m below ground level may result in plant stress.
- A decline of more than 1 metres in areas where groundwater is less than 5m below ground level may result in plant stress.
- Where depth to groundwater is greater than 10m, the vegetation community is unlikely to be groundwater dependent, or only a minor portion of the groundwater dependent species water requirements are met by groundwater.

Noting that groundwater drawdown will be limited within each of the groundwater compartments within the mining area, and noting the threshold values above, an assessment of impacts to GDE and potential GDE vegetation can be made. Table 30 discusses impacts to the four vegetation types listed above. Figure 25 demonstrates the vegetation communities in relation to predicted groundwater drawdown contours.

Table 30: Assessment of Impacts from Groundwater Abstraction

Vegetation Unit	Potential Area of Impact	Nature of Impact
Groundwater Dependent Vegetation		
MaMgCYPv	19.6	This vegetation type occurs in two locations within the potential extent of groundwater drawdown. The largest area occurs within a gorge downstream of the most western extent of the MDE immediately east of a dolerite dyke. This dyke represents the westward extent of groundwater drawdown in this compartment. Groundwater within this compartment has been recorded at 393 mAHD. The presence of *M. argentea* suggests the vegetation is highly dependent on groundwater. Surface water pools were present in this area in March 2017 and June 2014 and given the elevation at the bottom of the gorge is 383 mAHD, these pools may be a surface expression of groundwater. Indeed, the presence of the dolerite dyke may be causing groundwater to surface within the gorge. However, the pools were not present in November 2005 which suggests that groundwater levels in the area may be highly variable depending on recharge events and annual rainfall and may decline to below 383 mAHD before the wet season. Dewatering in this area will lower the groundwater level by at least 30m suggesting that there will be a loss of *M. argentea* and a decline in the health of this vegetation community. However, although the presence of *M. argentea* suggests the vegetation is highly dependent on groundwater, the pools have been noted as absent in November 2005, suggesting natural variation in groundwater levels may result in a natural, periodic decline in groundwater availability at this site. The second area of just 1 ha in size occurs in an area immediately outside the MDE which will also experience groundwater decline of at least 30m suggesting this area will also experience a loss of *M. argentea* and a decline in overall health.

Vegetation Unit	Potential Area of Impact	Nature of Impact
EcAcEuaTe	~1	This vegetation type occurs in two locations in proximity to groundwater drawdown: The first is to the west of a dolerite dyke in a gorge downstream of the far western portion of the MDE. This area is unlikely to be impacted by groundwater drawdown due to the presence of a dolerite dyke preventing groundwater drawdown propagating west of the dyke (Figure 7). The second is a very small area of approximately 1 ha that is located within the predicted 30 m drawdown zone. However, groundwater at this site is up to 30-35m below ground level and surface water pools have not always been observed suggesting a surface water dependency. It is likely that the *E. camaldulensis* growing in this area are likely to be obtaining most of their water requirements from the vadozone, fed by regular inundation during the wet season flows, with only a small percentage obtained from groundwater at this depth. However, there is a potential for some impact to deep rooted *E. camaldulensis* in this area. Several other minor occurrences of this vegetation type within the MDE near the accommodation camp and airstrip will not be impacted by groundwater drawdown.
Potential Groundwater Dependent Vegetation		
EvAcCcERIt	~105 ha	This vegetation community occurs in major drainage lines running through the MDE. Where these drainage lines occur within areas impacted by dewatering, the depth to groundwater varies from 50m to less than 10m (average 25m-35m) depending on topography. The absence of *E. camaldulensis* and *M. argentea* in these areas is indicative that depth to groundwater is largely too great for the communities to be groundwater dependant, particularly in the upper parts of the catchment areas. Within the proposed footprint, 157 ha of EvAcCcERIt will be disturbed by mining and infrastructure development and approximately 105 ha of small remnants will remain within areas impacted by groundwater abstraction. Even if this vegetation community is accessing groundwater for part of its water requirements, only these remnants will experience a drawdown beyond 5m. However, Fortescue contend that there is a greater risk to these remnants from changes to surface hydrology than the possibility of impacts to the community from groundwater drawdown. This is addressed earlier in this Section. Large areas of both EvAcCcERIt are located in the northern section of the MDE and are not impacted by groundwater drawdown (or changes to surface hydrology).
EvAcMgERIt	2 ha	A small section of this vegetation community occurs within the area impacted by groundwater drawdown. Depth to groundwater in this area is approximately 497mAHD, whilst elevation is approximately 505 m AHD, suggesting groundwater is approximately 7m below ground level. At this depth, it is possible that larger *E. victrix* are accessing groundwater for some of their water requirements, however given amount of surface water that would flow through this area each wet season, it is more likely that *E. victrix* are accessing the majority of their water requirements from the alluvial stream bed.

4.6.5.11 Cumulative Impacts

To undertake a cumulative impact assessment for the Eliwana Mine Proposal disturbance associated with Fortescue's Solomon Mine, the proposed Eliwana Railway and the Eliwana Iron Ore Mine have been used. Fortescue reviewed the information available in Rio Tinto's Brockman, Silvergrass and Nammuldi Public Review documents, however the information in those documents was not comparable.

The cumulative impact of the MDE, the Solomon Project and the Eliwana Railway on the Land Systems occurring within the Eliwana MDE are described in Table 31. No significant impact to any of the land systems will occur as a result of the cumulative disturbance of these projects. No more than 6% of each individual land system in the Hamersley subregion (occurring in the Eliwana MDE) will be impacted by the combined development envelopes of Eliwana Mine, Eliwana Rail and Solomon.

Table 31: Cumulative Impact to Land Systems

Land System	Extent in MDE	Total Area in Hamersley IBRA sub-bioregion (ha)	Extent in Eliwana Railway (ha)	Extent in Solomon Development Envelopes (ha)	Area outside of development envelopes
Boolgeeda	3,060	606,771	12,850	2,873	96.73
Newman	17,579	1,853,935	4,549	8,987	97.98
Platform	1,549	217,710	73	4,417	97.21
Robe	1,595	103,116	1,024	529	96.29
Rocklea	19,173	711,645	16,341	175	94.71

The cumulative impact to vegetation communities disturbed by both the indicative Eliwana Mine and Railway footprints is described in Table 32. Of the 16 communities impacted by both the Eliwana Mine and Rail proposed indicative disturbance footprint, no communities will be cleared below the 30% guidance threshold as discussed in EPA Position Statement No. 2 of the areal extent. Accordingly, no significant cumulative impact to the communities is anticipated. Vegetation communities in the Solomon Development Envelopes were not able to be compared to Eliwana Mine and Rail proposals.

Table 32: Cumulative Impact to Vegetation Communities

Community	Areal Extent (ha)	Proposed disturbance Indicative Rail Footprint (ha)	Proposed Disturbance Indicative Mine Footprint (ha)	% remaining
AanExAatAbCHfTe	144.8	2.7	7.1	6.8
AiTw	6074.1	372.6	0.8	6
AiTw/ElTa	8549.6	130.2	235.5	5.6
ChAarAadTw	3349.1	0.1	13.5	0.4
ChAiTw/ElAbTlo	26026.2	537.2	1407.1	7.4

Community	Areal Extent (ha)	Proposed disturbance Indicative Rail Footprint (ha)	Proposed Disturbance Indicative Mine Footprint (ha)	% remaining
ElAatTw	474.2	50.9	243.3	62
ElAmTw	16751	6.4	1511.8	8.9
ElTa	7555.4	418	106.4	6.9
EvAcCcERlt	566	29.8	149.1	32.8
EvAcMgErlt	357.9	12.5	0.2	3.5
ExAcTHtTe	557.7	0.9	121.7	22

The Priority Flora species that occur within both the Eliwana Mine and Rail indicative disturbance footprints are described in Table 33. Of the 4 Priority Flora Species occurring within both the Eliwana Mine and Rail proposed indicative disturbance footprint, none of the species will be reduced by greater than 2% of the known number of individuals. Accordingly, no significant cumulative impact to these species is anticipated.

Table 33: Cumulative Impact to Priority Flora Species as a result of both Eliwana Mine and Rail

Species	Total no. individuals	No individuals Rail footprint	No. Individuals Mine footprint	% loss
Priority 3				
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	~7,888	1	~519	6.6
Triodia basitricha	85,922*	~1500	~32,700	39.8
Priority 4				
Goodenia nuda	~9,735*	1	~41	0.4
Ptilotus mollis	2,073	1	193	9.4

Notes:

* Species counts with an asterix include records where local abundance was not recorded. For instance, Fortescue has 293 recorded locations of *Rhynchosia bungarensis* in its database, but only 218 have local abundance data.

~ some species growth habits result in difficulty in recording accurate numbers in the field eg. *Triodia basitricha*, Triodia sp. Robe River. For these species, the percentage cover of the species within the quadrat is often recorded. For instance, *Triodia basitricha* may occupy 15% of a 50 x 50 m quadrat. Fortescue has estimated 1 plant per square meter to estimate local abundance where percentage cover has been recorded. In this example, 15% of the quadrat is equal to an estimated 375 individual plants.

Note, a discussion on cumulative impacts to *Triodia basitricha* from Eliwana Mine, Rail and the Solomon Project is also included in Section 4.6.5.4.

4.6.6 Mitigation

Fortescue has applied the mitigation hierarchy to the Project in relation to flora and vegetation. A revised Vegetation Health Monitoring and Management Plan is located at Appendix 17. Mitigation measures to address potential impacts are detailed in Table 34:

Table 34: Avoidance, management and mitigation of impacts to flora and vegetation

Impact	Management Action
Direct Loss of Vegetation and Flora	• Undertake vegetation surveys in accordance with Guidance Statement No.51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia to determine the presence and distribution of significant flora and vegetation. • Review the proposed project design against the vegetation survey data to avoid/minimise clearing of significant flora and vegetation. • All Threatened and Priority Flora are to be identified on the ground by appropriate signage, fencing and/or flagging prior to clearing in accordance with the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042*. • Minimise clearing and vegetation disturbance to ensure significant flora and vegetation are protected. Conduct vegetation clearing in accordance with a permit issued under the *Land Use Certificate Procedure 100-PR-TA-0001*, the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042*, and/or the *Exploration Environmental Management Plan E-PL-EN-0002*. • Ensure staff and contractors are aware of the location of significant flora and vegetation on site and their responsibility to ensure they are protected.
Fragmentation	• Ensure all vehicles, plant and equipment, including trailered equipment, are clean, inspected and certified prior to entry into the Fortescue Operations Area in accordance with the *Weed Management Plan 100-PL-EN-1017*. • To ensure vegetation conservation values are maintained, conduct rehabilitation in accordance with the *Eliwana Mine Closure Plan EW-PL-EN-0001*.
Altered fire regimes	• When constructing a fire break or carrying out a prescribed burn where significant flora and/or vegetation have been identified, adhere to the requirements outlined in the *Bushfire Management Plan 100-PL-EM-0009*.
Dust	• To minimise the potential for dust deposition on vegetation, implement dust suppression measures in accordance with the *Mine and Rail Dust Management Plan 45-PL-EN-0030.*
Chemical and Hydrocarbon Spills	• Prior to constructing new chemical and hydrocarbon storage facilities that have the potential to significantly impact on the environment, conduct a risk assessment in accordance with the *Team Based Risk Assessment Procedure 100-PR-RK-0004*. New chemical and hydrocarbon storage locations, design and construction shall be to design specifications which reflect risk assessment outcomes in minimising environmental impacts.

Impact	Management Action
	• When diesel storage areas are required to be licensed under the Environmental Protection Act 1986 and/or the Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007, ensure the facilities are designed and constructed in accordance with the *Standard Engineering Specification Diesel Storage and Handling 100-SP-ME0044*. • Ensure relevant personnel and contractors involved in chemical and hydrocarbon handling and storage activities are provided with the appropriate training and equipment as outlined in the *Chemical and Hydrocarbon Spills Procedures 100-PR-EN-0014* and *the Hazardous Materials Management Procedure 45-PR-SA-0051.* • Chemicals and hydrocarbons should be stored in accordance with AS 1940, AS 3833 or AS 3780 to minimise the potential for environmental harm. Storage should only be in designated areas and within the limits specified in applicable Licence conditions under the EP Act (see Table 2). • Store chemicals and hydrocarbons in accordance with Licence conditions under the EP Act. • Where a chemical or hydrocarbon spill has occurred, manage the spill including any contaminated material, in accordance with the *Chemical and Hydrocarbon Spills Procedure 100-PR-EN-0014* and investigate and report the incident in accordance with the *Incident Event Management Procedure 100-PR-SA-0011.* • Divert potentially contaminated water, including stormwater that has come into contact with potential sources of contamination, into an oily water separator for treatment. Sample treated water prior to reuse or discharge to confirm hydrocarbon concentrations meet specified Licence requirements. • Remediate any area declared contaminated as defined under the Contaminated Sites Act 2003 in accordance with the DER's Contaminated Sites Management Series – Assessment Levels for Soil, Sediment and Water (2011) • *Eliwana Mine Closure Plan EW-PL-EN-0001* developed in accordance with the Guidelines for Preparing Mine Closure Plans.
Altered surface hydrology	• Conduct a risk assessment to determine the likelihood of a change to the surface water regime that may lead to unacceptable environmental impacts. • Drainage infrastructure location, design, construction and operation to design specifications which reflect risk assessment outcomes in minimising interference and disruption of natural surface water flows and quality where practicable in accordance with the *Standard Engineering Specification for Drainage and Flood Protection 100-SP-CI-0004* and the *Standard Engineering Specification for Road Design for Projects 100-SP-CL-0002*. • Protect natural drainage lines from construction impacts where possible to minimise impacts to water quality. • To ensure erosion, water quality and surface water flow regimes achieve the closure objectives conduct rehabilitation in accordance with the *Eliwana Mine Closure Plan 100-PL-EN-0001*.

Impact	Management Action
Groundwater drawdown	• Where possible, utilise water from dewatering for onsite activities, such as dust suppression and OPF operations. • When construction or maintenance activities results in abstraction volumes in excess of what can be disposed of in accordance with the applicable Groundwater Operating Strategy, this will be disposed of through discharge down Pinarra Creek. • When a groundwater management activity requires a 5C licence under the Rights in Water and Irrigation Act 1914, conduct a hydrogeological assessment in accordance with the parameters outlined in the Operational policy no. 5.12 Hydrogeological reporting associated with a groundwater well licence (DoW). • Prior to undertaking groundwater management activities and constructing supporting infrastructure, conduct a risk assessment to identify high risk areas. Develop and implement management strategies that reflect risk assessment outcomes. • When required as a condition of a licence issued under the Rights in Water and Irrigation Act 1914, develop and implement a Groundwater Operating Strategy in accordance with the Operational policy 5.08: Use of operating strategies in the water licensing process (DoW). • Establish monitoring bores to monitor and where necessary mitigate the effects of dewatering and injection on phreatophytic vegetation in accordance with the *Significant Flora and Vegetation Management Plan 45-PL-EN-0017*. • Establish monitoring sites within Pinarra Creek to monitor impacts from changes to surface water flow, either a reduction in surface water flow, or discharge of excess water to creeks, to ensure impacts are within the expected range.

4.6.6.1 Avoidance

Fortescue has revised its disturbance footprint since the Proposal was referred to the EPA as detailed in Fortescue's submission to the EPA under Section 43(A) of the EP Act. Vegetation community ElAcTwTspr was identified during vegetation surveys as a potentially restricted community and was analogous to the *Triodia* sp. Robe River Assemblages of mesas of the West Pilbara PEC, although it did not occur on mesa formations. Fortescue recognised the importance of this restricted community and amended its disturbance footprint to reduce the level of direct impact to the community, from approximately 85% to 75% of its areal extent.

In addition, Fortescue has proposed two possible locations for a TSF within the indicative disturbance footprint. However only one of these locations is required. The construction and operation of just one TSF will reduce the overall impact to flora and vegetation as a result of the proposal.

4.6.6.2 Rehabilitation and Closure

Fortescue develops site specific closure objectives and closure plans for its operations, to ensure that local issues can be resolved in consultation with key stakeholders and specific to the post-mining land use. The *Eliwana Mine Closure Plan EW-PL-EN-0001* has been developed consistent with the DMP and EPA *Guidelines for Preparing Mine Closure Plans* (2015). The Plan describes the process by which Fortescue will rehabilitate the site to return local Pilbara native species.

The closure objectives of the Plan pertaining to flora and vegetation include:

- rehabilitated areas support local native, self-sustaining vegetation and native fauna foraging; and
- pit lakes do not present a significant risk to human health or a significant ecological threat.

The Plan will be review and revised regularly throughout the mine life, to incorporate the developing knowledge base and outcomes from studies and field trials.

Across Fortescue's operating sites, there are many examples of rehabilitation as well closure trials being undertaken to better inform Fortescue's closure planning. For instance, Fortescue routinely undertakes physical waste rock and tailings characterisations as part of geotechnical sampling programs and geochemical characterisation. Example 1 below demonstrates Fortescue's commitment to leading edge practices for waste characterisation.

Example 1: Accelerating Geochemical Risk Assessment

Leaching tests have been used consistently across the Pilbara to establish the potential for waste rock and tailings to generate salinity or release major ions into the groundwater system after closure. These tests take multiple years to run before accurate results are available to establish geochemical risks. This can delay decision making processes and lead to overly conservative approaches in waste rock management.



Fortescue's Saline Leaching Study – sequential leach testing laboratory at Curtin University, supervised by the ChemCentre

To accelerate risk assessment processes, Fortescue is working with the ChemCentre to develop a supplementary *Bottle Roll* leaching test. These tests are completed over 24 hours, 1 week and 1 month intervals, instead of multiple years, to artificially accelerate the chemical decomposition of the rock. The accelerated process enables low risk materials to be quickly identified. The higher risk materials can then be progressed to more advanced analysis, to establish the likely leaching sequence based on the local environmental conditions and the conditions predicted to develop post-mining.

Fortescue are also working on a short-term *Sequential Leaching* test, which will subject the material to increasingly aggressive solutions to identify possible contaminants, and a *Saline Leaching Study*, which uses a saline leachate to identify the major ions that are likely to be released from waste rock into saline pit lakes.

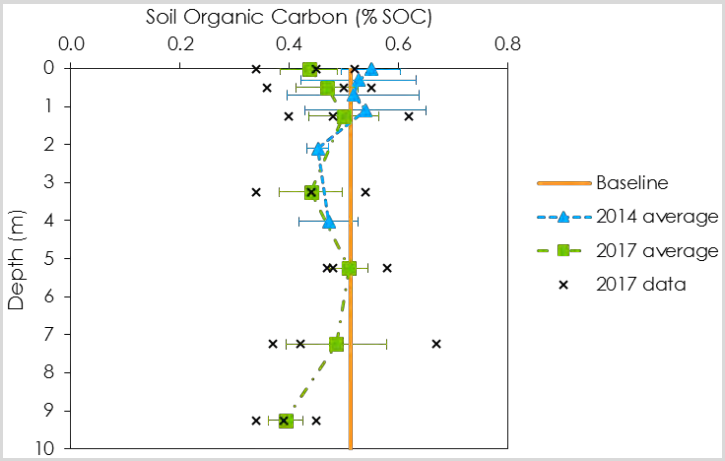
Fortescue has adopted industry practices that enhance the structural and biological integrity of soil over time. Example 2 demonstrates how Fortescue has trialled techniques for storage of topsoil to determine their suitability for a Pilbara environment.

Example 2: Kings 10 Metre Topsoil Stockpile Trial

Keipert (2005) concluded that most topsoil deterioration occurred in the first 12 months of stockpiling, regardless of the height of the stockpile (LPSDP – MR, 2016). Currently hundreds of hectares of native vegetation are disturbed to enable topsoil to be stockpiled. If it can be demonstrated that the height of long-term topsoil stockpiles can be increased, while preserving the beneficial aspects of the topsoil, less native vegetation would need to be cleared as part of the mine development.

The *Kings 10 Metre Topsoil Stockpile Trial* was established at Solomon iron ore mine in 2014. The trial is investigating the influence of stockpiling topsoil up to 10 m high on soil's physical, chemical and biological characteristics, including:

- Soil physical parameters i.e. Emerson Aggregate Test, Modulus of Rupture test and saturated hydraulic conductivity;
- Soil pH, electrical conductivity, plant available nutrient concentrations, organic carbon and exchangeable cations; and
- Seed viability via emergence trials and soil microbial biomass characteristics



Soil organic carbon measured in the Kings 10 Metre Topsoil Stockpile Trial (Stantec, 2017).

The results to date align with published literature (Stantec, 2017), demonstrating declining levels of soil organic carbon, microbial biomass and seed germination within the top 1 m. After 1 m depth, however, the results suggest there is limited to no further deterioration in the soil properties observed with increasing stockpile depth. Further trials are currently being developed to confirm that topsoil stockpiled at depth performs similarly to similarly aged topsoil stockpiled at 1-2m depth when used in rehabilitation programs.

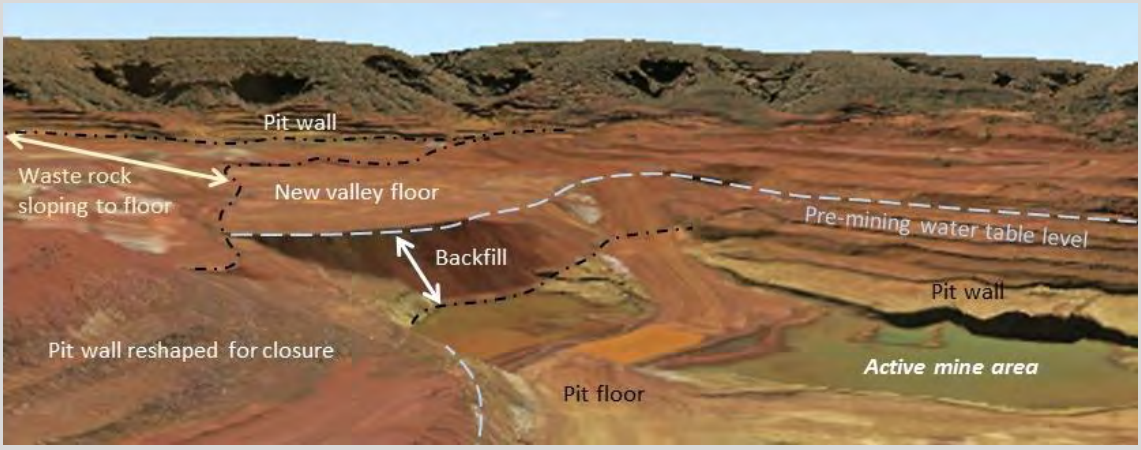
Waste landforms are required to safe, stable and non-polluting/non-contaminating. Final landforms may be dictated by mine planning, mine scheduling, the need to safely encapsulate potentially harmful material and reduce the risk of poor water quality in pit lakes. Example 3

demonstrates how Fortescue's commitment to backfilling pits at its Solomon operations to minimise final landform rehabilitation requirements and prevent pit lakes from forming.

Example 3: King's Deposit Backfill and Rehabilitation

The area of land disturbed by landform construction, the footprint, should be minimised where possible. The storage of waste rock inside mined-out pits, also known as backfill, is recognised as leading best practice for waste rock disposal.

At Fortescue's Valley of the Kings deposit at the Solomon mine 80 percent of the waste rock is routinely backfilled into pit. Initially backfill is scheduled, as part of the mine plan, to fill the areas of the pit that extend below the pre-mining water table to prevent the development of a post-closure pit lake. Excess waste rock is subsequently placed against the pit walls. On closure the pit will be reconnected to the undisturbed adjacent environment via the waste rock slopes and the new valley floor will be rehabilitated to support a native ecosystem.



Progressive Backfill at Valley of the Kings, Solomon Mine. Exhausted mine areas are backfilled with waste rock from active mine areas

One of the final steps in rehabilitating is the establishment of a soil profile on disturbed surfaces, often on slopes. Example 4 shows how Fortescue has rehabilitated old borrow pits by respreading topsoil over disturbed surfaces utilising techniques to prevent erosion

Example 4: Borrow Pit Rehabilitation

In 2012 rocky materials required for Fortescue's railway maintenance activities were excavated from a small area adjacent to the mainline rail. Topsoil was stripped from the site and stockpiled for later rehabilitation, the subsurface rock was then removed, altering the landform creating a 'borrow pit'. In 2015 this borrow pit was rehabilitated by reshaping the landscape, to minimise ponding, before the topsoil was replaced. The surface was subsequently ripped along the contour to increase infiltration and reduce surface runoff.

By 2016, vegetation cover inside the former borrow pit had increased to 13% with juvenile keystone *Triodia* and *Acacia* species present. By 2017 cover had increased to over 40%, with 25% of the cover attributed to *Triodia* species (primarily *Triodia wiseana*). Performance indicators for the borrow pit are within the range of the control sites, demonstrating that good rehabilitation outcomes can be achieved using simple rehabilitation techniques when good quality topsoil is available to recreate a soil profile.



2016 **2017**

Re-establishment of perennial vegetation over Borrow Pit A

The last stage of rehabilitation is the establishment of self sustaining vegetation on the rehabilitated landform. In most instances, topsoil will have been stored for many years and will have lost most of its seed bank viability. Therefore, a mix of seed species must be selected that is suitable for the final landform topography, while providing adequate species and structural diversity. Example 5 shows some trials undertaken by Fortescue to determine the optimum planting depth of seed species to improve rehabilitation outcomes.

Example 5: Seed Metering and Planting Depth Trials

Large-scale revegetation programs have traditionally used seed broadcasting techniques, where seeds are scattered across the surface of the ground, to re-establish vegetation. However, recent studies have demonstrated that 90% or more of broadcast seeds to fail to produce a seedling (Erickson, Barrett, Merritt, & Dixon, 2016); (Merritt & Dixon, 2011); (Commander, Rokich, Renton, & Dixon). Fortescue is currently studying the use of broad-acre farming techniques, with the aim of utilising alternate direct seeding approaches, to improve planting success.

Fortescue have allied with the civil construction and mine services company NEMMS JV and partner group Chatfield's Tree Nursery and Engineering to investigate mass sowing options. Pot trials are currently underway to review optimal seeding depths for local native species. The project is also evaluating new engineering solutions and implementation techniques, and improvements to seeding rates.



Fortescue's optimal seeding depth trials – Senna sp. Left: On surface, Centre: 1.5 x seed depth, Right: 3 x seed depth

Fortescue has applied these learnings to its rehabilitation and revegetation requirements at its older mining areas. Example 6 shows how Fortescue has trialled a range of rehabilitation techniques at its Cloudbreak operations to determine which will be most suitable for progressive rehabilitation

Example 6: Green Waste Dump Rehabilitation Trials

Prior to the rehabilitation, it is best practice to implement a trial to confirm the proposed rehabilitation techniques and designs will achieved the desired outcomes (Australian Government, 2016).

In February 2013 rehabilitation trials were established on Fortescue's Green waste rock dump at the Cloudbreak mine. The trials set out to assess vegetation establishment using 30 cm and 70 cm topsoil depths and the performance of landform design options including various slope angles from 10° to 20°, different slope shapes including linear, concave and convex slope morphology and the performance of rock drains and linked sloped basins (as recommended by DME, 1996)



Green waste dump rehabilitation trial. Left: Variable slope angles. Right: Rill erosion with vegetation at monitoring transect CB06

Monitoring is being conducted using LFA and LiDAR. LFA results shows that number of rills and their average diameter have increased over time; although some rills are filling in and vegetation can be observed growing in the rills. Slope angles between 14° to 18° appear to be performing the best, with lower slope angles, which have longer slope lengths, and steeper slopes developing more rill erosion.

Vegetation establishment is slow but progressing (Biota, 2017). The waste dumps are currently dominated by annual herbs and grasses, with very few weeds. The local keystone vegetation species Triodia (spinifex) is slowly starting to establish. Varying the topsoil depth appears to have made no difference to vegetation emergence or sustainability.

The rock drains with linked basins have already failed, showing high levels of erosion. Closure designs for the site's permanent waste dumps have already been modified to remove these surface water control features. These designs will be further modified before mine closure based on the ongoing evaluation of the waste dump performance

4.6.7 Predicted Outcome

A summary of residual impacts after the implementation of the proposal and the application of the mitigation measures outlined in Table 3 above is provided in Table 35.

Table 35: Predicted Environmental Outcome

Impact	Residual Impact after Management	Regional Significance
Clearing of vegetation	There will be a permanent loss of 7,900 ha of native vegetation. Of this, 7,879 ha is in good to excellent condition. Fortescue will progressively rehabilitate disturbed areas at the end of their serviceable or operational life, however the vegetation that returns is unlikely to be floristically similar to vegetation from pre-disturbance.	The permanent loss of 7,879 ha of vegetation in good to excellent condition is considered regionally significant, requiring an offset. Offsets are discussed in Section 4.6.8.
Direct Loss of Priority Ecological Community	There will be a loss of 41.4 ha of vegetation communities which may be representative of the Priority 3 Ecological Community *Triodia sp. Robe River assemblages of mesas of the West Pilbara*. Fortescue highlights that the areal extent of the PEC is likely to be approximately 2,093 ha.	The loss of 41.4 ha or just 2% of the potential areal extent of the PEC is not a risk to the conservation of the community considering its potential extent. However, Fortescue consider that as the communities to be cleared are representative of the PEC assemblage, the loss of 41.4 ha of a PEC would be considered regionally significant. An offset proposal is discussed in Section 4.6.8.
Direct Loss of Priority Flora species	There will be a small loss to the local populations in the mine development envelope for up to 9 priority flora species. *Acacia bromilowiana* ~60 individuals *Eremophila magnifica subsp. magnifica* ~36 individuals *Eremophila magnifica subsp. velutina* ~60 individuals *Goodenia nuda* ~41 individuals *Indigofera* sp. Bungaroo Creek ~519 individuals *Ptilotus mollis* – 193 individuals *Rhynchosia bungarensis* – 18 individuals *Triodia basitricha* ~32,700 individuals *Triodia* sp. Robe River – 5,744 individuals	At a regional level, the loss of priority flora species as a result of the proposal is not significant.
Indirect impacts to Groundwater Dependent Vegetation	Mine dewatering will cause impacts approximately 19.8 ha of vegetation community MaMgCyPv through the loss of overstorey *Melaleuca argentea* species. Approximately 105 ha of EvAcCcERIt and 2 ha of EvAcMgERIt occur within areas subject to groundwater drawdown greater than 5 metres, however Fortescue consider it unlikely that these communities are groundwater dependent given the depth to groundwater in most areas and the volume of surface water that flows through these communities each wet season.	On a regional scale, *M. argentea* dominated vegetation occurs in areas where groundwater is close to the surface (approximately 2m from surface) or where groundwater is expressed at surface (groundwater fed pools). CSIRO have estimated that approximately 0.5% of the Pilbara region is covered by GDE vegetation (McFarlane, 2015). These ecosystems, although restricted by the abiotic requirement of permanent groundwater

Impact	Residual Impact after Management	Regional Significance
	Changes to surface hydrology is a greater risk for these communities (see below).	accessibility are sporadically distributed across the entire Pilbara region. Impacts to MaMgCyPv may be offset through the offsets discussed in Section 4.7.8. *E. victrix* dominated communities are very common in valley floor and drainage line areas in the Pilbara. A decline in 105 ha of *E. victrix* dominated vegetation is not a significant impact on a regional scale. The impacts to GDE are quantified in Table 27. Either from direct clearing or indirect impacts from groundwater drawdown, it is estimated that 41.7% of Ma MgCyPv and 5.1% of EcAcEuaTe may be impacted. On a regional scale, this is not considered significant.
Indirect Impacts to Riparian Vegetation	Fortescue highlights that predicted impacts are based on a 'maximum' hydrological change scenario where no surface water is diverted around pits and infrastructure. Diversion of surface water around pits and infrastructure will be implemented where possible during detailed mine planning and engineering design, which when implemented will reduce downstream impacts. Fortescue contends that whilst there may be a change to the structure and species composition of vegetation communities considered riparian, there will still remain vegetation within riparian areas post-disturbance (i.e. new riparian communities) that have adapted to the change in surface water availability, or that have been sustained by moisture from rainfall and local runoff. For areas downstream of the proposed disturbance, impacts are restricted to between one and several kilometres. Where surface diversion infrastructure is constructed, these impacts are likely to be significantly reduced.	The regional impacts to riparian vegetation are quantified in Table 27. Either as a result of direct clearing or indirect impacts from changes to surface water flows, it is estimated that 44% of vegetation community EvAcCcERIt and 6% of EcAcMgERIt that has been mapped may be impacted. Note, as discussed, impacts from changes to surface water flow does not remove vegetation but there will be changes to community floristics.
Indirect impacts to Priority Flora species	The following Priority Flora species may experience some loss from reduced surface water flow: *Dicladanthera glabra* (P2) *Indigofera* sp. Bungaroo Creek (P3) *Pleurocarpa gracilis* (P3) *Sida* sp. Hamersley Range (P1) *Rhynchosia bungarensis* (P4) *Terminalia supranitifolia* (P3) *Ipomoea racemigera* (P2) Of these species, only *T. supranitifolia* may experience significant impacts at a local scale as the population within the area subject to reduced surface water flow is the only population within the MDE.	All of these species are either found elsewhere within the MDE (except *Terminalia supranitifolia*) and more regionally.

Impact	Residual Impact after Management	Regional Significance
Degradation from fragmentation, weeds and altered fire regimes	As a result of the implementation of standard weed and fire management practices, impacts to native vegetation from weeds and fire as a result of the proposal will remain low. Fortescue considers that weed control practices within the proposal area are likely to reduce the level of weed infestation to the extent that levels of weed species within the mine development envelope are likely to be lower than in the surrounding environment. Remnant vegetation around mine areas will likely experience some levels of degradation from edge effects, however after the implementation of mine closure activities, ecological linkage to some areas will be restored. Remnant areas of riparian vegetation will experience changes in vegetation structure and species composition.	At a regional level, the impact to vegetation from weeds and fire is likely to be very low. Impacts from fragmentation are likely to be localised and not regionally significant.

In summary, Fortescue consider that the proposal can be implemented to meet the EPA's objective for vegetation and flora as:

- The majority of vegetation to be disturbed consists of common, widespread communities with impacts restricted to the local area.
- Fortescue's surveys have increased the extent of the Triodia sp. Robe River assemblages of mesas of the West Pilbara to approximately 3000 ha, from the 66-ha mapped by DBCA.
- Impacts to priority flora species are minor and do not increase the conservation status of any species.
- Impacts to GDE, Potential GDE and riparian vegetation are limited to the small areas within the MDE.
- Environmental offsets are proposed for significant residual impacts from the proposal (see next section).

4.6.8 Offsets

Fortescue consider that the significant residual impacts from the proposal are:

- The loss of 7,879 ha of vegetation that is in good to excellent condition;
- The loss of 41.4 ha of vegetation representative of Triodia sp. Robe River assemblages of mesas of the West Pilbara Priority 3 PEC.
- A loss of 19.6 ha of GDE vegetation MaMgCyPv owing to groundwater abstraction

Consistent with its current offset obligations under existing Ministerial Statements, Fortescue proposes to offset these residual impacts by contributing to a government established offset fund at the following rates, indexed to CPI:

- $798 per ha for vegetation in good to excellent condition.
- $1,596 per ha of PEC cleared as a result of the proposal.
- $1,596 per ha of GDE vegetation degraded as a result of the proposal.

Fortescue considers that the establishment of a Pilbara Offset Fund as proposed by the WA Government will result in the most effective and efficient delivery of conservation outcomes to ameliorate the threats posed to conservation significant species and communities.

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4.7 Terrestrial Fauna

Terrestrial fauna was identified as an environmental factor relevant to the Proposal in the Environmental Scoping Document (EPA, 2017). The following sections provide an environmental impact assessment for this factor.

4.7.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for terrestrial fauna as follows:

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

4.7.2 Policy and Guidance

The following policy and guidance is relevant to this factor:

Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016g)

This guideline provides an outline of how Terrestrial Fauna is considered by the EPA in the IA process. Relevant matters discussed in the Guideline include the following:

- description of EIA considerations, including:
- application of the mitigation hierarchy;
- the terrestrial fauna affected by the proposal;
- the potential impacts and the activities that will cause them;
- surveys and analyses required;
- the significance of and risks to the fauna;
- the current state of knowledge of terrestrial fauna and the level of confidence underpinning the predicted residual impacts;
- describes issues commonly encountered by the EPA during EIA of this factor; and
- provides a summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

Fortescue has specifically considered this guidance in the following ways:

- surveys and analyses undertaken and planned to describe the receiving environment and its significance;
- identification of activities which may lead to impacts to terrestrial fauna; and
- application of the mitigation hierarchy in elements of project design.

Technical Guidance – Terrestrial Fauna Surveys (EPA, 2016h)

This guidance is intended to provide information on standards and protocols for terrestrial fauna surveys to ensure adequate data of an appropriate standard are obtained and used in EIA, specifically providing advice on:

- survey preparation and planning;
- determining the type of survey required; and
- presentation and reporting.

Fortescue has specifically applied this guidance in the planning, design and implementation of terrestrial fauna surveys currently underway in the Proposal Area.

Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA, 2016i)

This guidance is intended to provide information on standards and protocols for terrestrial fauna surveys to ensure adequate data of an appropriate standard are obtained and used in EIA, specifically providing advice on:

- pre-survey protocols;
- determining the level of survey required;
- sampling techniques for specific fauna;
- survey design; and
- data analysis and reporting.

Fortescue has specifically applied this guidance in the planning, design and implementation of terrestrial fauna surveys currently underway in the Proposal Area.

Guidance Statement No. 20: Sampling of short-range endemic invertebrate fauna for environmental impact assessment (EIA) in Western Australia (EPA, 2009)**.**

This guidance statement was current when SRE invertebrate surveys were undertaken over the proposal area in 2012 and 2013. The methodology used for the surveys meets the guidance statement:

- a range of sampling methods were used (wet pit traps, foraging, soil and litter sieving);
- all habitat types were sampled;
- surveys were conducted over two phases in 2012 and a follow up survey in 2013;
- the use of molecular techniques to identify separate species; and
- EPA guidance was considered in determining potential for short-range endemism.

4.7.3 Studies and Surveys

Information from 41 previous vertebrate fauna surveys that are conducted in the local area were available for the development of the Eliwana Project: Consolidated Vertebrate Fauna Survey (Table 6 of Appendix 18). Of these 41 surveys, five surveys overlapped with the MDE. These were:

- Western Hub Project - Eliwana and Flying Fish Terrestrial Vertebrate Fauna Assessment (Ecologia Environment, 2015)
- Western Hub Project: The Edge Vertebrate Fauna Survey (Biologic, 2014a)
- Nammuldi Infill Areas Fauna Survey Report, (Biota, 2010)
- Vegetation, Flora and Fauna Assessment and Targeted Conservation Significant Flora and Fauna Survey: Eliwana (Ecoscape, 2012a)
- Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Flying Fish (Ecoscape, 2012b)
- Short Range Endemic Invertebrate Fauna Consolidation Report: Eliwana (Phoenix , 2018) (Appendix 19)

The information from these 41 surveys reports and available databases resulted in a very comprehensive dataset from which to design the 2017 terrestrial fauna surveys (Ecoscape, 2017b). Surveys conducted in 2017 aimed to complement surveys previously undertaken within the MDE and to target areas where survey data may be out of date or where previous fauna surveys may not meet current EPA guidance (Ecoscape, 2017b).

4.7.3.1 2017 Eliwana project Targeted Level 2 Survey

Ecoscape (Ecoscape, 2017b) undertook a supplementary Level 2 terrestrial vertebrate fauna survey to target habitat types and areas of the MDE where previous surveys did not meet the relevant guidance or were outdated. The supplementary level 2 survey included systematic trapping programs (pitfall traps, funnel traps, Elliot traps and cage traps), bird surveys, bat echolocation and opportunistic searches (nocturnal and diurnal) and was conducted in two

phases, May 2017 and July 2017 (see Table 36 below). The previous terrestrial vertebrate fauna survey effort within the MDE is summarised in Table 6 (Section 3.1.1 of Appendix 18) and shown in Figure 27. A summary of previous local and sub-regional terrestrial vertebrate fauna survey effort is provided in Table 37 of Appendix 18.

Table 36: Eliwana Consolidated Terrestrial Fauna Assessment Survey Effort

Survey Type	Survey Effort	Dates
Eliwana Level 2 (1 phase) Targeted survey	1,970 pit trap nights 4,060 funnel trap nights 2,030 Elliot trap nights 1,207 cage trap nights 4,405 bird survey minutes 5,530 diurnal opportunistic search minutes 3,420 nocturnal opportunistic search minutes832 bat recording hours91,872 camera trap hours - 59 motion cameras at long term sites for 61 days -58 motion cameras at 11 new locations for 4 days 70 hours active diurnal searches (POP) 52 hours nocturnal searches (POP)	**Ecoscape (2017)** -11 – 21 May 2017 -18 – 26 July 2017 **The Edge (Biologic 2013)** -Phase 1: April 2013 -Targeted: July 2013 **Eliwana: Vegetation, Flora and Fauna Assessment and targeted Conservation Significant Flora and Fauna Survey (Ecoscape 2012b)** -August 2011 **Nammuldi Infill Areas Fauna Survey Report (Biota 2010)** -November 2009
Eliwana Targeted Pilbara Leaf-nosed Bat and Ghost Bat Survey	10 SM2 bat recorders – 480 hours 2 SM2 bat recorders – 84 hours 3 SM2 bat recorders –132 hours	17 – 27 February 2017 3 – 13 April 2017 18 - 26 July 2017

480,000 500,000 520,000

7,520,000

7,500,000

Trapping Grid Site
Active Search Site
Opportunistic Survey Sites

Fauna Habitat

- Drainage Line/River/Creek (Major)
- Drainage Line/River/Creek (Minor)
- Gorges/Gullys
- Hills/Ranges/Plateaux
- Lower slopes/hillslopes
- Plain (shrubland)
- Plain (stony/gibber)

SERPENTINE CREEK
DUCK CREEK
Eliwana
PINARRA CREEK
BOOLGEEDA CR
BOOLGEEDA CREEK

Legend

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:170,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.050_r1

Date: 21-Aug-18
Size: A3L
Revision: 0
Confidentiality: 1

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Figure 27
Conservation Significant Fauna and Fauna Habitat

Fortescue Metals Group Ltd
The New Force in Iron Ore

4.7.4 Receiving Environment

Broad fauna habitat types mapped within the MDE include (Ecoscape, 2017b):

- Drainage Line/River/Creek (Major)
- Drainage Line/River/Creek (Minor)
- Gorges/Gullies
- Hills/Ranges/Plateau
- Lower Slopes/Hillslopes
- Plain (Shrubland)
- Plain (Stony/Gibber)

These fauna habitats including whether they support conservation significant fauna are discussed in Table 37. Fauna habitats are displayed in Figure 28.

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460,000 470,000 480,000 490,000

7,520,000

7,510,000

Legend

Fauna Habitat

- Drainage Line/River/Creek (Major)
- Drainage Line/River/Creek (Minor)
- Gorges/Gullys
- Hills/Ranges/Plateaux
- Lower slopes/hillslopes
- Plain (shrubland)
- Plain (stony/gibber)

Eliwana

Map A

460,000 470,000 480,000 490,000

Legend

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Significant Fauna

- Ghost Bat
- Northern Quoll
- Pilbara Leaf-nosed Bat
- Pilbara Olive Python
- Rainbow Bee-eater
- Western Pebble-mound Mouse

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

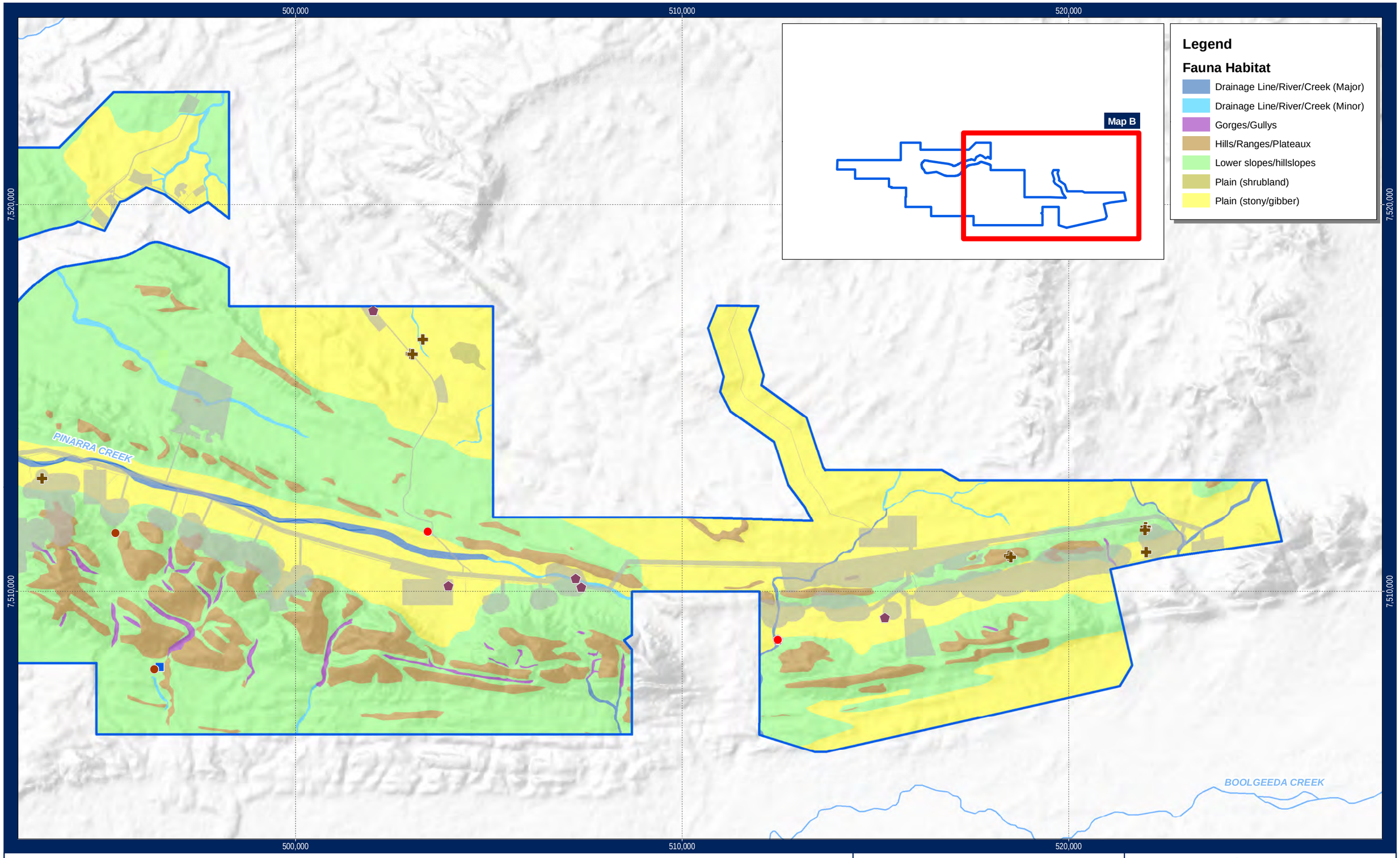
Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:90,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.038a_r2

Date: 23-Aug-18
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Figure 28
Conservation Significant Fauna and Fauna Habitat - Map A

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The New Force in Iron Ore



Legend

- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Significant Fauna

- Ghost Bat
- Northern Quoll
- Pilbara Leaf-nosed Bat
- Rainbow Bee-eater
- Western Pebble-mound Mouse

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

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Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
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Figure 28
Conservation Significant Fauna and Fauna Habitat - Map B

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The New Force in Iron Ore

Table 37: Fauna habitats of the Mine Development Envelope

Habitat Type	Area mapped (ha)	Description	Significant Fauna
Drainage Line/River/Creek (Major)	284	Large Eucalyptus victrix over a shrub layer of *Acacia*, *Gossipium* and grasses including *Triodia* hummock grasses and *Themeda*, *Eriachne* tussock grasses. Buffel grass (**Cenchrus ciliaris*) often encountered. Soils often clay with alluvial pebbles in the creek bed. Some areas recorded with surface water present.	Northern Quoll (foraging, dispersal) Pilbara Leaf-nosed Bat (foraging) Ghost Bat (foraging) Pilbara Olive Python (dispersal and foraging) Eastern Great Egret (foraging when pools present) Peregrine Falcon (foraging)
Drainage Line/River/Creek (Minor)	539.5	Dense, variable shrub layer, sometimes with occasional Eucalypt overstorey. Shrub layer of *Acacia*, *Grevillea* over *Themeda* tussock grasses.	Peregrine Falcon (foraging) Grey Falcon (foraging)
Gorges/Gullies	307.2	Moderately dense layer of *Corymbia hamersleyana* over Acacia shrubs over spinifex and herbs such as *Indigofera* sp. Bungaroo Creek. This habitat type often has large amounts of leaf litter, holding moisture and attracting insects.	Northern Quoll (denning, foraging) Pilbara Leaf-nosed Bat (roosting, foraging) Ghost Bat (roosting, foraging) Pilbara Olive Python (shelter and foraging)
Hills/Ranges/Plateaux	5,335.5	Areas of higher elevation with sparse vegetation of scattered small shrubs and spinifex clumps on rocky surface with skeletal soils, pebbles and stones. Some cliff faces and areas bisected by Gorges/Gullies habitat. Some caves can occur.	Northern Quoll (foraging, dispersal) Pilbara Leaf-nosed Bat (foraging) Ghost Bat (foraging) Pilbara Olive Python (foraging/dispersal) Pilbara Barking Gecko Western Pebble-mound Mouse Long-tailed Dunnart
Lower Slopes/Hillslopes	26,025.3	Rolling hills, footslopes of hills with a hard-rocky substrate. Tree strata of *Eucalyptus leucophloia*, *Acacia*, over a shrub layer of *Senna* and a spinifex hummock grassland.	Western Pebble-mound Mouse
Plain (Shrubland)	74.1	Mixed *Acacia* (mulga) woodland over spinifex hummock grassland.	Nil.
Plain (Stony/Gibber)	11,238.3	Relatively flat, slightly undulating plain with open shrubland of Acacia's and *Senna* over a spinifex hummock grassland. Substrate of bedrock with scattered pebbles and stones.	Western Pebble-mound Mouse Grey Falcon (foraging)

4.7.4.1 Conservation Significant Fauna

A total of ten significant fauna species have previously been recorded from within the MDE. An additional three species are considered to have a high likelihood of occurrence based on preferred habitat type (Ecoscape, 2017b). These species are listed in Table 38. All records of conservation significant fauna are displayed in Figure 28.

Table 38: Conservation Significant Fauna within the Mine Development Envelope

Species	Conservation Status	Habitat Preference	Records in MDE
Mammals			
Northern Quoll *Dasyurus hallucatus*	EN (EPBC) EN (WCA)	Most common on dissected rocky escarpments, gorges and boulder piles. Typically, rocky areas with suitable denning sites and access to surface water. Also found in eucalypt forest/woodland and along major drainage lines.	Two individuals recorded on motion camera in 2017. A potential Northern Quoll scat was collected in 2012.
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*	VU (EPBC) VU (WCA)	Dissected rocky escarpments with suitable roost caves (high humidity (95%) and temperature (32°C)). Able to forage in a variety of habitats particularly along water bodies and fringing vegetation.	Recorded from 6 locations within the Mine Development Envelope.
Ghost Bat *Macroderma gigas*	VU (EPBC) VU (WCA)	Wide variety of habitats with suitable roosts (caves, rock piles and abandoned mines). Will travel 2 km from roost to hunt and utilise other structures as feeding roosts (culverts, rock overhangs, trees)	Recorded from 3 locations within the Mine Development Envelope
Long-tailed Dunnart *Sminthopsis longicaudata*	Priority 4	Rocky hills, ranges and escarpments with spinifex.	One individual recorded. Extensive suitable habitat available.
Western Pebble-mound Mouse *Pseudomys chapmani*	Priority 4	Rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex.	Recorded from several locations within the Mine Development Envelope.
Birds			
Grey Falcon *Falco hypoleucos*	VU (WCA)	Generally open inland plains and woodland.	Not recorded from the Mine Development Envelope but likely to occur on occasion.
Peregrine Falcon *Falco peregrinus*	OS (WCA)	Widespread; coastal cliffs, riverine gorges and wooded watercourses.	A pair has been recorded from the Mine Development Envelope.
Fork-tailed Swift *Apus pacificus*	MIG (EPBC) MIG (WCA)	Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Recorded opportunistically from the Mine Development Envelope
Rainbow Bee-eater *Merops ornatus*	MIG (WCA)	Variety of habitats, prefers open woodlands with availability of dunes, banks for breeding. Also near water when available.	Commonly encountered within the Mine Development Envelope. This species recently removed from the EPBC Act Migratory species list.

Species	Conservation Status	Habitat Preference	Records in MDE
Reptiles			
Pilbara Olive Python *Liasis olivaceus barroni*	VU (EPBC) VU (WCA)	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies.	Two individuals previously recorded within the Mine Development Envelope.
Gane's Blind Snake *Anilios ganei*	Priority 1	Variety of habitats; thought to prefer moist gorges. Cryptic nature reduces likelihood of recording during fauna assessments.	Not previously recorded from the Mine Development Envelope, but there are numerous records from the region and suitable habitat is present.
Pilbara Barking Gecko *Underwoodisaurus seorsus*	Priority 2	Rocky upland habitats including hills, plateaus and ranges.	Not previously recorded from the Mine Development Envelope but suitable habitat is present.
Western Striped Snake-eyed Skink *Notoscincus butleri*	Priority 4	Associated with spinifex dominated areas near creek and river margins.	Recorded from seven sites within the Mine Development Envelope

EN = Endangered
VU = Vulnerable
MIG = Migratory
OS = Specially Protected
Priority = DBCA Priority Fauna List
CE = Critically Endangered

Species listed under the EPBC Act are discussed at Section 5 (Matters of National Environmental Significance). All other species from Table 35 are discussed below.

Long-tailed Dunnart

This small, carnivorous marsupial occurs in rocky country in the Pilbara, Murchison, north-eastern Goldfields, Ashburton and Gibson Desert (Burbidge, et al., 2008). A single Long-tailed Dunnart was recorded from the MDE in 2017. Habitat for this species in the MDE is likely to be the Hills/Ranges/Plateaux habitat. Extensive areas of this habitat type have been mapped (Table 34 above).

Threats to the Long-tailed Dunnart are likely to include predation by foxes and cats and changes to habitat through altered fire regimes and feral herbivores.

Western Pebble-mound Mouse

The Western Pebble-mound Mouse was previously distributed across most of the arid region of Western Australia but has more recently declined to the central and southern Pilbara and the smaller ranges of the Great Sandy Desert (Start, 2008). The decline in the species' distribution is thought to be caused by predation by feral cats and foxes. This species inhabits gently sloping hills of rocky ranges where the ground is stony and vegetated by spinifex. It is usual to find both active and in-active mounds within an area of suitable habitat. Western Pebble-mound Mouse has been recorded numerous times within the MDE in Hills/Ranges/Plateaux, Plain (Stony/Gibber) and Lower Slopes/Hillslopes habitat. There are extensive areas of all three habitat types within the MDE.

Grey Falcon

A nomadic species, the Grey Falcon can be found across much of the arid and semi-arid parts of Australia. In Western Australia, Grey Falcon occur mostly in the northern half the state, foraging in open woodlands, Acacia shrublands, grasslands, wetlands and waterholes. Grey Falcon are likely to roost in tall trees or high cliffs but are known to roost in man-made structures such as high-tension powerline pylons and radio towers. This species has not been recorded from the MDE but is likely to occur there occasionally while foraging. Large areas of foraging habitat for this species occurs in the Hills/Ranges/Plateaux, Plain (Stony/Gibber), Plain (Shrubland) and Lower Slopes/Hillslopes habitat.

Threats to this species are changes to habitat through fire and removal of habitat by mining development.

Peregrine Falcon

The Peregrine Falcon is considered uncommon in the Hamersley Range, nesting in cliff type habitat. Peregrine Falcon forage over a wide area and would use most habitats within the MDE.

Two individuals have been recorded on three occasions within the MDE and are thought to be a breeding pair. Potential cliff nesting habitat occurs in the western half of the MDE (Ecoscape, 2017b).

In the Pilbara, the loss of habitat through mining development may be a risk to their conservation.

Rainbow Bee-eater

The Rainbow Bee-eater is found across most of Australia, including the Pilbara, where it is often observed around permanent pools, and riparian areas. It occupies a range of habitats including woodlands and shrublands and grasslands, riparian areas and pools (Department of Environment; Energy, 2017b). Rainbow Bee-eaters use dunes, riverbanks and sometimes road windrows to excavate a tunnel for nesting. Rainbow Bee-eaters are considered migratory, with southern populations moving north for the winter before returning south to breed. However, northern populations can be resident throughout the year. Populations may migrate to Papua New Guinea and Indonesia (Department of Environment; Energy, 2017b). The Rainbow Bee-eater was taken off the EPBC Act list of migratory bird species in 2016 but remains on the Western Australian Threatened Species list as a migratory species.

In the MDE, habitat for the Rainbow Bee-eater is most likely to be represented by the Drainage Line/River/Creek (Major) habitat type but may be encountered across most habitat types.

Gane's Blind Snake

There is very little known regarding the ecology of Gane's Blind Snake (*Anilios ganei*). Due to most records being from gorges and gullies and other habitats with accumulation of leaf litter (Ecoscape, 2017b), this is thought to be its most likely habitat. As a blind snake, it is likely to live in subterranean habitats, emerging at night to feed. This species has been recorded between Newman and Pannawonica and is likely to be found where suitable habitat occurs.

This species has not been recorded from within the MDE but suitable habitat for the species is found in Gorges/Gullies and Drainage Line/River/Creek (Major) habitat where leaf litter has the opportunity to accumulate. There are multiple records of this species in the surrounding area.

Threats to this species are most likely to be removal of habitat due to mine development.

Pilbara Barking Gecko

Pilbara Barking Gecko (*Underwoodisaurus seorsus*) was recognised as a separate species to *U. milii* in 2011. It has been recorded from rocky habitats in the Central Hamersley Ranges. The rocky gorges and moderately high elevations of the Pilbara ranges provide relatively moist and potentially cooler areas, allowing *U. seorsus* to persist (Doughty & Oliver, 2011)

This species has not been recorded from within the MDE, however, suitable habitat exists in the Gorges/Gullies habitat and there are records of *U. seorsus* in the surrounding area.

Western Striped Snake-eyed Skink

Once thought to be restricted to the near-coastal Pilbara area, this skink has now been found between Karratha and the MDE (Ecoscape, 2017b). Little is known of *Notoscincus butleri*, however it has been recorded from spinifex dominated areas near creek and river margins.

N. butleri has been recorded from five locations within the MDE from Lower slopes/Hillslopes and Plain (Stony/Gibber) habitat. These habitats are extensive and feature spinifex dominated grasslands (Ecoscape, 2017b).

There are no known threats to this species conservation, although habitat loss through mine development must be considered a risk.

4.7.4.2 Short Range Endemic Invertebrates

Short Range Endemic (SRE) Fauna species are those that display restricted geographic distributions, usually less than 10,000 km^2 (Harvey, 2002). Short-range endemism is thought to be caused either by long-term changes in climate, where species are forced to withdraw into small niche habitats to survive (relictual endemism), or where habitat becomes isolated, leading to evolution into separate species (habitat specialist SRE). Typically, SRE species have limited means of dispersal, low growth rates, low fecundity and reliance on discontinuous habitats (Harvey, 2002) which precludes them from wider distribution.

A consolidated SRE invertebrate fauna assessment of the Eliwana Mine and Railway Projects was completed by Phoenix Environmental Science in June 2018 (Phoenix , 2018). The scope of the assessment was to collate, summarise and update findings of the SRE surveys conducted to date within the MDE and the RDE for the Eliwana Project. This consolidated report is provided at Appendix 19.

Four surveys for SRE invertebrates were completed between 2012 to 2018 to identify potential SRE species and their habitat across the Eliwana Project area and several areas surrounding the proposal. This involved:

- A desktop review to locate any SRE species previously recorded within the survey area and surrounds, including
    - surveys undertaken at RTIO's Brockman 2 and 4, Silvergrass, Mesa A, G and K Projects
    - other Fortescue prospects in the region; and

- the Pilbara Biological Survey.

Forty-five (45) wet pitfall traps across 9 sites; 1,560 hours of foraging in leaf litter and soil and rocky habitat and 65 instances of litter and soil sifting. Figure 29 shows the extent of SRE survey.

The surveys were undertaken in accordance with EPA guidance current at the time of survey. The survey report is at Appendix 19.

The survey located 22 invertebrates that were considered to be potential SRE species and one species that was confirmed as an SRE (Table 39 below) (Phoenix , 2018). A summary of regional SRE records and locations in relation to the MDE can be found in Figure 4.1 of Appendix 19 (Phoenix , 2018). A complete list of all survey effort for all of the surveys within the MDE and their methods can be found in Table 3-1 of Appendix 19.

Table 39: Potential SRE species found within the MDE

Higher Family Taxon	Species	Status	Source	Habitat
Arachnida – Pseudoscorpiones (Pseudoscorpions)				
Chthoniidae	*Tyrannochthonius* sp. indet.	Potential	Ecologia (2015)	Woodland (open), Hummock grassland
Arachnida – Scorpiones (Scorpions)				
Urodacidae	*Urodacus* sp. indet.	Potential	Ecologia (2012a)	Clump of eucalypt on plain
Chilopoda (Centipedes)				
Chilenophilidae	*Chilenophilidae* sp. indet.	Potential	Ecologia (2015)	Drainage line/river/creek
Mecistocephalidae	*Mecistocephalida* sp. indet.	Potential	Ecologia (2015)	Plain (stony gibber), Woodland (open), Plain (cracking clay)
Mecistocephalidae	*Mecistocephalus* sp. indet.	Potential	Phoenix (2014b)	Gorge/gully, south facing rockface/ridge
Isopoda (Slaters)				
Armadillidae	*Buddelundia* '10BF'	Potential	Phoenix (2014b), Ecologia (2015)	Gorge/gully, woodland along drainage line
Armadillidae	*Buddelundia* '75'	Potential	Ecologia (2014), Ecologia (2015)	Drainage line/River/Creek (major), Plain (cracking clay), Plain (stony gibber), Woodland (open)

Higher Family Taxon	Species	Status	Source	Habitat
Armadillidae	*Buddelundia* '76'	Potential	Ecologia (2014), Ecologia (2015)	Plain (cracking clay), Plain (stony calcrete), Plain (stony gibber), Hilltops/Ridges/Plateaux, Woodland (Open Eucalypt), Drainage line/river/creek, Woodland (open)
Armadillidae	*Buddelundia* '77'	Potential	Ecologia (2015)	Plain (cracking clay), Hummock grassland
Armadillidae	*Buddelundiinae* 'EE1340'	Potential	Ecologia (2014), Ecologia (2015)	Plain (stony gibber), Open eucalypt woodland, Plain (cracking clay), Hilltops/Ridges/Plateaux, Shrubland (open), Drainage line/River/Creek (major), Plain (alluvial), Hummock grassland
Armadillidae	*Buddelundia* sp. indet.	Potential	Phoenix (2014b)	Gorge/gully, southfacing rockface/ridgeline
Armadillidae	*Cubaris* "EE1515"	Potential	Ecologia (2015)	Hummock grassland, Plain (stony gibber)
Armadillidae	*Cubaris* '999'	Potential	Phoenix (2014b)	Gorge/gully

All potential SRE taxa listed in Table 36 have been recorded both in the MDE and outside the MDE in the wider study area with the possible exception of *Dampetrus* 1021DNA02. A confirmed SRE, *Antichiropus* 1021DNA02, has to date only been recorded from within the MDE at a single location within the proposed disturbance footprint. Both species are discussed below. Locations of both species are shown in Figure 30.

Antichiropus 1012DNA02 Confirmed SRE

This keeled millipede has only ever been recorded from within the MDE and may occur within the proposed disturbance footprint. It was located in woodland in a drainage line. According to Phoenix (2018), species from the Genus *Antichiropus* are largely considered to be SRE species. The status the single confirmed SRE millipede Antichiropus '1021DNA02' has been checked with the WA Museum and it is currently only known from the original record, a single site (12-E04) in the MDE.

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However, it is possible that this millipede may be found elsewhere given another species of the same genus, *Antichiropus 1021DNA01*, identified during the 2012/13 surveys, has been found over a wide area, including areas outside the MDE and given the availability of wooded drainage line habitat within the local area outside of the potential disturbance footprint.

Dampetrus 1021DNA02

The herdsman *Dampetrus 1021DNA02* was recorded from within the MDE in 2012 (Phoenix , 2018), but has since been recorded from two other locations outside of the MDE (WAM T128028 and WAM T128030). The WAM now lists this as *Dampetrus* sp. indet. and therefore, its distribution is uncertain. *Dampetrus* sp. indet. taxa have been recorded elsewhere in the region therefore it is not possible to state if the record from the MDE is conspecific with either of the two records outside the MDE.

480,000 500,000 520,000

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

SERPENTINE CREEK

DUCK CREEK

Eliwana

PINARRA CREEK

BOOLGEEDA CREEK

Fauna Mapping

- Drainage Line/River/Creek (Major)
- Drainage Line/River/Creek (Minor)
- Gorges/Gullys
- Hills/Ranges/Plateaux
- Lower slopes/hillslopes
- Plain (shrubland)
- Plain (stony/gibber)

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Sampling Type: Active
- Sampling Type: Trapping Grid Site
- Sampling Type: Oppertunistic

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

0 2 4 6 8 10
Kilometres

N

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.052_r1

Date: 23-Aug-18
Size: A3L
Revision: 1
Confidentiality: 1

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Figure 29
SRE Survey Extent and Habitat

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480,000 500,000 520,000

7,540,000

7,520,000

7,500,000

Dampetrus sp. indet.

SERPENTINE CREEK

DUCK CREEK

Antichiropus '1021DNA02'

Eliwana

PINARRA CREEK

Dampetrus, 1021DNA02 (Dampetrus sp. indet.)

BOOLGEEDA CREEK

Fauna Mapping

- Drainage Line/River/Creek (Major)
- Drainage Line/River/Creek (Minor)
- Gorges/Gullys
- Hills/Ranges/Plateaux
- Lower slopes/hillslopes
- Plain (shrubland)
- Plain (stony/gibber)

LEGEND

- FMG SRE Fauna Significant
- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M.Dowling
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Figure 30
SRE and Potential SRE Locations

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The New Force in Iron Ore

4.7.5 Assessment of Impacts

Threats to terrestrial fauna, including the conservation significant fauna and SRE invertebrates mentioned above include:

- Habitat loss from direct clearing of fauna habitat, including habitat for SRE invertebrates;
- Habitat fragmentation, resulting in:
  - Restriction or removal of access to breeding habitat, foraging habitat or water sources through placement of infrastructure
  - Increased feral animal species
  - Increased weed species
- Increased vehicle strike;
- Changes to surface water regime; and
- Altered fire regimes

These impacts are discussed further below.

4.7.5.1 Habitat Loss

Clearing for mine development will result in the loss of fauna habitat. Loss of fauna habitat can result in direct mortality of individuals, the forced relocation of fauna and a reduction in foraging or breeding habitat. Impacts to individual conservation significant species is discussed further in this Section. Table 40 quantifies the loss of habitat by habitat type.

Table 40: Potential fauna habitat loss within the mine development envelope

Habitat Type	Regional (ha)	Local (ha)	Potential Disturbance (ha)	% remaining
Drainage Line/River/Creek (Major)	535	284	54.9	89.7
Drainage Line/River/Creek (Minor)	931	539.5	133.6	85.6
Gorges/Gullies	429	307.2	36	91.6
Hills/Ranges/Plateau	7,830	5,335.5	944	87.9
Lower Slopes/Hillslopes	37,466	26,025.3	4,374.9	88.3
Plain (Shrubland)	162	74.1	18.9	88.3
Plain (Stony/Gibber)	24,802	11,238.3	2,336.6	90.6

Table 40 demonstrates that no fauna habitat type will be substantially cleared within the MDE and therefore direct and indirect impacts to terrestrial fauna on a local and regional scale are not

considered significant. Significant fauna such as Long-tailed Dunnart, Western Pebble-mound Mouse and the reptiles Gane's Blind Snake, Pilbara Barking Gecko and Western Striped Snake-eyed Skink may not be able to move into other areas of habitat that will remain undisturbed, however, individuals or sub-populations remaining in large areas of undisturbed habitat post-disturbance will remain secure.

Removal of habitat also impacts on fauna species' ability to forage and disperse, particularly for species that are not highly mobile. This is particularly the case for SRE invertebrates, however for the species located within the MDE, this impact is minimal with SRE habitat type removal ranging between 3% and 25% (the greater 25% being for plain (shrubland) which is not typical SRE habitat) on a local scale and between 8% and 14% on a regional scale (Table 40). All the potential SRE invertebrate taxa recorded in the MDE to date have also been recorded outside the study area, and therefore have distributions beyond it with the possible exception of *Dampetrus* '1021DNA02' as discussed in Section 4.7.4.2.

The one confirmed SRE invertebrate identified during surveys, the millipede, *Antichiropus 1021DNA02* is likely to be impacted by a loss of habitat. Species located in areas of undisturbed habitat are unlikely to be significantly impacted by loss of foraging habitat. Fortescue considers that the species most likely at risk from habitat loss, the millipede *Antichiropus 1021DNA02* is likely to be found in similar habitat in the local area which will remain undisturbed.

The location of the confirmed SRE species occurs within the proposed footprint for the TSF. Wet processing at Eliwana is not expected for the first 5-7 years of mining. During this period, Fortescue will:

(a) undertake further surveys to locate additional specimens outside the disturbance footprint;

(b) if (a) proves unsuccessful, Fortescue will undertake research to determine whether the species is a candidate for translocation;

(c) If both (a) and (b) prove unsuccessful, Fortescue will design the TSF to avoid the location where the species was recorded.

Species such as the Grey Falcon, Peregrine Falcon and Rainbow Bee-eater are unlikely to be significantly impacted by a loss of foraging habitat due to their high mobility across the landscape.

4.7.5.2 Fragmentation of Habitat

Fragmentation occurs when a large expanse of habitat is transformed into a number of smaller patches of smaller total area due to clearing, isolating these smaller fragments from each other by cleared areas (Wilcove, et al., 1986). Where the landscape surrounding the fragments is inhospitable to species of the original habitat and when dispersal is low, remnant patches can be

considered true habitat islands and local communities will be isolates. Small habitat fragments are likely to be low in heterogeneity, that is, the habitat may not present the range of habitat variety required by some species (e.g. both foraging and breeding habitat) (Wilcove, et al., 1986).

This fragmentation and isolation may result in species residing within these fragments, in particular for those species with lower mobility, to become isolated from the population in surrounding uncleared areas. Individuals may no longer be able to access nesting or denning habitat or alternatively may lose access to areas where they may forage. Ultimately, if connectivity with surrounding habitat is permanently lost, or is not re-established within a reasonable timeframe, individual species with poor mobility living in these habitat fragments may not persist. It is likely that clearing for mine development and the placement of infrastructure will cause a barrier to some species movement within their home ranges, particularly small reptiles and mammals. However, large areas of undisturbed habitat will remain post-disturbance and populations in these areas will not be impacted.

Fragmentation of habitat can also cause 'edge effects'. Newly created edges experience changes in microclimate characteristics, which may significantly alter plant and animal communities present (Collinge, 1996). Weed infestation, dust and light impacts may degrade the habitat value of areas adjacent to cleared areas such that they are no longer suitable as fauna habitat for some species.

Fragmentation of habitat also provides increased access opportunity for feral predators such as feral cat, or feral herbivores such as cattle, horses and donkeys to access areas adjacent to the proposed development footprint. Feral predators and herbivores are more likely to preferentially use cleared areas such as roads for moving through the landscape. An increase in feral predation may cause local populations of small mammals and reptiles to decline; similarly, an increase in feral herbivores can cause degradation of habitat through increased erosion leading to a reduction in the fauna habitat value of the area, particularly in riparian habitats.

Impacts to fauna from isolation in habitat fragments and edge effects can be mitigated through progressive rehabilitation to re-establish ecological linkage. This is discussed in Section 4.7.6.1.

4.7.5.3 Increased Vehicle Strike

The presence of the Eliwana Mine will result in an increase in the number of vehicles in the local area. Vehicles may strike fauna species on roads, particularly slow-moving animals or species that are easily startled. Vehicles travelling at night are more likely to strike native fauna when visibility is reduced and more animals are on the move. Species such as birds of prey are also likely to feed off dead carcases on roads and may also become victim to vehicle strike.

Fortescue keeps a record of all vehicle related fauna incidents. The species with the highest number of vehicle strikes at Fortescue's operating sites is the kangaroo, usually at dawn and

dusk. There have been relatively few vehicle strikes involving significant fauna at Fortescue sites, including Fortescue's operating rail network. Management of vehicle traffic within operational sites is discussed later in Section 4.7.6.

4.7.5.4 Increased Weed Species

Clearing for development and increased movement of vehicles, including earth moving machinery may result in the establishment of new populations of weed species. Increased numbers of weeds can significantly increase the risk of fire, which can impact on fauna habitat value (see further discussion later in this section). Areas of dense weed infestation can also reduce the ability of fauna to move through their habitat and impact on their ability to forage. Weed species palatable to feral herbivores may attract these animals to the area causing potential land degradation and further spreading weed species either by movement of soil or in the animal's dung.

4.7.5.5 Changes to Surface Water Regime

Changes to surface water flows may cause changes to fauna habitat values, particularly in riparian zones. Areas where surface water flows are truncated may suffer from water starvation, leading to changes in vegetation health and structure. These areas may no longer be suitable for some fauna species. Impacts to fauna habitat may extend into closure, although it is expected that the fauna habitats will reach a new equilibrium following closure. The impacts to flora and vegetation caused by changes to surface water flow is discussed in Section 4.6.5.

Species such as Gane's Blind Snake and the Western Striped Snake-eyed Skink may be impacted by changes to vegetation health caused by reduced surface water flow as they are likely to have small home ranges and may not be able to relocate to alternative habitat.

4.7.5.6 Altered Fire Regime

Changes to fire regimes has a significant impact on vegetation structure. Too-frequent fires reduces vegetation cover, potentially exposing fauna species to a higher risk of predation and may reduce abundance of food or increase the prevalence of weed species. Fires can be caused by:

- Sparks from grinding or welding;
- Inappropriate disposal of cigarette butts; or
- Ignition of flammable vegetation through sparks and radiated heat from vehicle exhausts.

Fortescue consider the risk of fires caused by the implementation and operation of the proposal to be low. Management of fire risk is discussed in Section 4.7.6.

4.7.6 Mitigation

Fortescue has applied the mitigation hierarchy to the Project in relation to terrestrial fauna. A revised Conservation Significant Fauna Management Plan is located at Appendix 20. Mitigation measures to address potential impacts are detailed in Table 41.

Table 41: Avoidance, management and mitigation of impacts to terrestrial fauna

Impact	Management Actions
Loss of habitat	• Undertake targeted fauna surveys in accordance with applicable EPA and DoE guidance to determine distribution of conservation significant fauna • Record conservation significant fauna and habitat identified during a targeted fauna survey in the Corporate GIS and PIMS in accordance with the *Environmental Datasets – Data Governance Guidelines 100-GU-EN-0020*. • Conduct a risk assessment to identify high risk areas, including areas where conservation significant fauna species and habitat have been identified and potential impacts are likely in accordance with *Standard 4 – Risk Assessment Criteria 100-ST-RK-0014.* • Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat. • Ensure staff and contractors are provided with appropriate training to ensure conservation significant fauna and associated habitat are protected. • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging in accordance with the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042*.
Loss of SRE Invertebrate Species	• Undertake further surveys to locate additional specimens/populations. • Investigate whether the species can be translocated to suitable habitat. • If mitigation measures are unsuccessful, redesign the TSF to avoid the SRE species.
Fragmentation of habitat	• Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the *Land Use Certificate Procedure 100-PR-TA-0001_0* • Conduct progressive rehabilitation of disturbed areas, particularly those areas with known conservation significant fauna and associated habitat, in accordance with the *Exploration Environmental Management Plan E-PL-EN-0002* or *Eliwana Mine Closure Plan EW-PL-EN-0001.*
Increased Feral Animals	• Develop and implement a Feral Animal Program to effectively manage and control feral animals within Fortescue controlled sites to minimise impacts on conservation significant fauna. • Manage waste materials and on-site landfill facilities in accordance with the *Waste Management Plan 45-PL-EN-0014* to minimise potential impacts on fauna and the likelihood of increases in feral animal numbers.
Vehicle Strike	• To minimise the potential for fauna injuries or deaths on haul and access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving.
Weeds	• Ensure all vehicles, plant and equipment, including trailered equipment, are clean, inspected and certified prior to entry into Fortescue controlled sites to prevent the degradation of priority fauna habitat in accordance with the *Weed Management Plan 100-PL-EN-1017.*

Impact	Management Actions
Changes to surface water	• Conduct a risk assessment to determine the likelihood of a change to the surface water regime that may lead to unacceptable environmental impacts. • Drainage infrastructure location, design, construction and operation to design specifications which reflect risk assessment outcomes in minimising interference and disruption of natural surface water flows and quality in accordance with the *Standard Engineering Specification for Drainage and Flood Protection 100-SP-CI-0004* and the *Standard Engineering Specification for Road Design for Projects 100-SP-CL-0002*. • Protect natural drainage lines from construction impacts where possible to minimise impacts to water quality. • To ensure erosion, water quality and surface water flow regimes achieve the closure objectives conduct rehabilitation in accordance with the *Eliwana Mine Closure Plan EW-PL-EN-0001.*
Altered fire regimes	• When constructing a fire break or carrying out a prescribed burn where conservation significant fauna and habitat have been identified, adhere to the requirements outlined in the *Bushfire Management Plan 100-PL-EM-0009*.

4.7.6.1 Rehabilitation and Closure

Fortescue develops site specific closure objectives and closure plans for its operations, to ensure that local issues can be resolved in consultation with key stakeholders and specific to the post-mining land use. The *Eliwana Mine Closure Plan EW-PL-EN-0001* (Appendix 2) has been developed consistent with the DMP and EPA *Guidelines for Preparing Mine Closure Plans* (2015). The Plan describes the process by which Fortescue will manage direct and indirect impacts to significant habitat so that environmental values are maintained post-closure.

The closure objectives of the Plan pertaining to terrestrial fauna and their habitat include:

- waste rock landforms are safe to people and animals and geotechnically stable,
- rehabilitated areas support local native, self-sustaining vegetation and native fauna foraging,
- sediment movement within and downstream of rehabilitated areas does not adversely impact environmental or heritage values,
- water quality does not adversely impact downstream environmental or heritage values,
- pit lakes do not present a significant risk to human health or a significant ecological threat, and
- changes to hydrological regimes do not adversely impact downstream environmental or heritage values.

The Plan will be review and revised regularly throughout the mine life, to incorporate the developing knowledge base and outcomes from studies and field trials.

4.7.7 Predicted Outcome

A summary of residual impacts after the implementation of the proposal and the application of the mitigation measures outlined in Table 41 above is provided in Table 42.

Table 42: Predicted Environmental Outcome

Impact	Residual Impact after Management	Regional Significance
Loss of fauna habitat	Loss of 7,900 ha of fauna habitat. Rehabilitation during operations and closure will re-establish fauna habitat in disturbed areas and new permanent landforms. There may be some permanent loss of habitat such as Gorges/Gullies, Drainage Line/River/Creek habitat.	Fauna habitats are common throughout the local area and the region. Few species of conservation significance are present within the mine development envelope.
Loss of significant fauna (including SRE)	Fortescue will undertake further surveys for the confirmed SRE species *Antichiropus* 1021DNA02 to determine whether this species occurs outside the disturbance footprint. If unsuccessful, Fortescue will undertake research to determine whether the species can be relocated to suitable habitat. If both these measures are not successful in reducing the level of impact to the species, Fortescue will redesign the TSF to avoid the species known location.	The minor loss of conservation significant vertebrate fauna is not significant on a local or regional scale. A loss of the confirmed SRE species would be considered significant. However, Fortescue will take all necessary steps to ensure that the impacts to the species are acceptable.
Fragmentation of habitat	Rehabilitation will establish habitat for fauna species post-disturbance to restore ecological linkage for some species. Whilst the vegetation communities on rehabilitated surfaces are unlikely to be similar to those removed, the resulting habitats will be generally used by fauna species present. Some permanent landforms may provide new habitat for some fauna species post-closure.	Large areas of undisturbed fauna habitat occur surrounding the proposal footprint. Impacts from fragmentation are likely to be short-term and not significant.
Increased Feral Animals	Given there is currently no management of feral animals in the local area, the management of feral animals during operations may actually reduce the number of feral animals in the local area. This is likely to counterbalance the proposal's potential to provide improved access by feral predators into the area.	Given the size of the proposal, feral predator control will enhance fauna conservation values on a landscape scale.
Vehicle Strike	Implementation of speed restrictions will reduce impacts to fauna to as low as possible. Records of vehicle strikes have been kept by Fortescue since operations began in 2007 and average to approximately 80 per year (excluding impacts from rail operations), more than half of those kangaroo strikes. This is a	Impacts to fauna from vehicle strikes on a regional level will not be significant.

Impact	Residual Impact after Management	Regional Significance
	very low percentage of total hours worked or vehicle movements per day. Very few incidents involve significant species.	
Weeds	There is currently no weed management in the local area. Weed management during the operation of the proposed mine may reduce the level of weeds within the local area, counterbalancing the risks associated with earthmoving and vehicle movements through the proposal area.	There is unlikely to be an impact to fauna from weed infestation as a result of the project
Changes to surface water	There may be some impacts to surface water flow as a result of the proposal, which may cause local changes to vegetation health and structure. This could cause localised impacts to fauna that use Drainage Line/River/Creek habitats	On a regional scale, there is unlikely to be a significant impact to fauna from changes to the existing surface water regime.
Altered fire regimes	Weed management, construction of firebreaks and hot work permits will reduce the risk of fires caused by the proposal.	Wildfires are expected to continue within the region, however they are unlikely to be caused by the proposal.

In summary, the proposed disturbance is only a small percentage of the overall habitat available to fauna species in the local area and throughout the region. Fauna habitat in the area is common and relatively few species of conservation significance have been recorded within the mine development envelope. However, the loss of vegetation in good to excellent condition, discussed in Section 4.6.7, suggests that the impact to fauna habitat on a local scale may be considered a significant residual impact. This is discussed further below in Section 4.7.8.

4.7.8 Offsets

Fortescue is proposing an offset for a loss of vegetation in good to excellent condition. This vegetation is also a key component of fauna habitat. Therefore, the significant residual impact associated with the loss of fauna habitat, being vegetation in good to excellent condition, is the same as that for which the offset is proposed for the loss of this vegetation. Fortescue is not proposing any additional offset for loss of fauna habitat where it is already subject to a proposed offset.

4.8 Subterranean Fauna

Subterranean fauna was identified as an environmental factor relevant to the Project in the Environmental Scoping Document (EPA, 2017). This section describes the potential impacts, proposed management and predicted outcomes associated with the subterranean fauna values occurring within the Proposal Envelope.

Subterranean fauna are animals that predominantly live underground; the group is mainly represented by invertebrates such as crustaceans, insects, arachnids, myriapods, worms, and snails, but also includes some vertebrates such as fish and reptiles. Subterranean fauna are commonly classed into two ecological categories:

- stygofauna - aquatic animals that inhabit groundwater in caves, aquifers and water-saturated interstitial voids; and
- troglofauna - air-breathing animals that inhabit caves and smaller voids or micro-caverns.

Both troglofauna and stygofauna exhibit a high level of endemism and the Pilbara is considered a globally important region particularly for stygofauna with species density greater than anywhere other than the Dinaric karst of Europe (Bennelongia , 2014).

4.8.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for subterranean fauna as follows:

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

4.8.2 Regulatory Framework

Western Australia's subterranean fauna is considered globally significant due to an unprecedented richness of species and high levels of short-range endemism (EPA, 2013a). The EPA's primary objective for subterranean fauna is to "maintain representation, diversity, viability and ecological function at the species, population and assemblage level" (EPA, 2013a). Protection for listed (conservation significant) subterranean species and/ or Threatened or Priority Ecological Communities is provided under State and Federal legislation, including:

- Environmental Protection Act 1986 (EP Act 1986) (WA);
- Wildlife Conservation Act 1950 (WC Act 1950) (WA); and

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999) (Commonwealth).

The majority of subterranean species and communities are not listed, due to incomplete taxonomic or ecological knowledge. Consideration of subterranean fauna species during EIA is not limited to listed species or ecological communities, but also may include species or communities that occur only within restricted habitats, as per short-range endemic (SRE) species (Harvey 2002, Eberhard et al. 2009).

4.8.3 Policy and Guidance

The following policy and guidance is relevant to this factor:

- Environmental Factor Guideline: Subterranean Fauna (EPA, 2016j);
- Consideration of Subterranean Fauna Survey in Environmental Impact Assessment in WA (EPA, 2013a) and
- Guidance Statement 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a)

Environmental Factor Guideline: Subterranean Fauna

This guideline provides an outline of how Subterranean Fauna is considered by the EPA in the environmental impact assessment (EIA) process. Relevant matters discussed in Guideline include the following:

- description of EIA considerations, including:
  - application of the mitigation hierarchy;
  - the subterranean fauna affected by the proposal;
  - the potential impacts and the activities that will cause them;
  - surveys and analyses required;
  - the significance of and risks to the fauna; and
  - the current state of knowledge of subterranean fauna and the level of confidence underpinning the predicted residual impacts.
- describes issues commonly encountered by the EPA during EIA of this factor; and
- provides a summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

- Fortescue has specifically considered this guidance in the following ways:
- surveys and analyses undertaken and planned to describe the receiving environment and its significance;
- identification of activities which may lead to impacts to subterranean fauna; and
- application of the mitigation hierarchy in elements of project design.

Technical Guidance – Subterranean Fauna Surveys

This guidance is intended to provide information on standards and protocols for terrestrial fauna surveys to ensure adequate data of an appropriate standard are obtained and used in EIA, specifically providing advice on:

- determining the type and level of survey required;
- survey design (including sampling, use of genetics and use of surrogates);
- specimen vouchering and lodgement; and
- data interpretation and reporting.

Fortescue has specifically applied this guidance in the planning, design and implementation of subterranean fauna surveys conducted within the Proposal Area.

4.8.4 Studies and Surveys

Previous Fortescue surveys within the MDE or in the wider Central Pilbara region are listed in Table 43 below.

Table 43: Previous survey effort within the MDE or wider central Pilbara region

Location	Survey Effort	Date
Troglofauna Assessment for the Solomon Project: Firetail Deposits	263 troglofauna samples - 468 specimens, 45 species	(Bennelongia, 2010)
Solomon Project: Kings Deposits Subterranean Fauna Survey & Assessment	76 stygofauna samples – 138 specimens, 19 species 165 troglofauna samples – 240 specimens, 23 species	(Subterranean Ecology, 2010)
Central Pilbara Project Stage One Subterranean Fauna Survey	199 stygofauna samples – 1492 specimens, 31 species 307 troglofauna samples – 2695 specimens, 21 species	(Subterranean Ecology, 2011a)

Location	Survey Effort	Date
Solomon Project: Regional Subterranean Fauna Survey	28 stygofauna samples – 2166 specimens, 25 species 11 troglofauna samples – 56 specimens, 14 species	(Subterranean Ecology, 2011b)
Solomon Iron Ore Project: 30 Month Troglofauna Report at Kings Mine	448 troglofauna samples – 670 specimens, 55 species	(Bennelongia, 2013a)
Solomon Iron Ore Project: Troglofauna Survey at Zion Deposit	77 troglofauna samples – 134 specimens, 27 species	(Bennelongia, 2013b)
Mt Macleod Subterranean Fauna Assessment	23 stygofauna samples – 196 specimens, 10 species 64 troglofauna samples – 196 specimens, 2 species	(Ecologia, 2014a)
Solomon: Stygofauna Assessment of Northern and Southern Borefields	80 stygofauna samples - 2439 specimens, 70 species	(Bennelongia , 2014)
Stingray Subterranean Fauna Assessment	11 stygofauna samples, 135 specimens, 8 species 43 troglofauna samples, 138 specimens, 8 species	(Ecologia, 2014b)
Addendum to Stygofauna Assessment of Northern and Southern Borefields	38 stygofauna samples, 761 specimens, 41 species	(Bennelongia, 2015a)
Western Hub Baseline Subterranean Fauna Assessment	140 stygofauna samples - 928 specimens, 30 species 146 troglofauna samples - 293 specimens, 43 species	(Bennelongia, 2015b)
Solomon Mine Castle Valley Deposit: Level 2 Subterranean Survey	16 stygofauna samples – 285 specimens, 16 species	(Bennelongia, 2016a)

Location	Survey Effort	Date
	46 troglofauna samples – 28 specimens, 14 species	
Solomon Mine Frederick's Deposit: Troglofauna Survey	18 troglofauna samples – 99 specimens, 17 species	(Bennelongia, 2016b)

The most recent survey effort (Biologic, 2017) within the MDE is summarised in Table 44 below.

Table 44: Eliwana Project Survey Effort

Location	Survey Effort	Date
Eliwana Project: Subterranean Fauna Assessment	76 stygofauna samples – 281 specimens, 15 species 223 troglofauna samples – 242 specimens, 31 species	(Biologic, 2017)

A total of 299 subterranean fauna samples were collected over the course of four field trips within the MDE (Biologic, 2017). During Phase 1, a total of 94 troglofauna sites were sampled over two field trips, (10 – 16 March, and 26 April – 1 May 2017), comprising 35 troglofauna trapping sites, 41 scraping sites and 18 combined scrape/net hauling sites. Twenty-seven stygofauna sites were sampled during Phase 1, including 8 net hauling sites, 1 karaman sampling site and 18 combined scrape/net hauling sites previously mentioned.

During Phase 2, a further 129 troglofauna sites were sampled over two field trips (30 August – 1 September, and 30 October – 3 November 217), consisting of 50 troglofauna trapping sites, 54 scraping sites and 25 combined scrape/net hauling sites. A total of 49 stygofauna sites were sampled during the second phase, comprising 24 net hauling sites in addition to the aforementioned 25 combined scrape/net hauling sites.

4.8.5 Existing Environment

The Western Hub Baseline Subterranean Fauna Assessment comprised surveys of the Eliwana and Flying Fish areas in combination with results of two other survey areas; Delphine and The Edge (Bennelongia, 2015b) (The 2015 Study Area). This assessment reported a total of 120 troglofauna specimens, representing 20 species (Bennelongia, 2015b). A quarter (5) of these species (including millipedes, cockroaches, bugs, beetles and flies), were known to have wide ranging distributions extending beyond the 2015 Study Area. Four (4) species (nr *Cryptops* sp. B36, Japygidae sp. B37, *Gracilanillus cordatus*, *Paradraculoides* sp. B12), had locally wide-ranging distributions (37, 23, 19 and 15 km respectively) but were known only from the 2015

Study Area. The remaining 11 troglofauna species were known only from a single record or single drill-hole.

A total of 423 stygofauna specimens, representing 15 species, were also collected from surveys in the 2015 Study Area (Bennelongia, 2015b). With the exception of three species, *Areacandona* nr *triangulum*, *Brevisomabathynella* sp. B03 and *Bogidiella* sp. B05), all of the stygofauna species had distributions extending beyond the 2015 Study Area.

The most recent two-phase survey recorded a total of 523 subterranean fauna specimens from 42 bores and holes (Biologic, 2017). Troglofauna specimen made up nearly half of these records with 242 specimens collected, representing 25 species from eleven higher groups; mites, schizomids, spiders, centipedes, pauropods, myriapods, diplurans, silverfish, cockroaches, hemipterans and beetles. This represents a slightly more diverse troglofauna assemblage than previously recorded (20 species) during the Western Hub Survey (Bennelongia, 2015b).

A total of 281 stygofauna specimens were collected from the most recent Eliwana Project area two-phase survey, representing 15 species from five higher groups; oligochaetes, ostracods, copepods, syncarids and amphipods (Biologic 2017). This represents a very similar stygofauna assemblage as previously recorded (15 species belonging to the same five groups) (Bennelongia, 2015b).

Three higher groups (oligochaetes, copepods and amphipods) comprised the majority of the species richness (12 of the 15 species). Amphipods and copepods were the most abundant groups with 112 and 80 specimens collected respectively.

Indicative locations of bores and drill holes sampled during the previous and recent survey of the MDE are shown in Figure 30 (Maps 1 & 2).

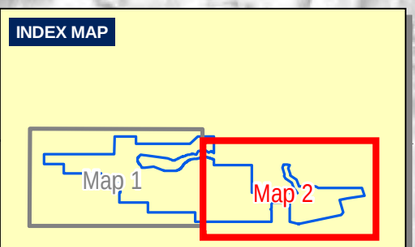
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7,510,000
Eliwana
INDEX MAP
Map 1
Map 2
Fortescue Projects
Mine Development Envelope
Indicative Mine Footprint
Major Drainage
Stygofauna
Troglofauna
Data Sources:
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.
N
0 1 2 3 4 5
Kilometres
Requested By: A. Winzer
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:80,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.016a_r2
Date: 21-Aug-18
Size: A3L
Revision: 2
Confidentiality: 1
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Figure 31
Subterranean Fauna Survey Effort
(Map 1 of 2)

Fortescue Metals Group Ltd
The New Force in Iron Ore

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7,520,000
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INDEX MAP



Mine Development Envelope
Indicative Mine Footprint
Major Drainage
Rio Tinto Rail
Stygofauna
Troglofauna

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

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Figure 31
Subterranean Fauna Survey Effort
(Map 2 of 2)

Fortescue Metals Group Ltd
The New Force in Iron Ore

The combined troglofauna results (including the previous 2015 survey of the Study Area) result in a total of 365 potential troglofauna specimens recorded within the MDE (Biologic 2017). This represents 37 troglofauna morphospecies belonging to 15 higher order groups; Diplura (8 species), Pauropoda (5 species), Coleoptera (5 species), Araneae (3 species), Isopoda (2 species), Thysanura (2 species), Hemiptera (2 species), Symphyla (2 species), Chilpoda (2 species) and single species of Acari, Palpgradi, Shizomida, Polyxenida, Blattodea and Diptera. An additional three (3) indeterminate taxa were recorded that may represent species already known from the MDE, including Thysanura sp., *Nocticola* sp. and *Macranillus* sp. indet.

The combined stygofauna results (including previous and current survey of the MDE) result in a total of 694 potential stygofauna specimen recorded from the MDE. This represents 26 stygofauna morphospecies belonging to 6 higher order groups; Amphipoda (7 species), Copepoda (6 species), Oligochaeta (5 species), Ostracoda (2 species), Syncarida (2 species) and Nematoda (single species). An additional two indeterminate taxa (Enchytraeidae sp. and *Parastenocaris* sp.) were recorded that may represent species already known from the MDE.

4.8.5.1 Troglofauna

While the earliest work on troglofauna was focussed on their occurrence in caves, surveys during the past five years have shown that troglofauna occur commonly in the landscape matrix of the Pilbara and are represented by many invertebrate groups, including isopods, palpigrads, spiders, schizomids, pseudoscorpions, harvestmen, millipedes, centipedes, pauropods, symphylans, diplurans, silverfish, cockroaches, bugs, beetles and fungus-gnats. Although abundance and diversity of troglofauna appear to be greatest in the Pilbara, troglofauna seem to occur outside caves in all Western Australia regions with documentation from the Kimberley (Harvey, 2001), Cape Range (Harvey, M.S., Gray, M.R., Hunt, G.S. and Lee, D.C., 1993)(Harvey *et al*. 1993), Barrow Island (Biota, 2005a), Mid-West (Ecologia, 2008) and Yilgarn (Bennelongia, 2009b), and South-West (Biota, 2005b).

Troglofauna are air-breathing animals that exist exclusively below the land surface, usually at depths greater than 3-4 m, with a distribution that extends down to the water table. There have not been any large-scale surveys for troglofauna in the Pilbara but many fauna surveys have targeted troglofauna as part of environmental impact assessments in areas of mining development. Troglofauna in the Pilbara has been collected frequently from mineralised iron formations (e.g. Biota 2006, (Bennelongia, 2008a) (Bennelongia, 2008b) (Bennelongia, 2008c); (Bennelongia, 2009a); (Bennelongia, 2009b) but have also been recorded from other geologies such as calcrete and alluvial detrital deposits in the Pilbara (Edward and Harvey 2008; Rio Tinto 2008). Troglofauna occupy interstices, vugs, cavities and fissures within geologies with a rather constant climate of stable temperatures and relatively high humidity (Culver 1982, Howarth 1983). If no fissures or voids are present, troglofauna will not occur. Geologies that may limit habitat connectivity, such as solid rock strata or thick layers of alluvium between vuggy geologies,

may lead to range restriction in troglofauna species and promote regional endemism. In the Pilbara troglofauna appear to be most commonly collected high in the landscape where mineralised iron and hardcap occur, whilst they are less often recorded in palaeovalley sediments that may be more compacted. It is still unclear whether this is because the sediments offer smaller interstitial spaces or because fewer holes are available for sampling in valleys.

Troglofauna Habitat

The habitat assessment for potentially restricted species within the MDE is based upon available geological and hydrogeological reports, drill logs, diamond drill cores, surface geology maps and available geological cross sections at each of the deposits. The troglofauna fauna habitat assessment is based around eight geological cross sections at key locations throughout the MDE, corresponding to the sampling locations of potentially restricted troglofauna taxa (where possible). These cross-sections are listed in Table 45 and their locations are shown in Figure 32.

Table 45: Location and Details of Geological/Hydrogeological Cross-sections used in habitat assessment

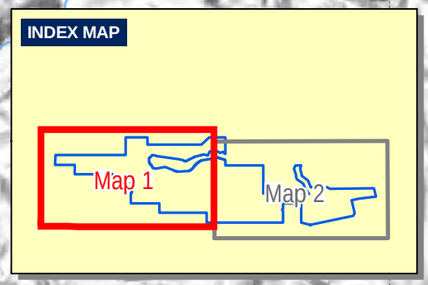
Section Number	Location	Distance S-N (m)	Bore/hole on section	Troglofauna Species
XS1	Broadway 1	1400	EW1061	Pauropodidae B42 and B43, *Prethopalpus* sp. MW21, Campodeidae sp. EW, *Gracianillus cordata*, and Symphyella sp. EW, *Paradraculoides* sp. new2 (near)
XS2	Outside Broadway 1 pit (west)	860	EWD0034	
XS3	West End	1620	EW1788	Pauropodidae B41
XS4	Talisman	1120	TM0015	Pauropodidae B29, Palpigradi sp., *Lepidospera* B10 (near)
XS5	East 3	2410	EW0372	*Macranillus* sp. EW
XS6	East 4	1300	EW0507	*Macranillus* sp. indet., *Paradraculoides* sp. B12A
XS7	Flying Fish West	960	EWD0017	*Anapistula* sp. EW,
XS8	Flying Fish 2	650	FF0038	Projapygidae B17, *Troglarmadillo* B46 (near)

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INDEX MAP



X Section 2
X Section 1
X Section 4
X Section 3
X Section 9

Eliwana

Interpreted Geology

- Dolerite dykes
- Brockman Iron Formation
- Mt McRae Shale
- Mt Sylvia Formation
- Wittenoom Iron Formation
- Marra Mamba Formation
- Jeerinah Formation

Troglofauna

- Campodeidae sp. 'EW'
- Lepidospera sp. B10
- Palpigradi sp.
- Paradraculoides sp. new 2
- Pauropodidae sp. B29
- Pauropodidae sp. B41
- Pauropodidae sp. B42
- Pauropodidae sp. B43
- Prethopalpus sp. 'MW21'
- Projapygidae sp. B14
- Symphyella sp. 'EW'

- Fortescue Projects
- Mine Development Envelope
- Troglofauna Habitat
- Cross Section
- Major Drainage
- Indicative Mine Footprint

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 1 2 3 4 5
Kilometres

Requested By: A. Winzer
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:80,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.012a_r3

Date: 23-Aug-18
Size: A3L
Revision: 2
Confidentiality: 1

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Figure 32
Troglofauna - Restricted Species
(Sheet 1 of 2)

Fortescue Metals Group Ltd
The New Force in Iron Ore

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X Section 5 X Section 6 X Section 7 X Section 8 X Section 10 X Section 11 X Section 12

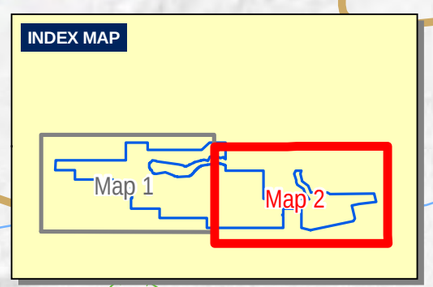
Interpreted Geology

- Dolerite dykes
- Brockman Iron Formation
- Mt McRae Shale
- Mt Sylvia Formation
- Wittenoom Iron Formation
- Marra Mamba Formation
- Jeerinah Formation

Troglofauna

- Anapistula sp. 'EW'
- Macranillus sp. 'EW'
- Paradraculoides sp. B12A
- Projapygidae sp. B17
- Troglarmadillo sp. B46

INDEX MAP



- Mine Development Envelope
- Troglofauna Habitat
- Cross Section
- Major Drainage
- Rio Tinto Rail
- Indicative Mine Footprint

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

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Kilometres

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Figure 32
Troglofauna - Restricted Species
(Sheet 2 of 2)

Fortescue Metals Group Ltd
The New Force in Iron Ore

FMG Fortescue
The New Force in Iron Ore

Broadway Pits

The Broadway 1 pit is situated in Marra Mamba Iron Formation (MMIF), with the upper layers of the Newman and McLeod Members being the main targets for mining. Hole EW1061 is shown to occur within a thin band of Macleod and Nammuldi Members on the mid slope area; geological modelling of these layers did not extend below the end of hole at EW1061 (18m), although it is reasonable to assume that these layers are much thicker than shown in Figure 33.

Six (6) potentially restricted troglofauna taxa were detected from this site, comprising *Pauropodidae* B42 and B43, *Prethopalpus* sp. MW21, *Campodeidae* sp. EW, *Gracianillus cordata*, and *Symphyella* sp. EW. *Paradraculoides sp. new2* were detected nearby from the Broadway south pit, in the Dales Gorge Member of the Brockman Iron Formation (BrIF). Cross-section 1 shows hole EW1061 is situated 100m within the indicative disturbance mining pit (Figure 33). As the modelled pits shown in Figure 32 are subject to a 150m buffer (under a precautionary approach), hole EW1061 would likely be just outside of the proposed pit boundary at Broadway 1. Nevertheless, the proximity to mining warrants assessment of these potentially restricted troglofauna species.

Nearby diamond drill cores EWD0034 (Plate 14), situated east-south-east of hole EW1061 sit within the same geological profile in the MMIF. Both drill cores show significant cavities, core loss (indicative of cavities and weathered geology) as well as high levels of fracturing and vugs from secondary weathering from the surface to the end of core (0 to approx. 40m). This highly weathered geology is likely to be highly suitable for troglofauna habitat.

The MMIF is shown to extend beyond the Broadway 1 pit along strike to the north and west (Figure 34, Cross section 2). Cross section 2 contains a very similar geological profile to the immediate west of the Broadway 1 Pit, indicating that the habitat in this area is likely highly similar, and well connected to the habitats likely to be directly impacted by the Broadway pits. Overall, the current geological information suggests that the potential habitats for troglofauna species found in the Broadway pits are likely to extend beyond the pit boundaries, particularly to the west.



Plate 12: Core showing cavities and core loss (potential habitat) at EWD0034

Surface geology (Figure 33) shows the MMIF (regarded as highly suitable troglofauna habitat at location EW1061) extending beyond the Broadway 1 pit along strike to the north and west. Figure 34 shows a very similar geological profile to the immediate west of the Broadway1 Pit, indicating that the habitat in this area is likely highly similar, and well connected to the habitats likely to be directly impacted by the Broadway pits. Overall, the current geological information suggests that the potential habitat for the troglofauna species found in Broadway 1 is likely to extend beyond the pit boundaries, particularly to the west.

Figure 33: Cross Section 1: Broadway Pit

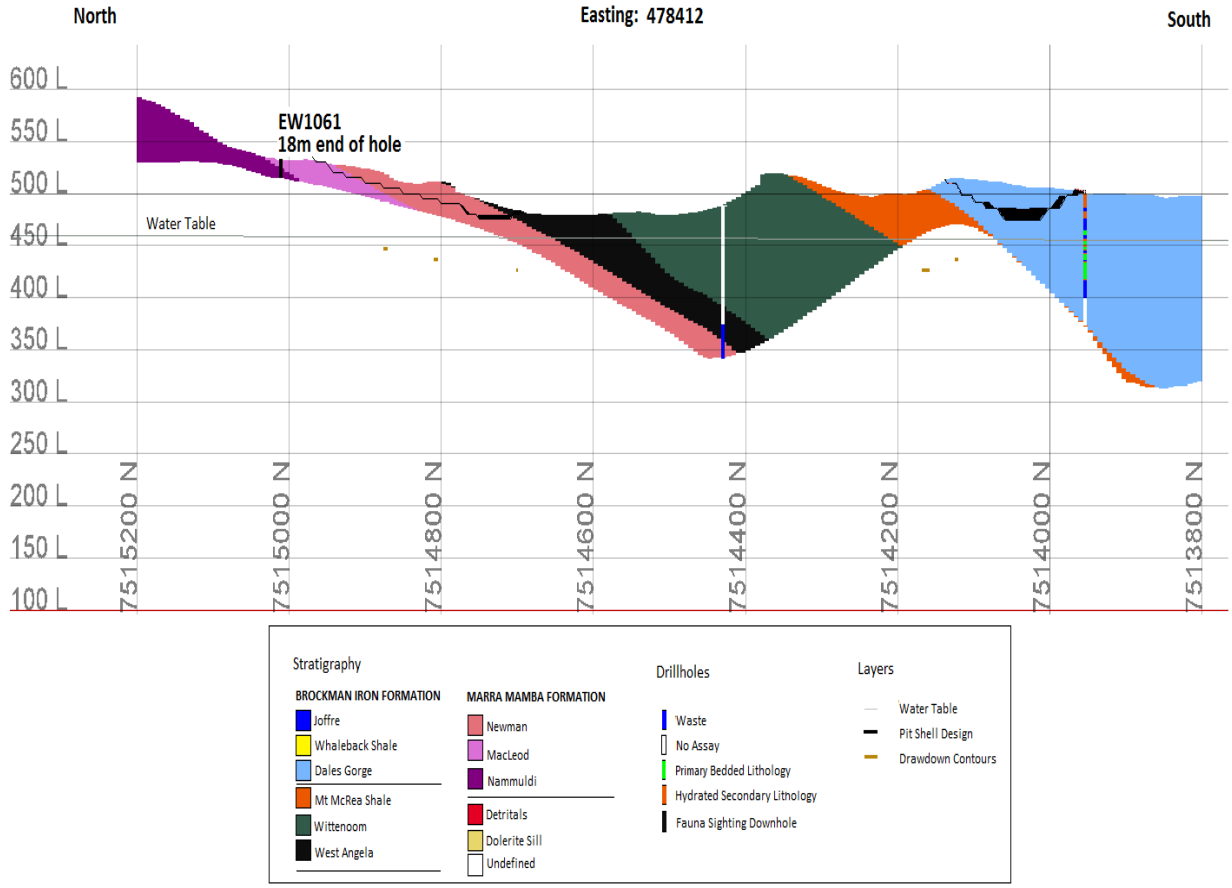
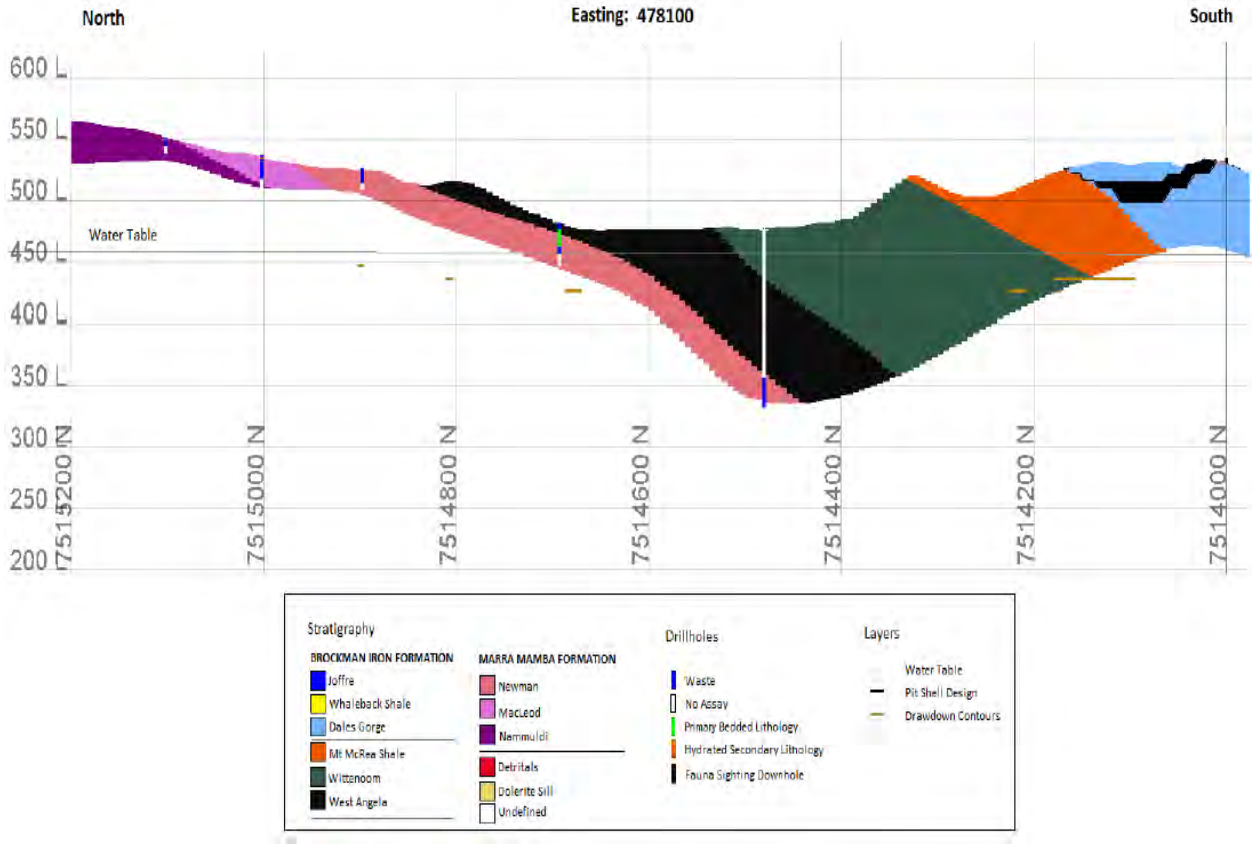


Figure 34: Cross Section 2: Outside Pit Immediately West of Broadway 1



West End

The West End pit targets the Joffre, Whaleback and Dales Gorge Members of the BrIF, as well as some detrital mineralised zones to the south (Figure 35). A nearby drill core, hole EW1788 (location of the troglofauna species Pauropodidae sp. B41) intersects a relatively thick secondary hydrated zone at the top of the profile in the Joffre Member and several bedded mineralised zones deeper in the profile within the Whaleback and Dales Gorge Members of the BrIF (Cross Section 3).

A Diamond core immediately north (EWD0010) of hole EW1788 within the West End pit, show characteristic high levels of weathering of the BrIF. All cores showed notable cavities, core loss (>1.5m), fractured geology, dissolution holes and vugs throughout the profile (from surface to beyond 50m), which are indicative of highly suitable troglofauna habitat (as shown in Plate 15 below).

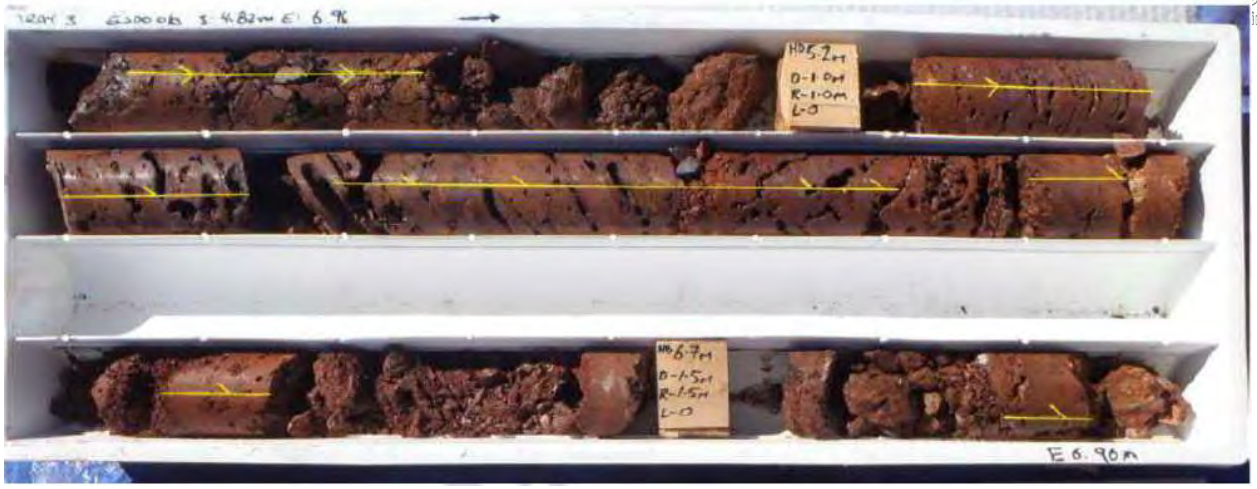
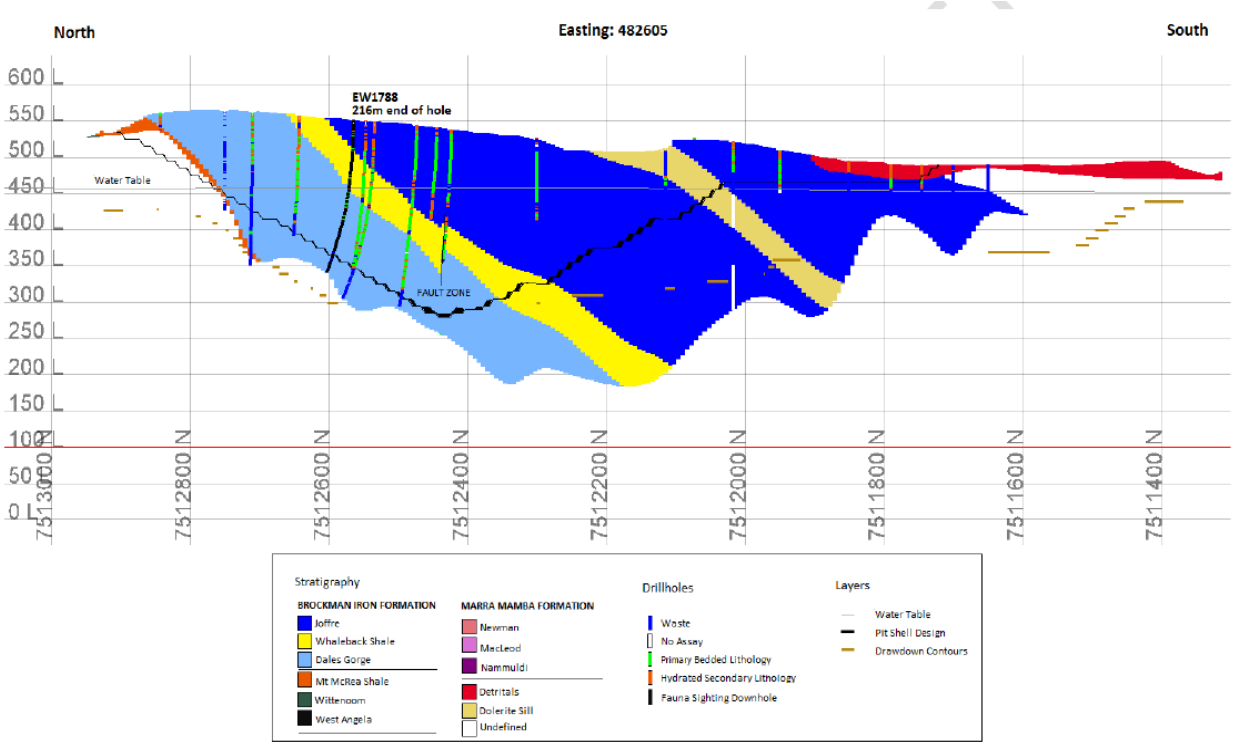


Plate 13: Core showing cavities and core loss (potential habitat at EWD0010)

The BrIF surface geology occurring at hole EW1788 extends along the strike west and east beyond the boundaries of West End Pit (Figure 35). Based on current geological information, it is likely that suitable habitat for the troglofauna species found within West End Pit occurs beyond the pit boundaries to the east and west.

Figure 35: Geological Cross Section 3 – West End Pit

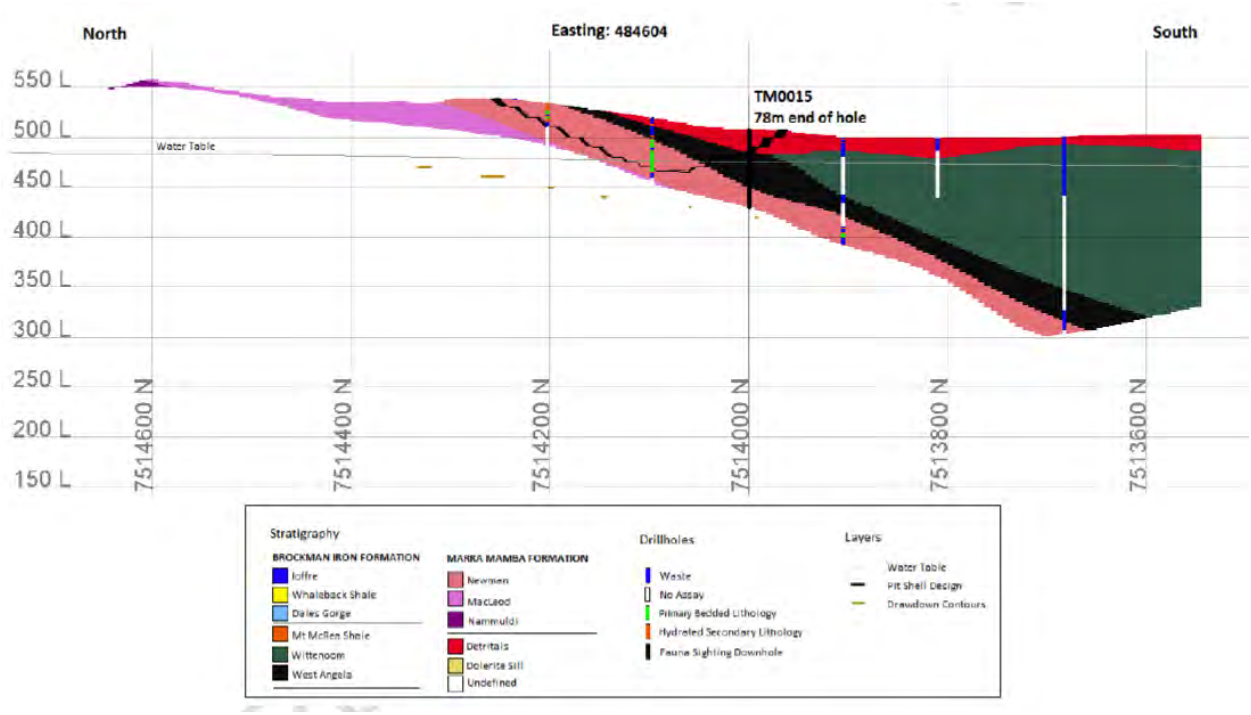


Talisman

The Talisman Pit is developed in MMIF targeting the upper Newman Member and surface detritals (Figure 36, Cross section 4). Hole TM0015 (shown below), situated in the south of Talisman, intersects surface detritals overlaying West Angela shales, terminating in the Newman Member of the MMIF (78m). Three potentially restricted troglofauna taxa were detected from Talisman, comprising two from hole TM0015 (Palpigradi sp. and Pauropodidae sp. 'B29') and one from hole TM0087 (*Lepidospera* sp. 'B10'), immediately east of cross section 4 (Figure 36).

This figure shows only detritals and the West Angela Member above the water table in the area of hole TM0015. It may be assumed that either the West Angela Member in this area is sufficiently weathered above water table to support troglofauna, or that troglofauna taxa collected from this hole were inhabiting the unconsolidated detritals.

Figure 36: Geological Cross Section 4 - Talisman



Diamond core (EWD0037) adjacent to hole TM0015 show characteristic gravels, fractures and void spaces within unconsolidated detritals near the surface. Diamond core EWD0037 depict surface detritals that are poorly consolidated and weathered, resulting in frequent core loss (Plate 16).



Plate 14: EWD0037 Core at Talisman Pit showing surface core loss of surficial unconsolidated detritals (potential habitat)

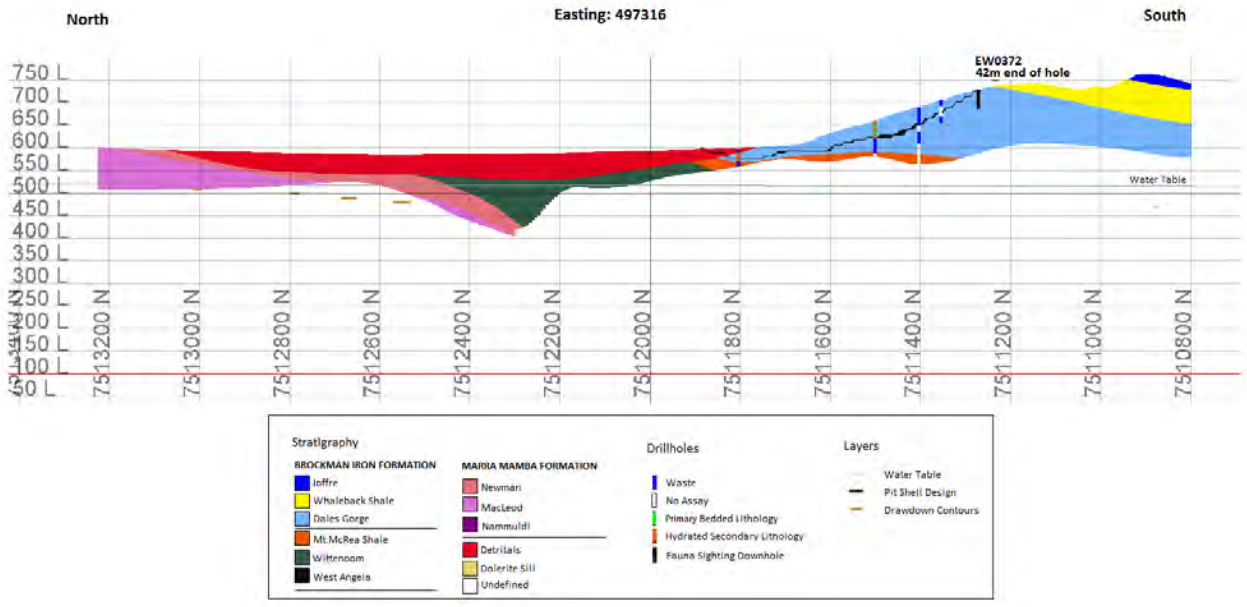
Surface geology (Figure 36) shows that the detritals (Tertiary colluvium) extend well outside the Talisman pit, east-west along the Eliwana Valley. This cross section also shows a significant extent of this layer further to the south of the pit boundary, atop Wittenoom Dolomite (which may also provide potential habitat where weathered/ karstified). Based on current geological information, it is likely that suitable habitat for the troglofauna species found within (and near) the Talisman Pit occurs beyond the pit boundaries to the east, west, and south.

East 3

East 3 Pit is developed almost entirely within the Dales Gorge Member (BrIF), with the northern margin extending slightly beneath the Tertiary detritals of the valley floor (Figure 37). Hole EW0372, where the carabid species *Macranillus* sp. 'EW' was detected, is situated on the southern margin of East 3 pit approximately 160m within the indicative pit (Figure 37). As the pit includes a conservative 150m buffer zone, only the surface of hole EW0372 is likely to be within the pit boundary (as shown in Cross Section 5).

There were no available diamond cores within the immediate vicinity of East 3 Pit; however, the Dales Gorge Member has been shown to provide high suitability troglofauna habitat in other parts of the MDE (e.g. West End Pit). Drill logs within Cross Section 5 showed hydrated secondary lithologies typically associated with highly suitable troglofauna habitat. Owing to the wider mapped extent of the BrIF and the relatively shallow depth of the East 3 Pit shown in Cross Section 5, it is considered likely that suitable habitat for troglofauna found at East 3 Pit extends beyond the pit boundaries.

Figure 37: Cross Section 5 – East 3 Pit



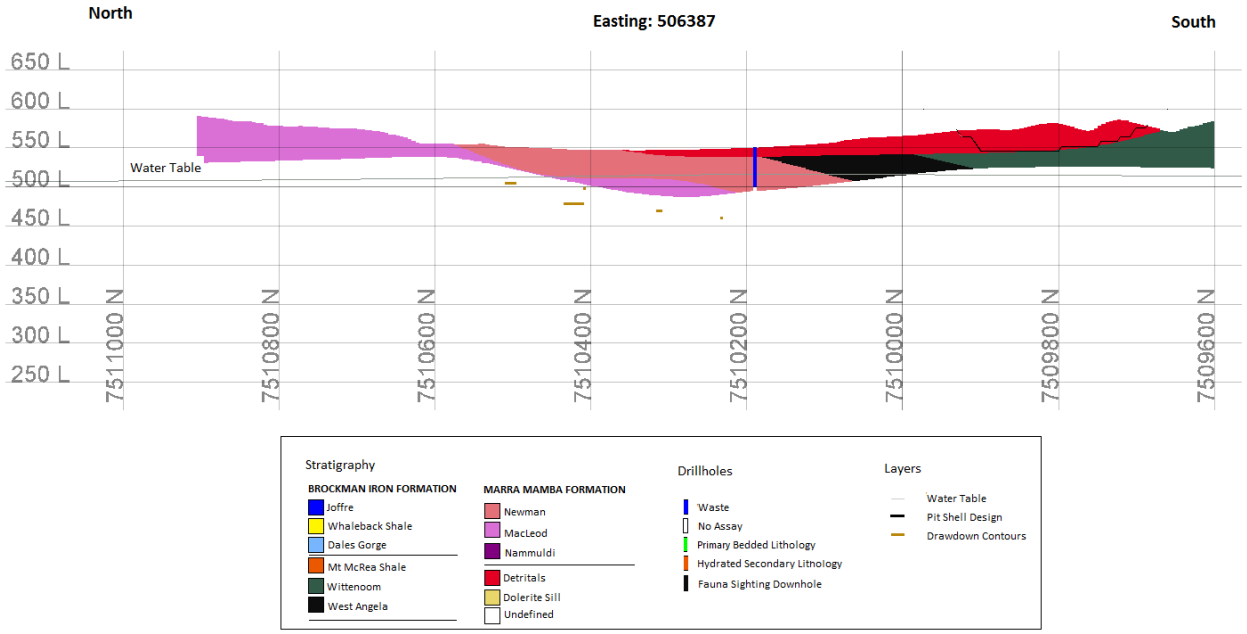
East 4

The southern East 4 Pit target the detrital mineralised zone in the south of Cross Section 6 and it can be inferred that the northern East 4 pit targets the MMIF (Figure 38).

Paradraculoides sp. B12A, known only from within northern East 4 pit, was recorded from hole EW0507 (MMIF) that is outside the proposed pit boundaries when considering the 150m disturbance buffer of the pits. A further indeterminate troglofauna taxon (*Macranillus* sp. indet.) was detected just outside the western boundary of the northern East 4 pit, in MMIF (Newman Member) or tertiary detrital geologies. There were no available diamond cores or drill logs in the area to further investigate habitat suitability, but both of these strata have been shown to form highly suitable habitats for troglofauna elsewhere within the MDE.

Based on the wider mapped extent of the MMIF and detritals to the north along Cross Section 6, the proposed extent of the East 4 Pit is not considered to impact a large proportion of the available habitat for troglofauna in this area.

Figure 38: Cross Section 6: East 4 Pit



Flying Fish West

Flying Fish West pit is developed within the MMIF, with the main target for mining being the upper Newman Member and mineralised zones within the Tertiary detritals (Figure 39). Cross Section 7 (Figure 39) showed a reasonable amount of the Newman Member and detritals outside of the pit to the south, and larger area of the Macleod and Nammuldi Members outside pit to the north that could potentially provide habitat for troglofauna, where sufficiently weathered and fractured.

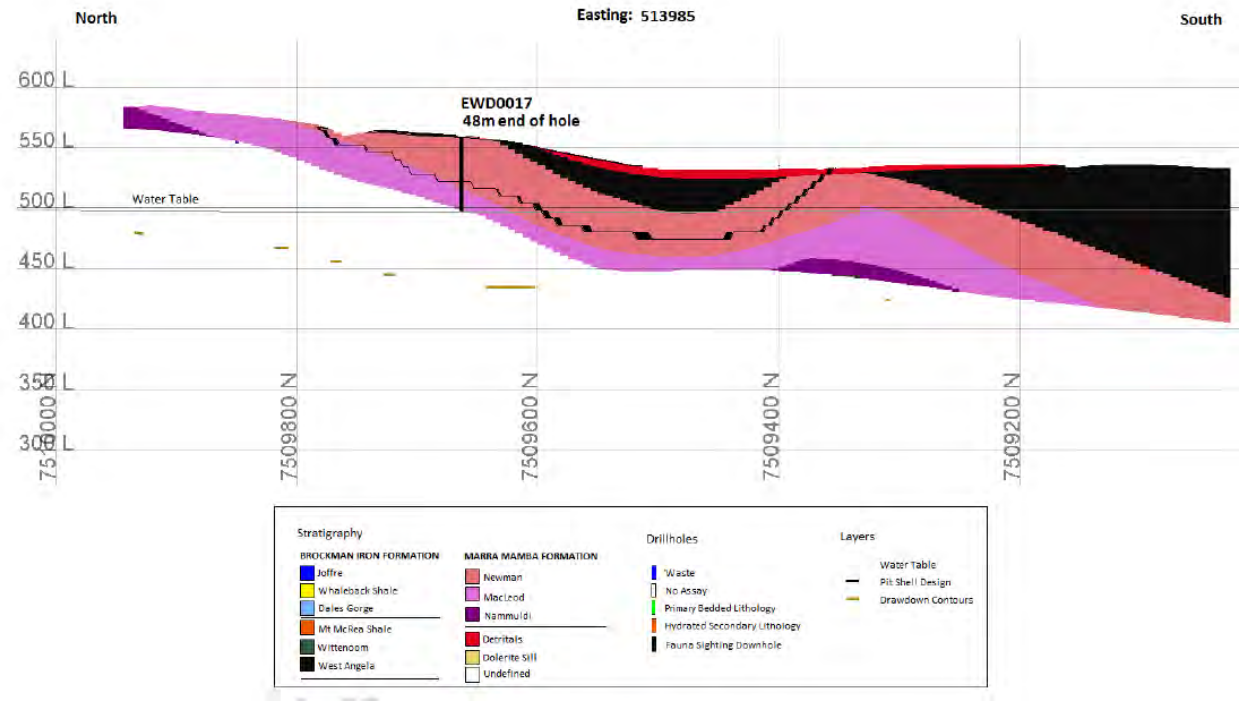
Sampling at hole EWD0017 (within the Newman and Macleod Members of the MMIF) recorded one potentially restricted troglofauna taxon, *Anapistula* sp. 'EW', as well as two other taxa *Macranillus* sp. ‘H-CCA021’ and *Paradraculoides* sp. ‘B12’ that are known to occur more widely outside mining impacts.



Plate 15: Diamond core from hole EWD0017 showing vugs from secondary weathering (highly suitable habitat)

Diamond drill core from EWD0017 (Plate 17) revealed a high degree of vugginess from secondary weathering of the MMIF throughout the profile, indicative of highly suitable troglofauna habitat. Based on the wider extent of highly suitable MMIF habitats along strike east and west of the Flying Fish West pit (Figure 39), and the likelihood of some remnant habitat to the south or north of pit as indicated by Cross Section 7, it is considered highly likely that suitable habitat for troglofauna species found at Flying Fish West extends locally beyond the impact areas.

Figure 39: Cross Section 7: Flying Fish West



Flying Fish 2

The Flying Fish 2 pit is developed laterally along a roughly east-west strike, with the northern margins in MMIF and the southern margins in Tertiary Detritals (Figure 40 - Cross Section 8).

The main mining target for mining as the Newman Member and mineralised zones within the detritals. Owing to the relatively high water table through the Flying Fish area, and the occurrence of Mt McRae Shales in the profile above water table, the majority of troglofauna habitat is likely to be within the MMIF close to the surface, particularly to the north of these sections.

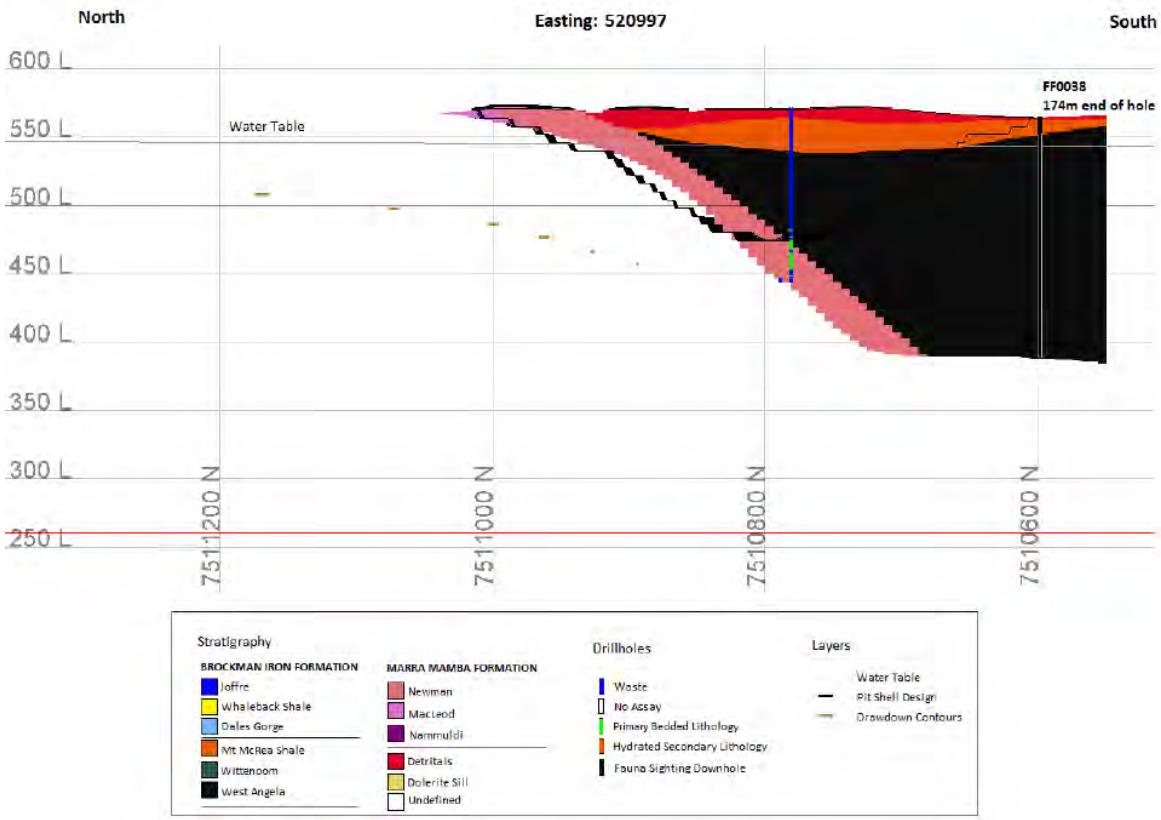
Two potentially restricted troglofauna taxa, Projapygidae sp. ‘B17’ and *Troglarmadillo* sp. ‘B46’, were recorded within pit at holes FF0038 (MMIF) and FF0245 (Wittenoom Formation) (Figure 39). Accounting for the conservative 150m disturbance buffer of the pits, both locations would be considered just outside, or very close to the proposed pit boundaries. *Projapygidae* sp. ‘B17’ was detected from the valley, where geological cross sections and drill logs showed only detritals above the water table, as well as Mt McRae Shales, which are generally regarded as low suitability for troglofauna. It is considered likely that this species could inhabit unconsolidated detrital formations throughout the Eliwana Valley to the south of Flying Fish Pit.



Plate 16: Diamond core from hole EWD0016 showing vugs from secondary weathering (potential habitat)

Diamond drill core from hole EWD0016 (Plate 18), (located immediately west of FF0245 where *Troglarmadillo* sp. 'B46' was collected within MMIF), showed considerable weathering and fracturing of the upper Newman Member and vugginess throughout the profile. Further evidence for suitable habitat was indicated by 'hydrated secondary lithology' zones in drill logs shown on Cross Section 8. As shown in most other MMIF pits within the MDE, the Newman Member is regarded as highly suitable troglofauna habitat where occurring above water table. Figure 40 shows the continued extension of the MMIF east and west along the strike beyond the Flying Fish 2 Pit, and to the north (although areas to the north may comprise a greater proportion of the less weathered Macleod and Nammuldi Members) suggesting that suitable habitat for troglofauna is likely to exist beyond the pit areas.

Figure 40: Cross Section 8: Flying Fish 2



Other Locations of Troglofauna

A dipluran species, Projapygidae sp. ‘B14’ was detected north of the Eliwana Valley within an area proposed for the Tailings Storage Facility (TSF). Regional geological information suggests that potential habitats for the species could occur in unconsolidated detritals or nearby Robe Pisolite, which extends to the north and east of the proposed TSF. Owing to the species record at the edge of the proposed TSF and the wider extent of potential troglofauna habitats beyond the TSF area (based on the limited information currently available), it is possible that this species could occur more widely beyond the TSF than currently recorded.

Troglofauna Species Significance

A total of 16 troglofauna taxa recorded during current and previous surveys of the MDE are known only from within proposed pit boundaries (and the TSF as stated above), comprising:

- five arachnids: Palpigradi sp., *Paradraculoides* sp. B12A, *Paradraculoides* sp. new2, *Anapistula* sp. 'EW', and *Prethopalpus* sp. MW21;
- an isopod: *Troglarmadillo* sp. B46;

- four pauropods: *Pauropodidae* sp. B29, *Pauropodidae* sp. B41, *Pauropodidae* sp. B42, and *Pauropodidae* sp. B43;
- a symphylan: *Symphyella* sp. 'EW';
- three diplurans: *Campodeidae* sp. 'EW', *Projapygidae* sp. B14, and *Projapygidae* sp. B17; and
- two insects: *Lepidospera* sp. B10 and *Macranillus* sp. 'EW'.

The recorded occurrence of these taxa is at least partly attributed to sampling artefacts such as the higher numbers of available drill holes within pit boundaries, and the low capture rates typically associated with troglofauna sampling.

Based on current taxonomic and ecological information, and the likely extent of suitable habitats for troglofauna beyond pit boundaries (buffered by 150m disturbance zone), the risks to these taxa are presented in Table 46.

A total of eleven of the 16 troglofauna taxa assessed were considered to be of 'low' risk. Taxa regarded as 'low' (or likely low) risk include *Paradraculoides* sp. B12A, *Prethopalpus* sp. MW21, *Troglarmadillo* sp. B46, Pauropodidae sp. B42, and Pauropodidae sp. B43, *Symphyella* sp. 'EW' and Campodeidae sp. 'EW', Projapygidae sp. B14, Projapygidae sp. B17, *Lepidospera* sp. B10, and *Macranillus* sp. 'EW'. A further two taxa were regarded as 'low – moderate' risk (Pauropodidae sp. B29, Pauropodidae sp. B41). and). The remaining three taxa were considered to be of 'moderate' risk (Palpigradi sp., *Paradraculoides* sp. new2 and *Anapistula* sp. 'EW').

Table 46: Troglofauna species risk assessment

Potentially Restricted Species	Taxon Comments	Habitat Comments	Risk Assessment
Palpigradi			
Palpigradi sp.	Singleton known only within pit (Talisman) – genus is known to have widespread and restricted species in the region.	Recorded from tertiary colluvium (valley fill) / CID - habitat likely extends beyond pit within valley.	Likely moderate risk, may be improved with further analysis Potential to further resolve through genetic analysis
Schizomida			
Paradraculoides sp. B12A.	Singleton known from within pit (East 4). Species within same genus (Paradraculoides sp. B12) have shown linear ranges of 9km within MDE	Recorded from MMIF - habitat appears to extend east-west (and north) along strike beyond pit boundaries. Hole located just outside proposed pit boundaries.	Low risk
Paradraculoides sp. new2	Singleton known from within pit (Broadway). Species within same genus (Paradraculoides	Recorded from BrIF – habitat appears to extend south and west of the Broadway south pit.	Moderate risk

Potentially Restricted Species	Taxon Comments	Habitat Comments	Risk Assessment
	sp. B12) have shown linear ranges of 9km within MDE.		
Araneae			
Anapistula sp. 'EW'	2 records known from a single site inside pit (Flying Fish West).	Recorded from MMIF - habitat appears to extend east-west along strike beyond pit boundaries.	Moderate risk
Prethopalpus sp. MW21	Singleton known from within pit (Broadway).	Recorded from MMIF - habitat appears to extend beyond pit along strike to north and west. Hole located just outside proposed pit boundaries.	Low risk
Isopoda			
Troglarmadillo sp. B46	9 specimens known from a single site in pit Flying Fish.	Recorded in MMIF – habitat appears to extend along strike north and west outside pit. Hole located just outside proposed pit boundaries.	Low risk
Pauropoda			
Pauropodidae sp. B29	Singleton known within pit (Talisman). May have a variety of different ranges – (e.g. Pauropoda sp. B33 from MDE - 37 km linear range).	Recorded from detritals or deeper MMIF –habitat appears to extend beyond pit boundaries to the east, west and south along the Eliwana valley.	Low - Moderate risk
Pauropodidae sp. B41	Singleton known within pit (West End) - May have a variety of different ranges – (e.g. Pauropoda sp. B33 from MDE - 37 km linear range).	Recorded from BrIF - habitat appears to extend along the strike west and east beyond pit boundaries.	Low - Moderate risk
Pauropodidae sp. B42	2 records known from a single site within pit (Broadway) - May have a variety of different ranges – (e.g. Pauropoda sp. B33 from MDE - 37 km linear range).	Recorded from MMIF - habitat extends beyond pit along strike to north and west. Hole located just outside proposed pit boundaries.	Low risk
Pauropodidae sp. B43	Singleton known within pit (Broadway) - May have a variety of different ranges – (e.g. Pauropoda sp. B33 from MDE - 37 km linear range).	Recorded from MMIF - habitat extends beyond pit along strike to north and west. Hole located just outside proposed pit boundaries.	Low risk
Symphyla			

Potentially Restricted Species	Taxon Comments	Habitat Comments	Risk Assessment
Symphyella sp. 'EW'	3 specimens recorded from a single site in pit (Broadway).	Recorded from MMIF - habitat appears to extend beyond pit along strike to north and west. Hole located just outside proposed pit boundaries.	Low risk
Diplura			
Campodeidae sp. 'EW'	Singleton known within pit impacts (Broadway).	Recorded from MMIF - habitat appears to extend beyond pit along strike to north and west. Hole located just outside proposed pit boundaries.	Low risk
Projapygidae sp. B14	Singleton known within a secondary impact area - TSF.	Recorded in Jeerinah formation bordering Robe Pisolite - geologies extending beyond (and potentially below) impact area	Low risk
Projapygidae sp. B17	Singleton known within pit (Flying Fish).	Recorded from detritals – habitat appears to extend south and east beyond pit boundaries. Hole located on margin of pit boundary.	Low risk
Thysanura			
Lepidospera sp. B10	Singleton known within pit impacts.	Recorded from detritals or deeper MMIF – habitat appears to extend beyond pit boundaries to the east, west and potentially south.	Low risk
Coleoptera			
Macranillus sp. 'EW'	Singleton known within pit (East 3).	Recorded from BIF, close pit boundary - habitat appears to extend beyond pit	Low risk

4.8.5.2 Biological Surrogates - Troglofauna

To further support statements in Section 4.8.5 regarding habitat connectivity a figure showing troglofauna found to be abundant across the MDE is provided in Figure 47.

One troglofauna species, Pauropodidae sp. B33 was recorded from two sites across the study area, has a 37km linear range and is considered a suitable biological surrogate for the remaining four potentially restricted Pauropods found to occur within the MDE. This particular species, Pauropodidae sp. B33 was recorded from both MMIF and BrIF which is recognised as highly suitable habitat with extensive vugs, cavities or fractures extending beyond the MDE. This

troglofauna taxa has recently been recognised as having a 6.6km median linear range (Halse, 2018 *in press*).

This reported linear range for Pauropods combined with the highly connective habitat would enable all four potentially restricted species i.e. Pauropodidae sp. B29 Pauropodidae sp. B41, Pauropodidae sp. B42 Pauropodidae sp. B43 to occur outside impact areas and therefore not be impacted by the proposal.

4.8.5.3 Stygofauna

Stygofauna are aquatic animals that live in groundwater and do not occur on the surface. Mining activities may potentially threaten stygofauna species with small ranges if mining occurs below the groundwater table. This could be through both physical excavation and more widely through the groundwater dewatering required for dry-floor mining. In addition, when significant groundwater abstraction is required for mineral processing, there may be impacts on stygofauna because of habitat loss in the water production borefields. Rich stygofauna communities are known from the Pilbara region of Western Australia (Halse *et al*. 2014).

Survey of stygofauna in the Pilbara began in the 1990s (Humphreys, W.F., 1999), with a rapid increase in knowledge over the last decade as a result of the systematic stygofauna sampling during the Pilbara Biodiversity Survey (Eberhard *et al*. 2005, 2009). It has been estimated that the Pilbara has between 500 and 550 stygofauna species, with the density of species being relatively uniform across the region (Eberhard *et al*. 2009). Alluvium and calcrete are usually considered to be the most productive habitats for stygofauna, although mafic volcanics may support rich populations and stygofauna occur in moderate abundance in banded iron formations (Halse *et al*. 2013).

The groundwater system of the MDE is complex, and appears to be compartmentalised into several discrete groundwater sub-catchments. Groundwater levels throughout the MDE is highly variable, depending on the associated aquifer compartment. The groundwater sub-catchments have been named for their respective groundwater levels and are shown in Figure 41.

A summary of local aquifers and aquitards/ aquicludes and the prospective for stygofauna appears below.

Tertiary Detrital Aquifer

Tertiary detrital deposits occur within the valleys of the MDE, particularly between the Marra Mamba and Brockman Iron Formation deposits. However, much of this material is unsaturated, forming a shallow, unconfined aquifer only where groundwater levels lie within the unit (Golder Associates, 2017a). Note, Tertiary clays in the valley may act as a local aquiclude (potential barriers to stygofauna movement). Channel Iron Deposits (CID) and calcrete deposits of

unknown and limited extent occur in the Flying Fish area. These superficial deposits are expected to be highly suitable for stygofauna where saturated, sufficiently porous and transmissive.

Mineralised Brockman Aquifer

The mineralised Brockman Iron Formation is considered to form an aquifer, and can be referred to as the “Mineralised Brockman Aquifer”. The hypergene enrichment that causes bedded mineralisation in the Hamersley Basin involves groundwater replacement of silicate and carbonate minerals with goethite, which results in stratigraphic thinning and associated increases in porosity and permeability. The Whaleback Shale Member is assumed to be part of the aquifer where it is weathered/mineralised and is expected to be moderately to highly suitable for stygofauna where sufficiently porous, vuggy or fractured.

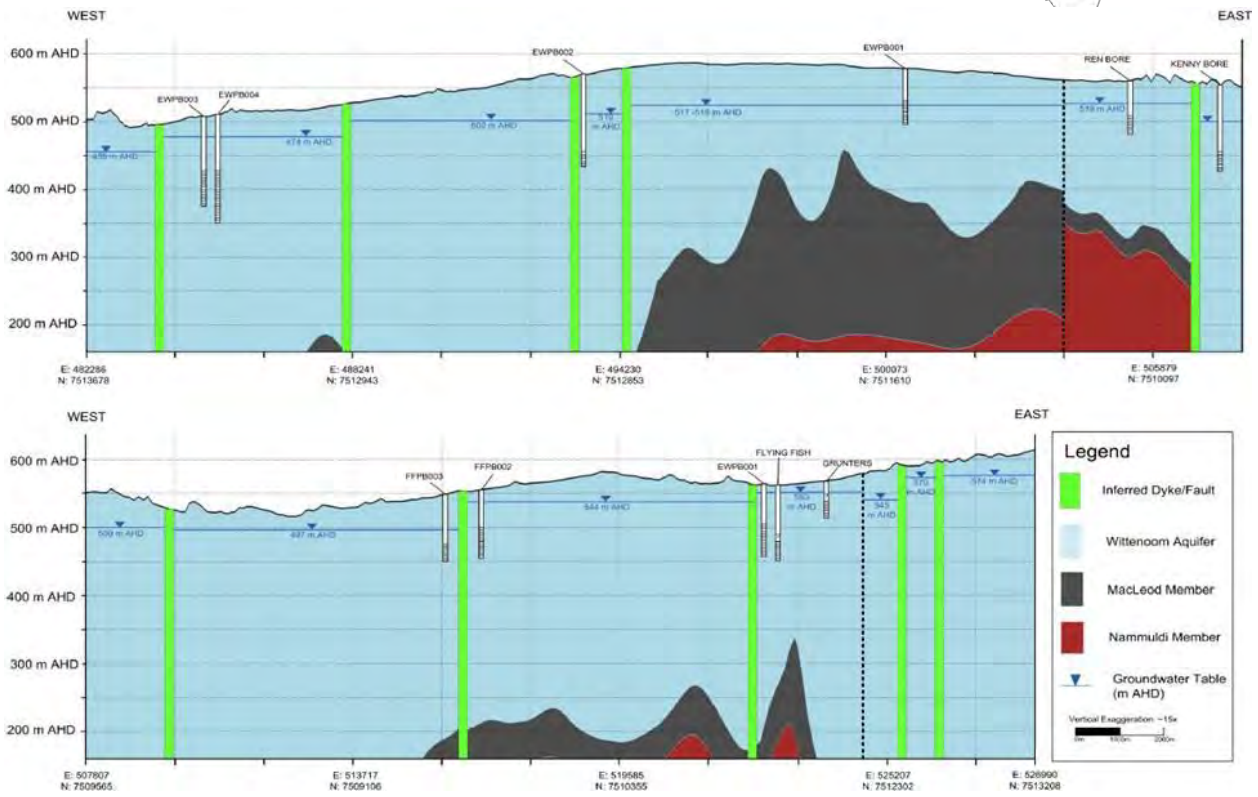
Wittenoom Aquifer

The Wittenoom Aquifer comprises all weathered Members of the Wittenoom Formation. The West Angela Member comprises shale dolomite and interbedded banded iron formation. Where weathered or karstic, the dolomitic Paraburdoo Member is known to form highly porous/ transmissive aquifers that provide suitable habitat for stygofauna, although the degree of weathering/ karstification of these units within the MDE is not fully known.

Mineralised Marra Mamba Aquifer

The mineralised upper Newman Member of the Marra Mamba Iron Formation is considered to form an aquifer and is in connection with the overlying Wittenoom Aquifer. The mineralised upper Newman Member of the Marra Mamba Iron Formation is considered to form an aquifer and is in connection with the overlying Wittenoom Aquifer. The upper Mount Newman Member is sometimes separated from the lower Mount Newman Member by an impermeable shale band which would be expected to form an aquitard/ aquiclude. Aquitards are not considered to provide suitable habitat for stygofauna, although within units considered to be largely aquitard (e.g. unmineralized Brockman Iron Formation), there may still be some potential for stygofauna to exist with smaller patches of more suitable (aquifer) habitat within fractures and fault zones.

Figure 41: Conceptual illustration of groundwater sub-catchments



Stygofauna Habitat

As was the case with troglofauna, the stygofauna habitat assessment for potentially restricted species within the MDE is based upon available geological and hydrogeological reports, drill logs, diamond drill cores, surface geology maps and available geological cross sections at each of the deposits. Four of the eight geological cross sections used for the troglofauna fauna habitat assessment correspond to sampling locations of potentially restricted stygofauna taxa. An additional four geological cross sections were used exclusively for the stygofauna habitat assessment. These eight cross-sections are listed below in Table 47 and their locations are shown in Figure 32. Locations of species listed in Table 47 are shown in Figure 42.

Table 47: Location and details of geological/hydrogeological cross sections used in habitat assessment

Cross Section number	Location	Distance S-N (meters)	Bore/hole on section	Stygofauna species
XS1	Broadway 1	1400	EW1061	*Brevisomabathynella* sp. B
XS4	Talisman	1120	TM0015	Paramelitidae B58, *Brevisomabathynella sp.* A, *Brevisomabathynella* sp. B
XS5	East 3	2410	EW0372	Paramelitidae B58, *Brevisomabathynella* sp. A
XS9	Eagles Nest	1300	EW0352	Paramelitidae B58, *Brevisomabathynella* sp. A
XS10	Flying Fish 1	650	FF0444	*Brevisomabathynella* B03
XS11	Flying Fish East	1100	FF0360	*Areacandona* nr. *triangulum*, *Areacandona* BOS1020
XS12	Outside impact NE of Flying Fish	960	EWD0017	*Areacandona* nr. *triangulum*, *Bogidiella* B05

477,500 480,000 482,500 485,000 487,500

7,515,000 7,512,500 7,510,000

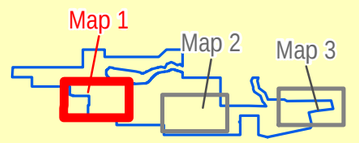
EWPB006 EWPB006 Pinarra Creek EWMB009 EW1437 EW1437

20 40 60 80 100 120 140 160

Interpreted Geology

- Dolerite dykes
- Turee Creek Group
- Boolgeeda Iron Formation
- Woongarra Rhyolite
- Dolerite sills
- Weeli Wolli Formation
- Brockman Iron Formation
- Mt McRae Shale
- Mt Sylvia Formation
- Wittenoom Iron Formation
- Marra Mamba Formation
- Jeerinah Formation

INDEX MAP



Stygofauna

- Mine Development Envelope
- Major Drainage
- Drawdown Contours
- Fault/Dyke

- Brevisomabathynella sp. A
- Brevisomabathynella sp. B
- Brevisomabathynella sp. B03
- Paramelitidae sp. B58
- Parastenocaris sp.

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 500 1,000 1,500
Metres

Requested By: R. Sharp
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.013a_r2

Date: 21-Aug-18
Size: A3L
Revision: 0
Confidentiality: 1

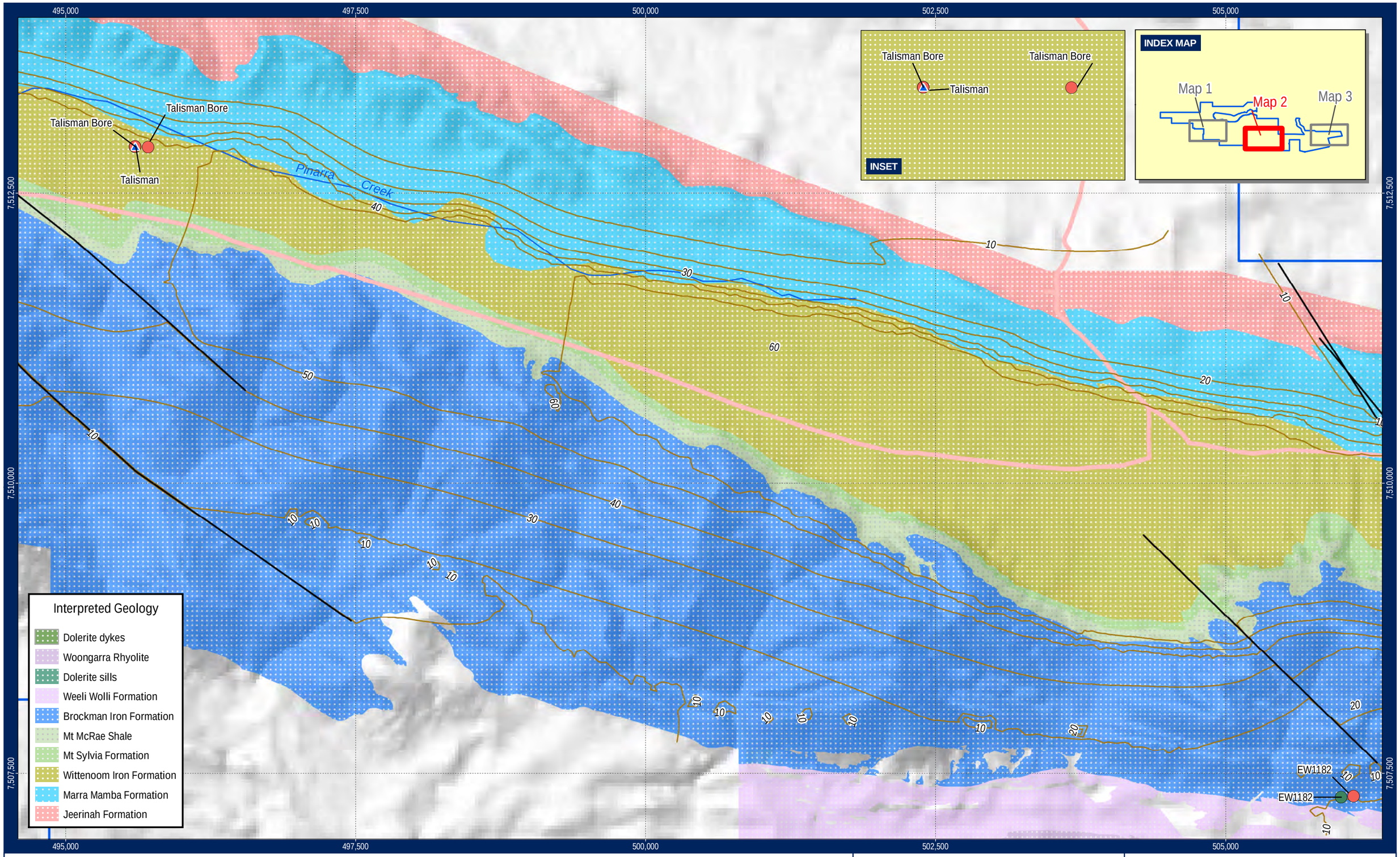
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Figure 42

Stygofauna - Potentially Restricted Species

(Sheet 1 of 3)

Fortescue Metals Group Ltd
The New Force in Iron Ore



Mine Development Envelope
Major Drainage
Drawdown Contours
Fault/Dyke

Stygofauna

- Brevisomabathynella sp. A
- Brevisomabathynella sp. C
- Paramelitidae sp. B58

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 500 1,000 1,500
Metres

Requested By: R. Sharp
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Revised By: scostello
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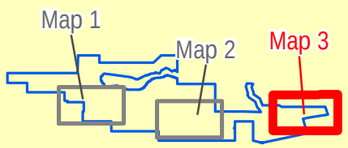
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Size: A3L
Revision: 0
Confidentiality: 1

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Figure 42
Stygofauna - Potentially Restricted Species
(Sheet 2 of 3)

Fortescue Metals Group Ltd
The New Force in Iron Ore

INDEX MAP



Interpreted Geology

- Dolerite dykes
- Woongarra Rhyolite
- Dolerite sills
- Weeli Wolli Formation
- Brockman Iron Formation
- Mt McRae Shale
- Mt Sylvia Formation
- Wittenoom Iron Formation
- Marra Mamba Formation
- Jeerinah Formation

517,500 520,000 522,500 525,000

7,515,000 7,512,500 7,510,000

FF0408 FF0023 FF0020 Grunters bore FF0360 FFUNK02 FF0444 FF0444

10 20 30 40 60 80 230

Mine Development Envelope
Access Routes
Rio Tinto Rail
Drawdown Contours
Fault/Dyke

Stygofauna

- Areacandona nr triangulum
- Areacandona sp. BOS1020
- Bogidiella sp. B05
- Brevisomabathynella sp. B03

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 500 1,000 1,500
Metres

Requested By: R. Sharp
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.013c_r2

Date: 21-Aug-18
Size: A3L
Revision: 0
Confidentiality: 1

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Figure 42
Stygofauna - Potentially Restricted Species
(Sheet 3 of 3)

Fortescue Metals Group Ltd
The New Force in Iron Ore

Broadway 1

Sampling within the vicinity of Cross Section 1 and 2 in the western part of the Broadway pits did not detect any potentially restricted stygofauna species, although *Brevisomabathynella* sp. 'B' and *Parastenocaris* sp. were detected from the eastern end of Broadway in a similar hydrogeological setting. Based on general hydrogeological information it can be assumed that there may be suitable habitats for stygofauna within the Newman Member of the MMIF, the Wittenoom Dolomite (and possibly within the West Angela Member, if sufficiently weathered), and the Dales Gorge Member of the BrIF. These layers are predicted to be subject to approximately 15-20m of groundwater drawdown based on current modelling. Current hydrogeological information suggests that there may be a range of potentially habitable strata below the predicted drawdown. The hydro bore log for EWPB006, where *Brevisomabathynella* sp. 'B' and *Parastenocaris* sp. were detected (Biologic, 2017), shows potential habitat within weathered and fractured dolomite (Paraburdoo Member) from the water table (approx. 25m BGL) to the end of hole at approx. 80m BGL (with aquifer yields between 10-20L/sec). Given the predicted 20m maximum drawdown in this area (Figure 42), it is reasonable to expect that some deeper habitats for stygofauna may occur within the hydrogeological compartment surrounding the Broadway pits.

Talisman

Wittenoom Dolomite (and West Angela shales), and the Newman Member of the MMIF extending well below the water table in the Talisman area. Based on the high likelihood of secondary weathering in the dolomite and Newman member, and the potential for some weathering within the West Angela, these units are regarded as forming the most likely habitats for stygofauna in this area.

Groundwater drawdown in the hydrogeological compartment surrounding Talisman Pit is predicted to be approximately 30m (maximum) (see Figure 42), and owing to the depth of Wittenoom dolomite, the West Angela, and Newman Members in the valley to the south, it is considered likely that there may be deeper potential habitats within these layers that are unaffected by drawdown. Hydrological bores in the southern part of Talisman Pit (EWPB004) and the valley further south (EWPB003) revealed significant depths of weathered dolomite in the Bee Gorge and Paraburdoo Members (to approximately 120m BGL) (Biologic, 2017). The aquifer yield from these deep weathered dolomite formations was approximately 30L/s (Golder Associates, 2017c), indicating a reasonably porous aquifer despite considerable depth below surface. The quality of stygofauna habitat within these deeper aquifers may also be influenced by water physicochemistry such as dissolved oxygen which was recorded at hole EW1437 (see Figure 42) approximately 20% saturation dissolved oxygen from near the surface of the groundwater. In summary, the general hydrogeological characteristics of the Wittenoom aquifers at depths well below the predicted drawdown in the Talisman area are indicative of suitable habitat for stygofauna.

Despite the occurrence of an inferred hydrological barrier (dyke) to the immediate west of Talisman Pit, Paramelitidae sp. 'B58' was detected to the south east at hole EW1437, and also west of the inferred dyke at bore EWMB009 (see Figure 42) (Golder Associates, 2017a). This species was also found to occur further east again in a different hydrogeological compartment at Talisman Bore (east of Eagles Nest Pit), indicating that its potential distribution may be wider than currently recorded within the MDE.

In contrast, two distinct species of *Brevisomabathynella* (*B*. sp. 'A' and *B*. sp. 'B') were detected either side of the inferred hydrogeological barrier to the immediate west of Talisman Pit. These species were morphologically conservative, but DNA sequencing (Biologic 2017) revealed genetic divergences of 3.4-3.9% COI, indicative of either a strong population-level divergence, or a species-level difference. As a precaution, these taxa are conservatively considered different species, and as such *B*. sp. 'B' is inferred to be restricted to the hydrogeological compartment surrounding Broadway, while *B*. sp. 'A' is known from two hydrogeological compartments; surrounding Talisman Pit and further to the east surrounding East 3 and East 4 pits.

The current hydrogeological data suggests a reasonable likelihood that suitable habitat for these species occurs below the predicted groundwater drawdown (maximum 30m surrounding Talisman Pit and 20m surrounding Broadway Pit) within the deeper MMIF and Wittenoom dolomite aquifers.

Eagles Nest

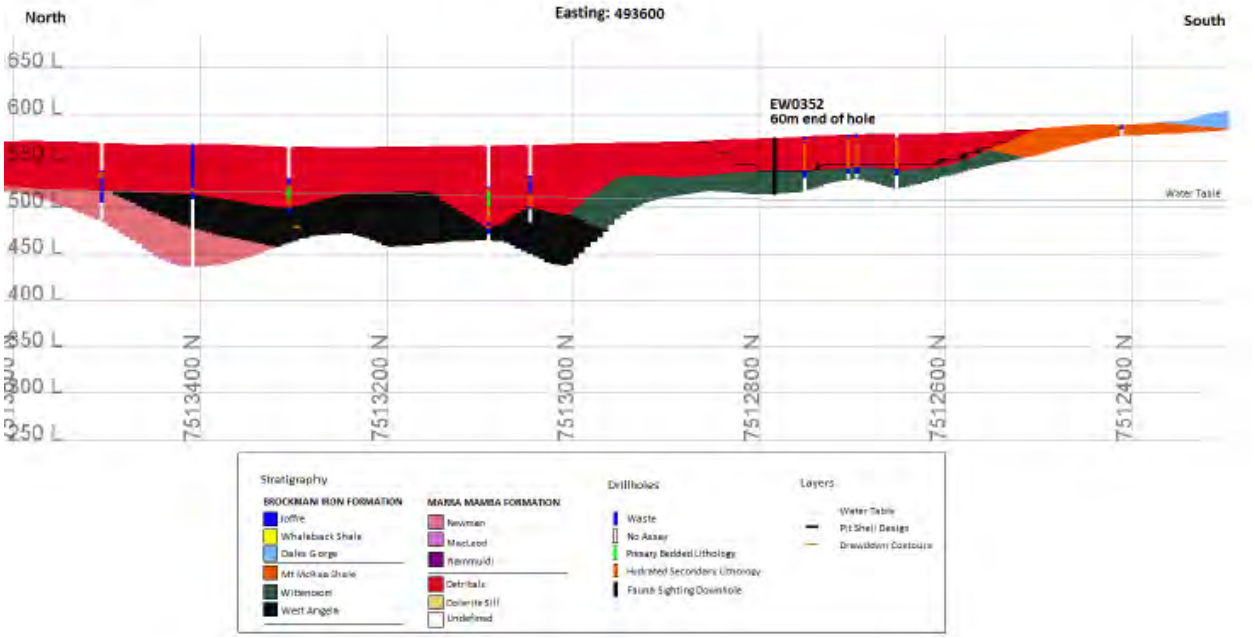
The cross section of Eagles Nest Pit (Figure 43) shows thick detritals above West Angela shales in the valley, and above the Wittenoom Dolomite to the south. The groundwater appears to be well below the pit floor of Eagles Nest Pit and is concentrated around two distinct 'dips' in the palaeochannel floor in the middle of the valley, respectively formed in West Angela shales, the Newman Member of the MMIF and Tertiary detritals. Assuming that the West Angela shales may be sufficiently weathered, these areas where the palaeochannel dips deeper beneath the water table would be expected to form a prospective habitat for stygofauna. Hydrological bore logs for EWPB001 immediately west of Eagles Nest pit indicated mainly fresh dolomite beneath the water table (Biologic, 2017).

No potentially restricted stygofauna taxa were detected from the immediate vicinity of Cross Section 5, but Paramelitidae sp. 'B58' and *Brevisomabathynella* sp. 'A' were detected at Talisman bore, in similar habitats between Cross Section 5 (East Pit 3) and Cross Section 9 (Eagles Nest). Based on extrapolation of habitats between these two sections, it is considered likely that these two species may inhabit the MMIF, Wittenoom Dolomite, West Angela shales or Tertiary detritals in the centre of the palaeochannel where these units dip beneath the water table.

This area is predicted to experience approximately 40-50m of groundwater drawdown during mining, which would be expected to deplete most of the potential stygofauna habitat shown on

Cross Section 5. Some deeper habitat may remain to the north within the Newman Member and the West Angela Shales (assuming sufficient weathering). Deeper palaeochannel habitats off Cross Section 5 further to the east of Talisman bore may also be less affected by drawdown and therefore represent suitable stygofauna habitat.

Figure 43: Cross Section 9: Eagles Nest



East 3

Cross Section 5 shows potential stygofauna habitats largely confined to a ‘dip’ in the centre of the palaeochannel to the north of East 3 Pit, where the MMIF, Wittenoom Dolomite, and Tertiary detritals occur beneath the water table. The other potentially habitable strata shown along section are all largely above water table and not expected to provide potential stygofauna habitat. Hydro bore EWPB002 (further to the east of Cross Section 4 but inferred to be in the same central palaeochannel area) showed highly weathered shales in the Bee Gorge Member, and weathered dolomite in the Paraburdoo Member at depth (110-120m BGL) (Biologic 2017). These layers yielded approximately 15-20L/sec, which would suggest moderate potential for stygofauna habitat, although there were thick overlying clay layers in the Bee Gorge Member (fully weathered shales) with much lower permeability.

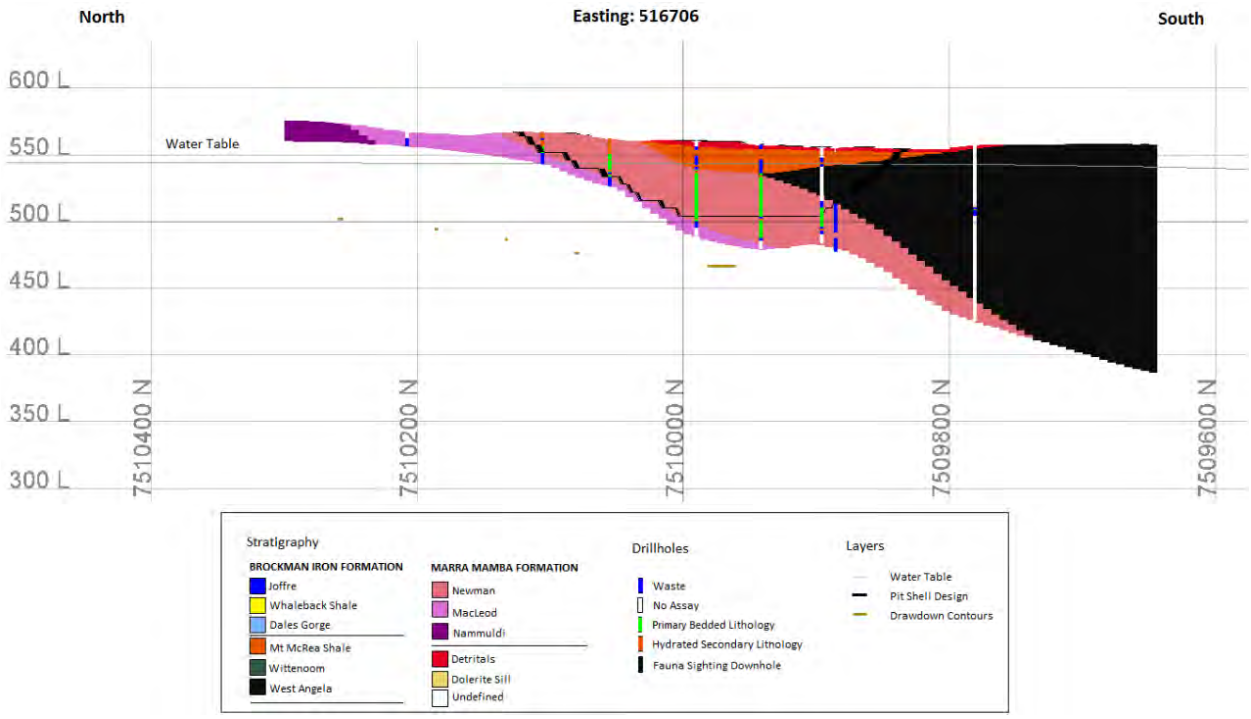
As previously mentioned, Paramelitidae sp. ‘B58’ and *Brevisomabathynella* sp. ‘A’ were detected at Talisman bore between cross section 5 and 9. Based on extrapolation, it is likely that these species inhabit the MMIF, Wittenoom Dolomite, or Tertiary detritals in the centre of the palaeochannel where these units dip beneath the water table. This habitat is predicted to experience approximately 50-55m of groundwater drawdown, which may leave some deeper habitats beneath the predicted drawdown as shown on Cross Section 4. Both of these stygofauna

species are also known to occur further to the west near the Talisman Pit which is expected to experience less groundwater drawdown.

Flying Fish 1

Groundwater levels are higher in the Flying Fish area than most other parts of the MDE, with depth to water at drill hole FF0444 (Figure 42 Map 3) (along cross section 10, where *Brevisomabathynella* sp. 'B03' was detected) observed at 16m during the Western Hub survey (Bennelongia 2015). This depth approximates the contact point between the Newman Member, the Mt McRae Shale, and the water table in the centre of cross section 10 (Figure 44). No genetic sequence information was available at the time of writing to enable DNA comparisons of *Brevisomabathynella* sp. 'B03' with the other *Brevisomabathynella* species; however, owing to the occurrence of one of the other species *B.* sp. 'A' over two different hydrogeological compartments (i.e. surrounding Talisman Pit and surrounding East 3 and East 4 pits), there is potential for *B.* sp. 'B03' to align genetically to one of the other known *Brevisomabathynella* species.

Figure 44: Cross Section 10: Flying Fish 1



The bore log for FFPB002, located to the immediate south west of hole FF0444 within the Flying Fish Pit, revealed a range of potential habitats beneath water table, including fractured cemented detritals (CID), weathered and fractured Bee Gorge and Paraburdoo Dolomite (including large fractures indicative of a potential fault zone) to approximately 100 m BGL, lying atop weathered West Angela shales (Biologic, 2017). Hydraulic yields from these habitats were in the range of

15-35 L/ sec, indicating highly porous/ transmissive aquifers that would be expected to provide suitable habitat for stygofauna, even at depth. Water physicochemistry data from near surface bailer samples in the Flying Fish deposit revealed dissolved oxygen levels ranging between 26-54% saturation, and although this does not provide an adequate indication of the oxygen levels lower in the profile, the readings were amongst the highest recorded within the MDE.

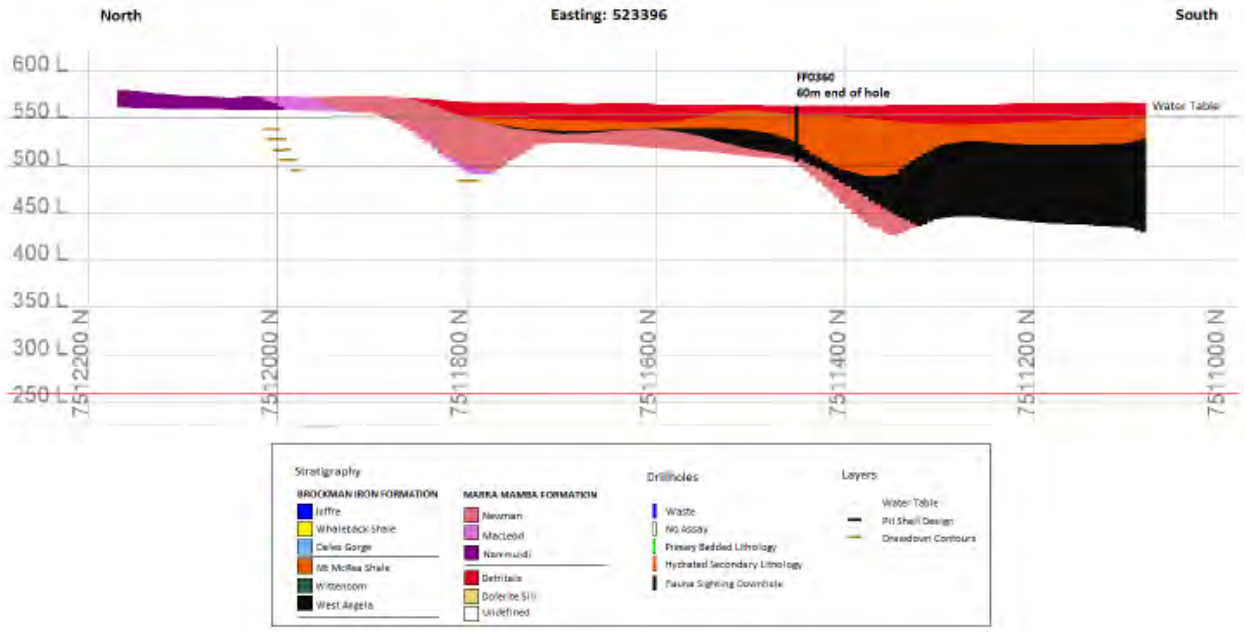
Owing to the depth of mining and porosity of the MMIF, groundwater drawdown is predicted to reach a maximum of 85m in the hydrogeological compartment surrounding Flying Fish Pit. Based on current information, it appears that a small proportion of potential habitat within the Newman Member and a greater proportion of the West Angela Member are likely to remain saturated beneath the predicted drawdown. The results from the bore logs in the area and aquifer yields at depths around 100 m BGL suggest that, notwithstanding potential differences in groundwater physicochemical characteristics at depth, it is reasonably likely that suitable habitats for stygofauna may occur below the predicted extent of drawdown in the Flying Fish area.

Flying Fish East

Extensive potential stygofauna habitats exist within the MMIF in the centre and north of the section, and potentially, within a thin layer of Tertiary Detritals below water table in the centre and south of the cross section, and/ or West Angela Shales if suitably weathered (Figure 45).

As previously mentioned, the Mt McRae Shales are generally regarded as having lower permeability and would not be expected to provide suitable habitat for stygofauna. Few drill cores were available in this immediate area but drilling logs for hydrological bores in the southern part of Flying Fish East Pit (bores FFPB001 and FFMB001) noted several potential groundwater habitats within fractured mudstone/ siltstone (5-25 m BWT), weathered dolomite (35-60m BWT), and high-yielding fractures within fresh dolomite at the bottom of the profile (70-90m BWT) (Biologic, 2017). Despite the relatively deep drawdown modelled within vicinity of Flying Fish East (approx. 65m), the hydrological bore logs and cross sections suggest that some deeper potential habitats may remain saturated below the predicted drawdown (Biologic, 2017).

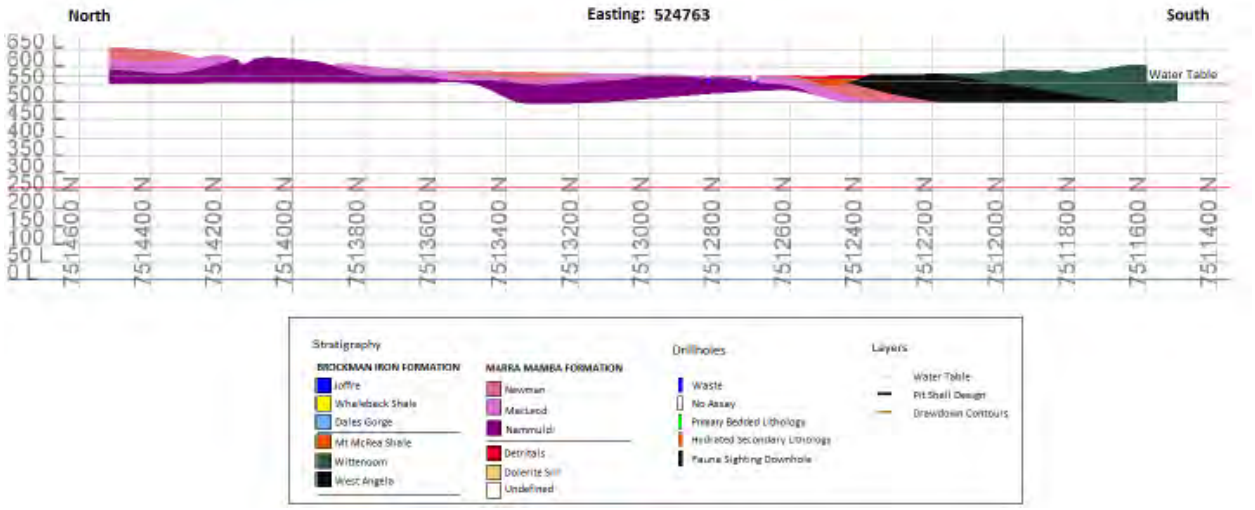
Figure 45: Cross Section 11: Flying Fish East



Outside Drawdown North East of Flying Fish

Sampling at three bores in the immediate vicinity of cross section 12 detected two ostracod species, *Areacandona* nr *triangulum* and *A*. sp. 'BOS1020' (see Figure 42). The former was also detected at sites further beyond the north east of Flying Fish East, in MMIF habitats beyond three inferred dykes (Figure 46). The occurrence of *Areacandona* nr *triangulum* across both these areas, despite the presence of inferred hydrogeological barriers, may indicate some potential for other similar species (such as *A*. sp. 'BOS1020') to also occur more widely. Nevertheless, current groundwater drawdown modelling regards these areas as hydrogeologically disconnected; therefore, while *Areacandona* nr *triangulum* and *Bogidiella* sp. 'B05' are considered to occur outside of drawdown impacts, *Areacandona* sp. 'BOS1020' is only known to occur within the extent of drawdown associated with Flying Fish East.

Figure 46: Cross Section 12: Outside Drawdown Area North-east of Flying Fish

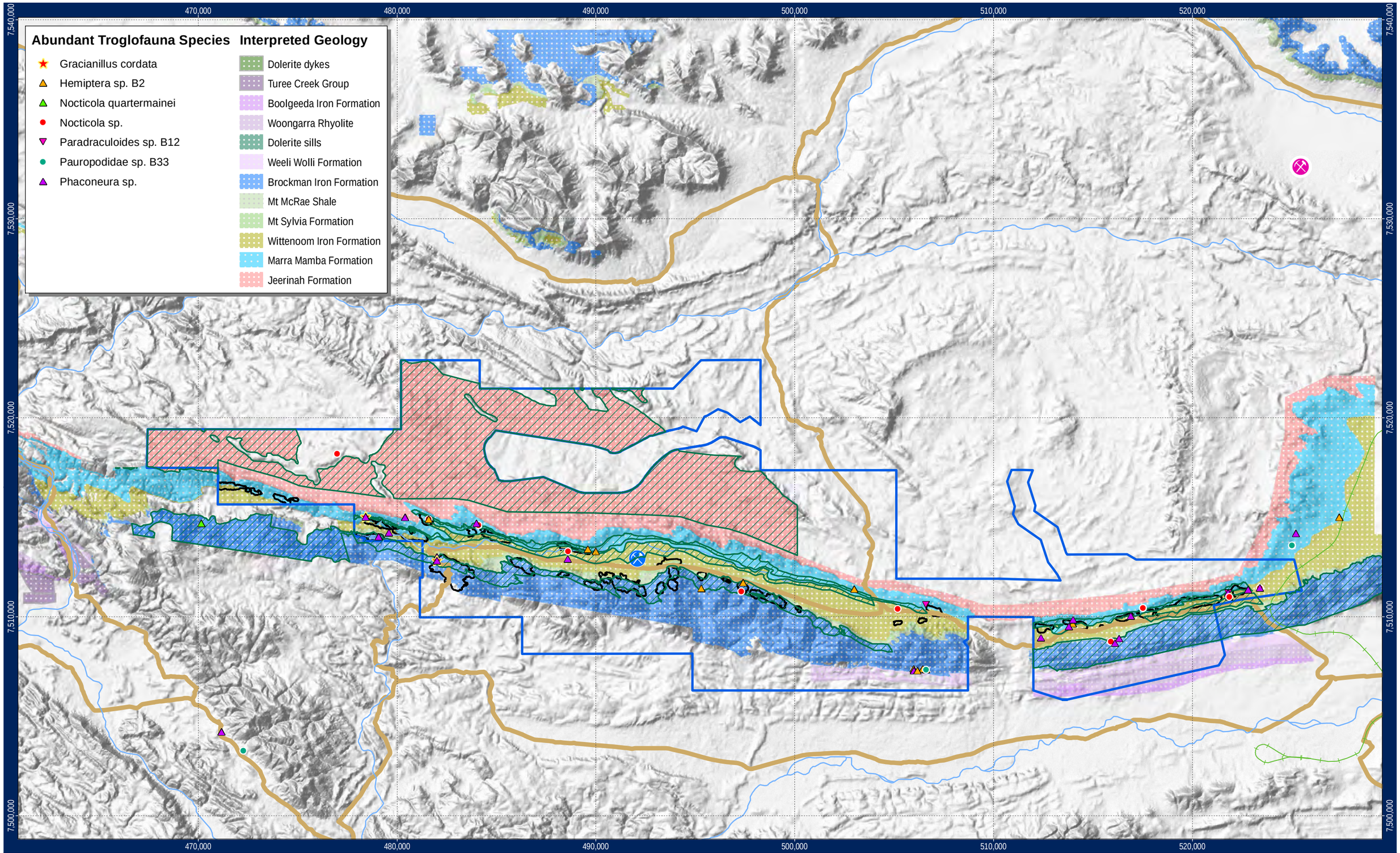


Stygofauna Species Significance

Current and previous surveys recorded nine (9) stygofauna taxa known only from the MDE. These comprised;

- two ostracods: *Areacandona* sp. BOS1020, and *Areacandona* nr *triangulum*;
- a copepod: *Parastenocaris* sp.;

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Fortescue Projects
Rio Tinto Mines
Mine Development Envelope
Suitable Habitat
Major Drainage
Rio Tinto Rail
Indicative Mine Footprint

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: A. Winzer
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.049_r1

Date: 21-Aug-18
Size: A3L
Revision: 2
Confidentiality: 1

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Figure 47
Abundant troglofauna species

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- four syncarids: *Brevisomabathynella* sp. B03, *Brevisomabathynella* sp. A and *Brevisomabathynella* sp. B and *Brevisomabathynella* sp. C;
- two amphipods: *Bogidiella* sp. B05 and Paramelitidae sp. B58.

Based on current taxonomic and ecological information, modelling of groundwater drawdown and likely extent of suitable habitats for stygofauna beyond these impacts, the risks to these taxa are presented in Table 48 which consider the current records of each of these taxa and the potential dykes/hydrological barriers (interpreted) relative to modelled groundwater drawdown (based on current and available hydrological information).

Three of the nine taxa were regarded as 'low' risk, comprising *Areacandona* nr *triangulum*, *Brevisomabathynella* sp. C and *Bogidiella* sp. B05. Three of the nine taxa, *Parastenocaris* sp., , *Brevisomabathynella* sp. B, and Paramelitidae sp. B58, were regarded as 'low to moderate' risk. One taxa was regarded as moderate risk, *Brevisomabathynella* sp. A. An additional two taxa *Brevisomabathynella* sp. B03 and *Areacandona* sp. BOS1020, were considered to be of 'high' risk to proposed mining impacts of the MDE. Locations of species are shown in Figure 42.

Table 48: Stygofauna species risk assessment

Potentially Restricted Species	Taxon Comments	Habitat Comments	Risk Assessment
Ostracoda			
Areacandona sp. BOS1020	Known from 2 sites outside pits (east of Flying Fish). Small species range (0.15 km linear range)	Within same hydrogeological compartment as eastern Flying Fish.	High risk
Areacandona nr *triangulum*	Known from 3 sites outside pit impacts NE of Flying Fish (4.6 km linear range)	Species occurs north east of Flying Fish beyond 3 dykes	Low risk based on current drawdown extent
Copepoda			
Parastenocaris sp.	Known from single site near Broadway pit. Poorly resolved taxon, may represent other known species such as *P.* sp. B26 (56 km linear range). Genus often represented by wide ranging species in the region.	Recorded from Broadway area (15-20m predicted drawdown) - Potential habitat (MMIF or Wittenoom Dolomite) likely to occur below predicted drawdown.	Low - Moderate risk
Syncarida			
Brevisomabathynella sp. B03	Known from a single site at Flying Fish pit.	Recorded from a single aquifer compartment. Potential habitat (MMIF or dolomite) – some habitat expected to exist below predicted drawdown	High risk

Potentially Restricted Species	Taxon Comments	Habitat Comments	Risk Assessment
		(~65m at Flying Fish) though habitat quality unsure at increasing depth.	
Brevisomabathynella sp. Sp. A	Known from 2 sites near Talisman and Eagles Nest (14 km linear range)	Species recorded close to pits	Moderate risk
Brevisomabathynella sp. B	Known from a single site south of Broadway pit.	Recorded from a single aquifer compartment. Potential habitat (MMIF, Wittenoom dolomite or West Angelas) likely to exist below predicted drawdown (15-20m) east of Broadway.	Low - Moderate risk
Brevisomabathynella sp. C	Known from a single site south of East 4 pit.	Record south of East 4 Pit in BrIF habitat likely to remain relatively unaffected by drawdown (5m). Sufficient habitat likely to occur more widely than predicted drawdown.	Low risk
Amphipoda			
Bogidiella sp. B05	Known from a single site NE of Flying Fish.	Species occurs north east of Flying Fish beyond 3 dykes	Low risk based on current drawdown
Paramelitidae sp. B58	Known from 3 sites outside pits near Talisman and Eagles Nest.	Species recorded close to pits- likely within GW drawdown.	Low - Moderate risk

4.8.5.4 Biological Surrogates – Stygofauna

To further support statements in Section 4.8.5 regarding habitat connectivity a figure showing stygofauna found to be abundant across the MDE is provided in Figure 48.

One stygofauna species, Paramelitidae sp. B36 was recorded from six sites across the study area, has a 54km linear range and is considered a suitable biological surrogate for the one potentially restricted Paramelitidae sp. B58 found to occur within the MDE. This particular species, Paramelitidae sp. B58 was found in three separate aquifer compartments (12 km linear range) across the MDE in highly connective MMIF habitat despite the inferred hydrogeological barriers.

These reported linear ranges for both stygofauna species listed above supports the notion that Paramelitidae sp. B58 will occur outside impact areas i.e. either outside the MDE or beyond the drawdown zone and will therefore not be impacted by the proposal.

470,000 480,000 490,000 500,000 510,000 520,000 530,000

7,540,000 7,530,000 7,520,000 7,510,000

Abundant Stygofauna Species

- Diacyclops humphreysi humphreysi
- Nedsia sp. B04 (hulberti gp 1 spine)
- Orbuscyclops westaustraliensis
- Paramelitidae sp. B36
- Paramelitidae sp. B58
- Phreodrilidae AP SVC spp.

Interpreted Geology

- Dolerite dykes
- Turee Creek Group
- Boolgeeda Iron Formation
- Woongarra Rhyolite
- Dolerite sills
- Weeli Wolli Formation
- Brockman Iron Formation
- Mt McRae Shale
- Mt Sylvia Formation
- Wittenoom Iron Formation
- Marra Mamba Formation
- Jeerinah Formation

- Fortescue Projects
- Rio Tinto Mines
- Mine Development Envelope
- Suitable Habitat
- Major Drainage
- Rio Tinto Rail
- Indicative Mine Footprint

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
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All other data, FMG, 2017.

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Figure 48
Abundant stygofauna species

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4.8.6 Potential Impacts

The EPA requires that an impact assessment of subterranean fauna is undertaken when assessing mine developments because subterranean fauna have limited ranges. Small ranges make subterranean species particularly vulnerable to extinction as a result of anthropogenic activities (EPA, 2013a; EPA, 2013b). The following aspects of the Proposal have the potential to have a direct impact on subterranean fauna:

- direct mortality and loss of habitat through mining activity;
- direct impact to subterranean fauna habitat, assemblage and individuals through groundwater abstraction and groundwater injection;
- indirect impacts from blasting; and
- Indirect impacts to stygofauna due to elevated concentrations of contaminants in water due to chemical or hydrocarbon spills, leaching from waste dumps or tailings storage facilities.

4.8.7 Assessment of Impacts

4.8.7.1 Direct mortality and loss of habitat through mining activity

Troglofauna

Impacts due to mining are determined partially by the distribution of species and their abundance outside the impact area and partly by the rarity of the individual species. Having an extensive distribution suggests that troglofauna species have moderately high dispersal ability, either through inhabiting well connected subterranean habitats in which they migrate or through possessing a surface dispersal phase in their life cycles. Troglofauna sampling results demonstrated clearly that the mine pits do not represent isolated troglofauna habitat within the MDE.

Of the 45 troglofauna species detected from sampling at the MDE to date, 16 troglofauna taxa are known only from proposed pit boundaries (or TSF in case of Projapigidae sp. B14). Based on current taxonomic and ecological information, and the likely extent of suitable habitats for troglofauna beyond pit boundaries, the following taxa are regarded as;

- **Low risk** (11 taxa): Paradraculoides sp. B12A, *Prethopalpus* sp. indet., *Troglarmadillo* sp. B46, Pauropodidae sp. B42, and Pauropodidae sp. B43, *Symphyella* sp. 'EW' and Campodeidae sp. 'EW'; Projapygidae sp. B14, and Projapygidae sp. B17, *Lepidospera* sp. B10 and *Macranillus* sp. 'EW';

These taxa were regarded as low risk as they were recorded from locations outside proposed pit boundaries (though inside the 150m buffer of disturbance), and from areas where suitable troglofauna habitat extends beyond proposed pit boundaries.

- **Low – moderate risk** (2 taxa): Pauropodidae sp. B29, Pauropodidae sp. B41,

These taxa were regarded as low-moderate risk as they were recorded from; locations either on the margin of the pit boundaries, or from secondary impact areas (i.e. TSF), and there is some uncertainty regarding their ecological category (uncertain whether true troglobites). Both of these taxa are known from areas where suitable habitat extends beyond pit boundaries.

- **Moderate risk** (3 taxa): Palpigradi sp., *Paradraculoides* sp. new2 and *Anapistula* sp. 'EW';

These taxa were regarded as moderate risk as they are known within pit boundaries where suitable habitat extends beyond and taxon are likely to be true troglobite (and higher likelihood restricted SRE). The risks to these taxa are moderated by the fact that suitable habitat appears to extend beyond the impact areas in each case.

The troglofauna potential habitat summary provided in Section 4.8.5 demonstrated that there is a connection for troglofauna species between habitats within the potential mine pits at Eliwana and habitat outside the pits.

It is concluded that mining of the proposed pits is unlikely to threaten troglofauna.

Stygofauna

A total of 281 stygofauna specimens were collected from the most recent Eliwana Project area two-phase survey, representing 15 species from five higher groups; oligochaetes, ostracods, copepods, syncarids and amphipods. This represents a very similar stygofauna assemblage as previously recorded (15 species belonging to the same five groups) (Bennelongia, 2015b).

Based on current taxonomic and ecological information, and current habitat data (available hydrological information), three of the nine taxa were regarded as low risk (*Areacandona* nr *Triangulum, Brevisomabathynella* sp. C and *Bogidiella* sp. B05). These taxa were regarded as low risk as they are known from locations outside of the predicted drawdown beyond multiple hydrogeological barriers or from localities relatively unaffected by groundwater drawdown where sufficient habitat extends beyond drawdown.

Three of the nine taxa were regarded as low to moderate risk (*Parastenocaris* sp., *Brevisomabathynella* sp. A, *Brevisomabathynella* sp. B and Paramelitidae sp. B58). These taxa were regarded as low to moderate risk as known records (some across multiple aquifer compartments) were within the predicted drawdowns though potential habitat is likely to exist below the predicted drawdown.

One of the nine taxa were regarded as moderate risk (*Brevisomabathynella* sp. A). This is due to its occurrence only within a single aquifer compartment likely to be affected by considerable drawdown, with limited habitat beneath the drawdown extent.

One of the nine taxa were regarded as moderate risk (*Brevisomabathynella* sp. A). This is due to its occurrence only within a single aquifer compartment likely to be affected by considerable drawdown, with limited habitat beneath the drawdown extent.

Two of nine taxa were regarded as high risk (*Areacandona* sp. BOS1020 and *Brevisomabathynella* sp. B03). Both of these species were regarded as potential high risk as they are known within a single aquifer compartment with significant drawdown where limited habitat is expected to remain below predicted drawdown and habitat quality is unknown at increasing depths.

4.8.7.2 Direct Impact to Subterranean Fauna Habitat, assemblage and individuals through groundwater abstraction and groundwater injection

Stygofauna have also been recorded from a diverse range of aquifer habitats throughout the MDE. Despite the inferred hydrogeological discontinuities within the MDE, the majority of stygofauna species are known to occur throughout multiple aquifer compartments within the MDE, or more widely within the local / sub-regional area. Owing to gaps in the sampling of stygofauna to the north and south of the MDE, the wider local occurrence of some of the stygofauna species remains unconfirmed. Based on current groundwater drawdown modelling and hydrogeological information, suitable habitats for stygofauna appear to occur beneath the predicted drawdown in most hydrogeological compartments. Nevertheless, there are some species only known from areas as that maybe at a moderate to high risk from drawdown impacts.

4.8.7.3 Indirect impacts to subterranean fauna from blasting

Potential impacts of other activities associated with mining on subterranean fauna (such as impacts of blasting on surrounding areas) are poorly understood. However, the impacts of these activities are expected to dissipate rapidly outside the mine pit. Consequently, such activities are more likely to cause population reduction, if they have an impact, than to threaten persistence of the species as a whole. Secondary impacts of percussion from blasting may be summarised as follows. Subterranean fauna may potentially be affected by shock waves propagated from blasting and through altering underground structures (usually through rock fragmentation and collapse of voids) and causing transient increases in groundwater turbidity. The effects of blasting are often referred to in grey literature but are poorly quantified and the ecological impacts are not described. Any effects of blasting are likely to dissipate rapidly with distance from a mine pit. Blasting is not considered here as a significant impacting activity beyond the mine pit boundary.

4.8.7.4 Indirect impacts to stygofauna due to contamination of groundwater

Groundwater quality has the potential to decline during mining activities due to contamination. Sources of contamination include hydrocarbons and other chemicals, and acid, metalliferous and/or saline drainage from waste dumps and TSFs. Impacts from hydrocarbons and chemicals are reduced by appropriately bunding fuel depots and chemical storage facilities as well as having effective spill clean-up equipment available and therefore is not considered a significant risk. Contamination of groundwater from acid or metalliferous drainage is not anticipated at Eliwana.

Any potential for subterranean fauna population reduction as a result of indirect impacts of mining, such as hydrocarbon spills, leaching from waste dumps or tailings storage is likely to be localised and may be minimised by standard engineering and management practices.

4.8.8 Mitigation

Management and mitigation of impacts on subterranean fauna are detailed in Fortescue's *Groundwater Management Plan 100-PL-EN-1009* as well as the *Eliwana Groundwater Operating Strategy* that will be prepared and implemented under the conditions of a RIWI Act 5C Licence.

Fortescue has applied the mitigation hierarchy to the Project in relation to subterranean fauna. Mitigation measures are outlined in Table 49.

Table 49: Management and Mitigation Measures for Subterranean Fauna

Category	Mitigation
Avoidance	Limit groundwater abstraction in borefields to that which is needed for water supply
Minimisation	Limit dewatering profile to that which is necessary for mining
	Minimise contamination of groundwater by engineering management practices to contain hydrocarbon products
Management	Implement *Groundwater Management Plan 100-PL-EN-1009* and *Eliwana Groundwater Operating Strategy*
	Waste rock landforms to be designed in accordance with the *Eliwana Mine Closure Plan EW-PL-EN-0001.*
	Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine life
Research and Modelling	Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine life

4.8.9 Predicted Environmental Outcome

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Consistent with EPA objectives, the abundance, species diversity, geographic distribution and productivity of subterranean fauna at species and ecosystem levels will be maintained, thereby conserving regional biological diversity. The zoological surveys undertaken by Fortescue and implementation of the proposed management measures will ensure that direct disturbance to important fauna habitat is kept to that which is necessary and that subterranean fauna habitat is protected from indirect disturbance as far as practicable.

Direct mortality and loss of habitat

Subterranean fauna habitat will be removed during mining. This habitat forms part of the Eliwana orebody, which is also a partially connected aquifer. This continuous geological horizon extends beyond the economically viable areas to provide habitat for subterranean fauna that will provide an un-mined refuge.

Direct impact through groundwater abstraction and re-injection

Groundwater abstraction and groundwater injection will alter the hydrological conditions in the subterranean habitat. Water levels will drop, potentially increasing habitat for Troglofauna, but reducing habitat for Stygofauna. Populations of subterranean fauna outside the impact area will not be affected and therefore the species will survive beyond the impact area.

Indirect impacts through contamination of groundwater

Contamination of stygofauna habitat is not anticipated to be significant at Eliwana. Hydrocarbons and chemicals will be managed in accordance with the *Chemical and Hydrocarbon Management Plan 100-PL-EN-0011.* The following management actions are examples of chemical and hydrocarbon management at Eliwana:

- Diesel storage facilities are designed and constructed in accordance with the Standard Engineering Specification Diesel Storage and Handling 100-SP-ME-0044.
- appropriate types and quantities of spill response equipment are to be maintained and are proportionate to the volume of chemicals and hydrocarbons stored.
- Where a chemical or hydrocarbon spill has occurred, manage the spill including any contaminated material, in accordance with the Chemical and Hydrocarbon Spills Procedure 100-PR-EN-0014 and investigate and report the incident in accordance with the Incident Event Management Procedure 100-PR-SA-0011.
- Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards as outlined in the Hazardous Materials Management Procedure 45-PR-SA-0051.

- Divert potentially contaminated water, including stormwater that has come into contact with potential sources of contamination, into an oily water separator for treatment or take potentially contaminated water offsite by a licenced controlled waste contractor. Sample treated water prior to reuse or discharge to confirm hydrocarbon concentrations meet specified Licence requirements.

Any potential groundwater contamination from acid, metalliferous or saline drainage is not anticipated to be significant and is discussed in more detail in Section 4.5.6.

A summary of residual impacts for subterranean fauna is shown in Table 50.

Table 50: Summary of Residual Impacts for Subterranean Fauna after Mitigation Measures

Potential Impact	Residual Impact after Management	Regional Significance
Removal of potential habitat in MDE	Initial impact 1,411 ha of mine pits	Habitats at the regional scale are well represented with >99% remaining.
Direct impact to subterranean fauna habitat, assemblage and individuals through groundwater abstraction and groundwater injection	Groundwater levels will decline during operations due to mine dewatering. Groundwater levels will recover following mine closure, however, final levels will be influenced by potential mine void water bodies in some locations.	Impact unlikely to be significant.
Indirect impacts to stygofauna due to elevated concentrations of contaminants in water due to chemical or hydrocarbon spills, leaching from waste dumps or tailings storage facilities.	There is unlikely to be any significant contamination of groundwater from chemical, hydrocarbon spills or harmful leachates.	Impact unlikely to be significant.

In summary, the proposed disturbance is only a small percentage of the overall potential habitat available to subterranean fauna species in the local area and throughout the region. Potential subterranean fauna habitat in the area is common and relatively few 'high risk' species have been recorded within the mine development envelope. No significant residual impacts are predicted, and no environmental offset is proposed.

As a result of the avoidance, management and mitigation measures proposed for the proposal, the implementation of the Eliwana Mine will meet the EPA's objectives for Subterranean Fauna.

4.9 Social Surroundings

Social surroundings were identified as an environmental factor relevant to the Proposal in the Environmental Scoping Document, with particular focus on Aboriginal heritage and culture (EPA, 2017). The following sections provide an environmental impact assessment for this factor.

4.9.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for social surroundings as follows:

> *To protect social surroundings from significant harm.*

4.9.2 Policy and Guidance

The following policy and guidance is relevant to this factor:

- Environmental Factor Guideline: Social Surroundings (EPA, 2016k).

This guideline provides an outline of how social surroundings are considered by the EPA in the EIA process. Relevant matters discussed in the guideline include the following:

- aesthetic, cultural, economic and/or social values which may be impacted
- activities that may impact social surroundings
- consideration of relevant legislation, criteria or standards
- proposed management and mitigation of impacts.

Fortescue has specifically considered this guidance in the following ways:

- an assessment of the receiving environment
- consideration of the potential activities associated with the Proposal which may impact on social surroundings
- proposed management measures to mitigate potential impacts.

Other policies or guidelines considered are listed in Table 51.

Table 51: Guidelines, Policies and Framework for Social Surrounds

Document	Description
Pilbara Cities: Departments for Regional Development and Lands (2010)	Provides for the delivery of initiatives associated with health, energy, waste, water and community development for communities in the Pilbara region.
Pilbara's Port City Growth Plan	A growth plan to determine future planning and development in Port Hedland
Aboriginal Heritage Act 1972 (WA)	An Act to make provision for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants.
Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth)	An Act to preserve and protect places, areas and objects of particular significance to Aboriginals, and for related purposes
Native Title Act 1993 (Cth)	An Act for the advancement and protection of Aboriginal peoples and Torres Strait Islanders, and is intended to further advance the process of reconciliation among all Australians.
EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage	Considers Aboriginal Heritage in the Environmental Approvals process when heritage values are linked to the environment.

4.9.3 Studies and Surveys

Fortescue has commissioned heritage surveys in consultation with Aboriginal traditional owners to support exploration and future development of the Proposal. Fortescue has commissioned over 60 archaeological surveys and 35 ethnographic surveys within the MDE (Figure 49 and Figure 50). These surveys are consistent with the requirements and expectations for heritage surveys as defined in the EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage and the *Aboriginal Heritage Act 1972.*

Fortescue has also undertaken an Ethnobotanical survey of the MDE (Appendix 22).

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

SERPENTINE CREEK
DUCK CREEK
CAVES CREEK
CAVES CREEK
Silvergrass
Eliwana
PINARRA CREEK
BOOLGEEDA CREEK
BOOLGEEDA CREEK
Brockman 4

Fortescue Projects
Rio Tinto Mines
Access Routes
Mine Development Envelope
Significant Places
FMG Heritage Survey

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M. Dowling
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.039_r2

Date: 21-Aug-18
Size: A3L
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Figure 49
Archeological Surveys

Fortescue Metals Group Ltd
The New Force in Iron Ore

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

SERPENTINE CREEK
DUCK CREEK
CAVES CREEK
CAVES CREEK
Silvergrass
Eliwana
PINARRA CREEK
BOOLGEEDA CREEK
BOOLGEEDA CREEK
Brockman 4

Fortescue Projects
Rio Tinto Mines
Access Routes
Mine Development Envelope
FMG Ethnographic Survey

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

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Document Name: 750EW_MP_EN_0010.040_r2

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Figure 50
Ethnographic Surveys

Fortescue Metals Group Ltd
The New Force in Iron Ore

4.9.4 Receiving Environment

The MDE is located in the Pilbara region and intercepts Unallocated Crown Land and a number of pastoral stations. The Proposal is located within the Shire of Ashburton local government area, with the closest town being Tom Price. The dominant industries in the region are mining and construction, with other industries including cattle farming, fishing, aquaculture and tourism export (Pilbara Development Commission, 2014).

4.9.4.1 Exploration and Mining

The region's economy is dominated by the mining and petroleum industry. Approximately 95% of Australia's iron ore exports originate in the Pilbara as well as 70% of Australia's natural gas. These industries continue to grow in the region (Pilbara Development Commission, 2014).

Existing iron ore mines in proximity to the Proposal include Fortescue's Solomon Iron Ore Mine and Rio Tinto's Silvergrass, Brockman2/Nammuldi and Brockman 4 operations (Figure 51).

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475,000 500,000 525,000 550,000

7,525,000

Caves Creek

Serpentine Creek

Duck Creek

Duck Creek

Silvergrass

Brockman 2
Nammuldi

Eliwana

Pinarra Creek

Brockman 4

Boolgeeda Creek

Turner West

7,500,000

475,000 500,000 525,000 550,000

Fortescue Projects
Rio Tinto Mines
Access Routes
Rio Tinto Rail
Mine Development Envelope
Indicative Mine Footprint

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

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Scale: 1:250,000
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Figure 51
Local Mining Operations

Fortescue Metals Group Ltd
The New Force in Iron Ore

The Silvergrass mine is located approximately 15 km to the north of the MDE, while Brockman 2/Nammuldi and Brockman 4 are located approximately 10 km to the east. These mines involve below water table mining, dewatering and surplus water discharge. Ore is wet processed and transported via rail to Karratha. The easternmost portion of the MDE is proposed to intercept Rio Tinto's rail line servicing the Brockman 4 project.

4.9.4.2 Pastoralism

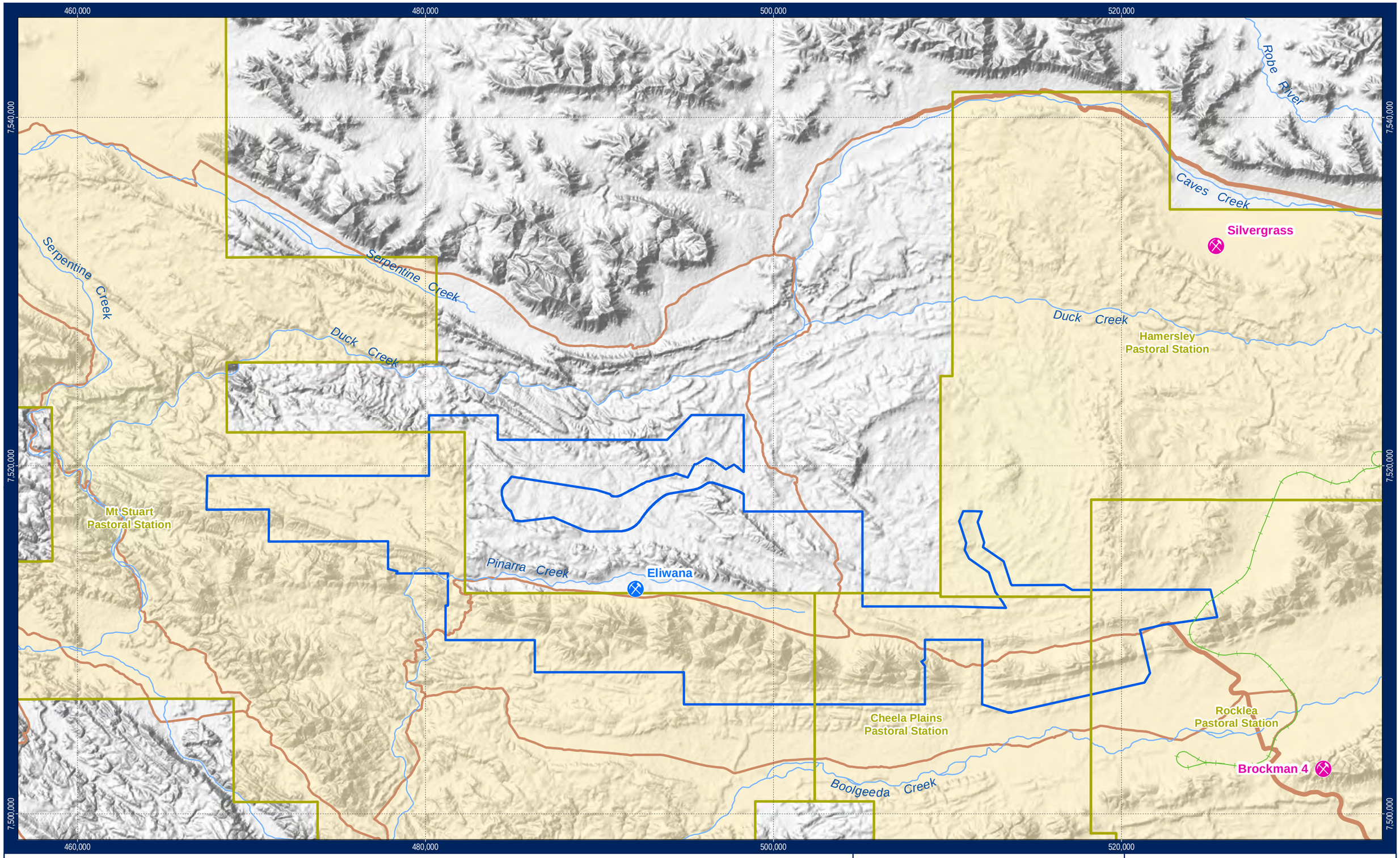
The primary land use within the vicinity of the Proposal is currently pastoral, involving free-range grazing of stock. In the Pilbara, pastoralism commenced in the 1860s when various European settlers, notably Walter Padbury, John Wellard and John and Emma Withnell, began arriving with livestock and supplies to establish sheep stations on the De Grey River. Pastoralism dominated the Pilbara's economy for the next 100 years and continues to provide employment in the region.

The Project intersects portions of the following pastoral stations (Figure 52):

- Hamersley
- Rocklea
- Cheela Plains
- Mount Stuart

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Fortescue
The New Force in Iron Ore



Fortescue Projects
Rio Tinto Mines
Access Routes
Rio Tinto Rail
Mine Development Envelope
Pastoral Lease Boundary

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

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Confidentiality: 1

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Figure 52
Pastoral Stations

Fortescue Metals Group Ltd
The New Force in Iron Ore

4.9.4.3 Population Centres

The population of the Shire of Ashburton has almost doubled in the last 10 years, increasing from 7,608 in 2006 to 13,262 in 2016 (Australian Bureau of Statistics, 2017). The majority of residents live in the towns of Onslow, Pannawonica, Paraburdoo and Tom Price, with a number of Aboriginal communities in more remote locations (Australian Bureau of Statistics, 2017). Approximately 40 % of the population of the Shire are employed in the mining industry, with a further 14 % employed in construction, which largely supports the mining industry (Australian Bureau of Statistics, 2017).

The closest town is Tom Price, which is located approximately 55 km east of the MDE. Pastoral homesteads located within the vicinity of the MDE are listed in Table 52 (Geoscience Australia, 2016).

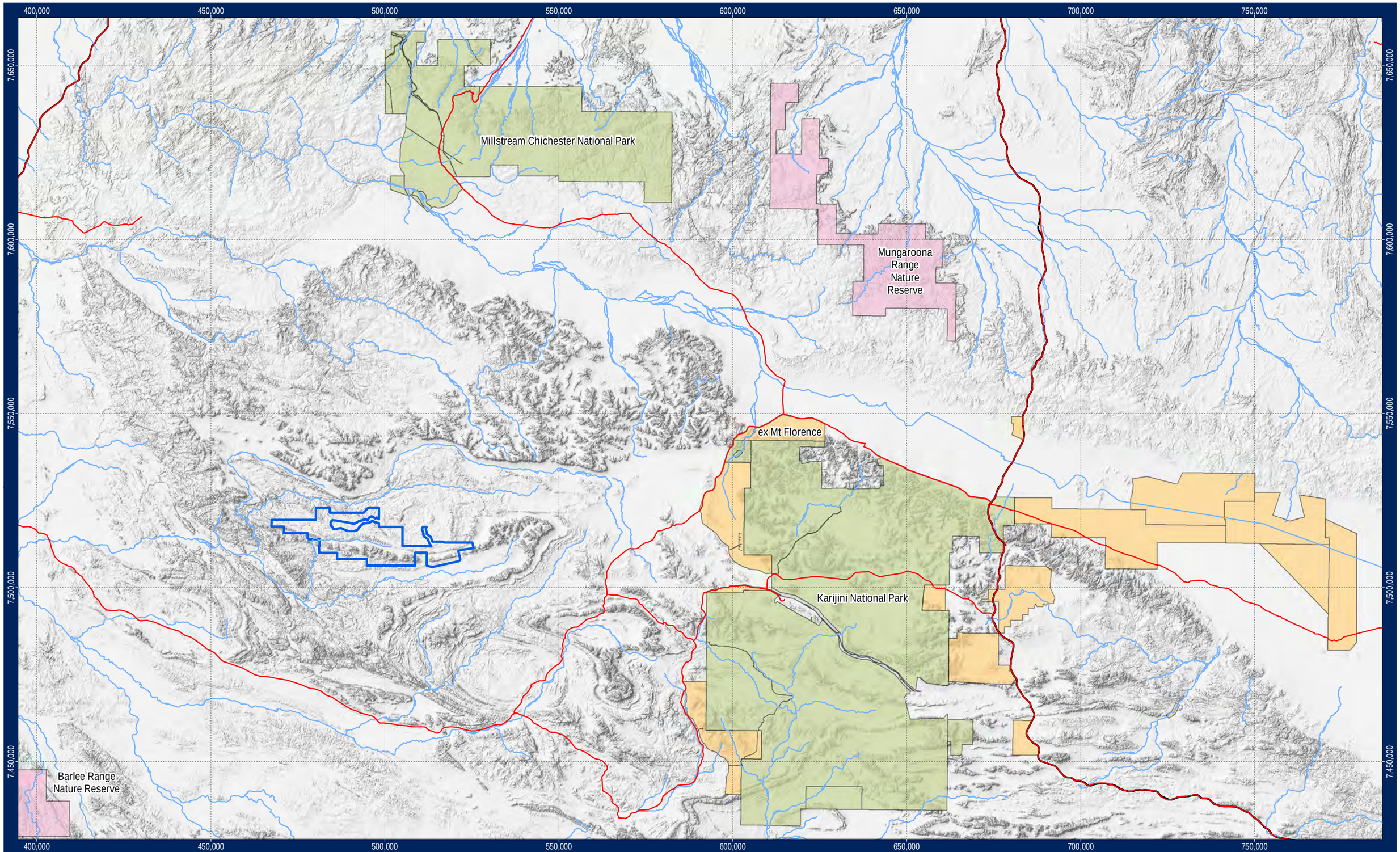
Table 52: Pastoral Homesteads within Vicinity of MDE

Homestead Name	Approximate Distance from MDE (km)
Duck Creek Homestead	10
Mount Brockman Homestead	12
Cheela Plains Homestead	42
Hamersley Homestead	43
Urandy Creek Outcamp	43
Rocklea Homestead	44
Cheela Plains Homestay	45
Cheela Outcamp	46
Wyloo Homestead	50
Cardo Outstation	59
Kooline Homestead	60
Mount Stuart	63
Hardey Homestead	64

4.9.4.4 Recreation and Tourism

Tourism is recognised as an important form of economic diversification for the Pilbara region (Kelly, 2005). The natural environment of the Pilbara region provides the basis for outdoor tourism activities including camping, boating and fishing (Pilbara Development Commission, 2014). Major tourist attractions in the Pilbara include the gorges within Karijini National Park (approximately 70 km east of the Project) and Chichester Millstream National Park (approximately 90 km north of the Project) (Figure 53).

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Mine Development Envelope
5(1)(g) Reserve
Former Leasehold
National Park
Nature Reserve

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 10 20 30 40 50
Kilometres

Requested By: M. Dowling
Drawn By: J. Burke
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Scale: 1:1,000,000
Coordinate System: GDA 1994 MGA Zone 50
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Size: A3L
Revision: 1
Confidentiality: 1

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Figure 53
Conservation Estate

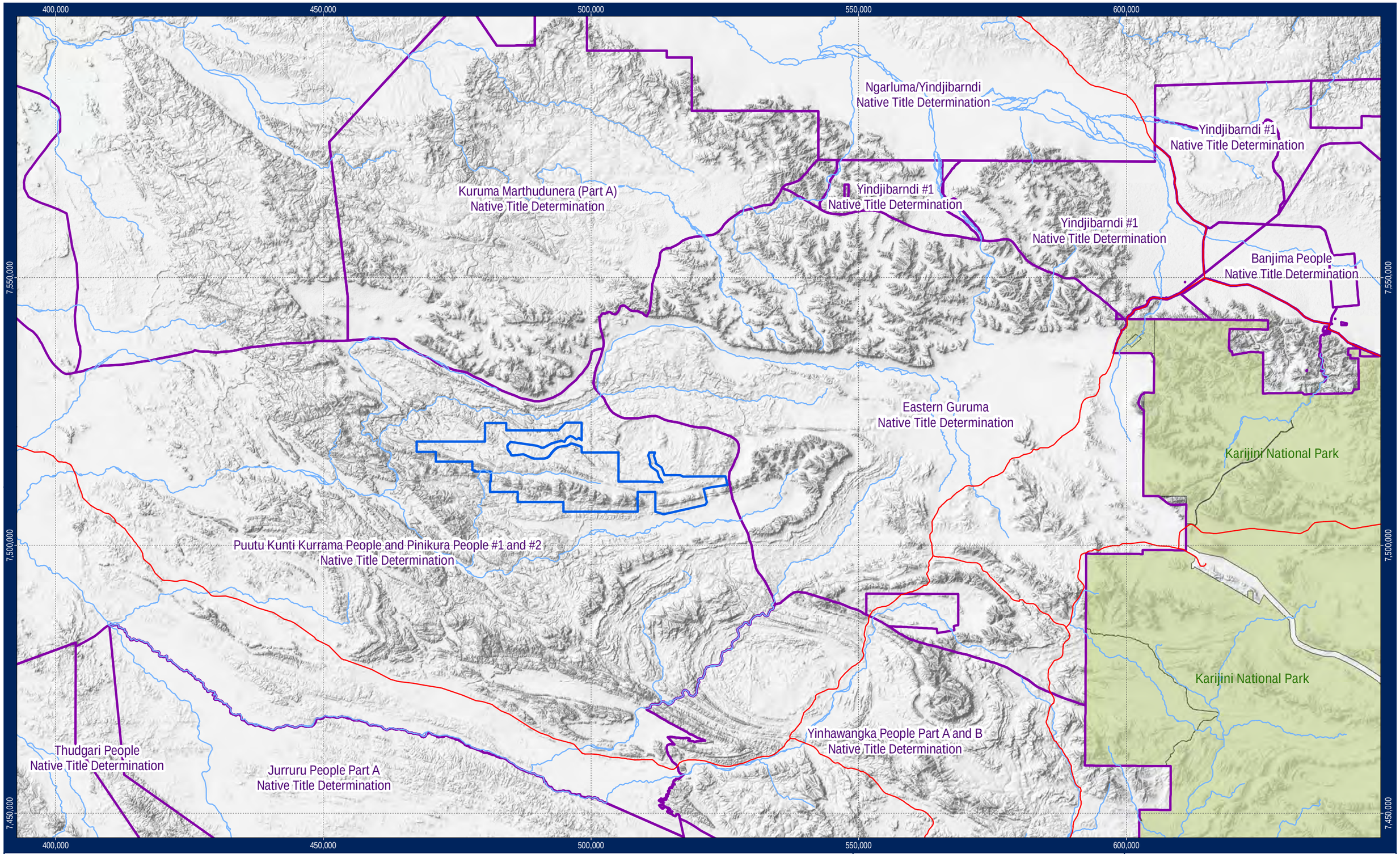
Fortescue Metals Group Ltd
The New Force in Iron Ore

An area of Duck Creek located approximately 500 m to the north of the MDE, and directly adjacent to the mine access road, is listed under Schedule 1, Clause 4 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2005. The area was addressed in the 'Red Book' reports of 1976-1984, and was examined as a potential reserve (EPA, 1993). However, no recommendation for reservation was made, and no other bioregional planning for biodiversity conservation has been attempted (Kendrick, 2001).

4.9.4.5 Native Title, Aboriginal Heritage and Other Cultural Values

The Proposal is located within the Puutu Kunti Kurrama and Pinikura (PKKP) determined area (Figure 54).

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Mine Development Envelope

Native Title Determination (Register)

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 10 20 30 40
Kilometres

Requested By: M. Dowling
Drawn By: J. Burke
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:650,000
Coordinate System: GDA 1994 MGA Zone 50
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Size: A3L
Revision: 0
Confidentiality: 1

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Figure 54
Native Title Areas

Fortescue Metals Group Ltd
The New Force in Iron Ore

Fortescue signed an LAA with the PKKP people on 28 May 2010. This agreement facilitates Fortescue's exploration, mining and development activities within the Native Title Determination areas. Fortescue meets with and consults regularly with the traditional owners over all aspects relating to the identification, protection and management of their cultural heritage, consistent with relevant heritage legislation and the cultural heritage principles agreed between Fortescue and the traditional owners as set out in the LAA's and to keep them informed about the progress of Fortescue projects.

Heritage surveys completed for the MDE involve anthropologists, archaeologists and traditional owner representatives. The surveys are consistent with the requirements and expectations for heritage surveys as defined in the EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage (EPA, 2004b) and the *Aboriginal Heritage Act 1972.*

A total of 17 archaeological or ethnographic surveys have been undertaken over the Mine Development Envelope to identify places of significance to the Traditional Owners. The details of these surveys have not been included for culturally sensitive reasons.

Surveys to date have identified 642 archaeological and 5 ethnographic places within the MDE. Archaeological places are places where physical evidence of the past activities of Aboriginal groups or people has been preserved. Ethnographic places may have a ritual, mythological or ceremonial function or meaning.

A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System for the MDE returned 21 registered and 151 other heritage places. The identified places are artefact scatters and rock shelters. Aboriginal heritage places identified in the vicinity of the Proposal are shown on Figure 49.

There is a likelihood that significant places may be identified during the ongoing consultation with the NTP traditional owners within the MDE. These places will be managed in accordance with Fortescue's legislative and contractual obligations and where practicable, disturbance will be avoided.

Fortescue has consulted with representatives of the PKKP community (specifically the Kuruma people) on-country to identify other significant cultural or social values that may require further consideration. This on-country visit occurred in late May 2018. As a result of this visit, the PKKP have identified that the following places are considered as significant:

- Duck Creek: Duck Creek holds a range of values to PKKP People including heritage (sites), social (family visits and teaching opportunities), recreational (camping and fishing) and ethnographic (stories and song lines). PKKP People consider themselves custodians of the parts of Duck Creek within their country and are responsible for the maintenance of the creek as water flows to traditional lands downstream.

- Eagles Nest: The hill known colloquially as Eagles Nest holds significant heritage and spiritual values which the PKKP People do not wish to be disturbed. Out of respect to the PKKP People, Fortescue will not discuss the values of Eagles Nest further in this document.

4.9.5 Cultural Use of Flora and Fauna

Fortescue commissioned an ethnobotanical study of the MDE (and Eliwana Rail) to identify those plants that have significance to Traditional Owners for food, tools, medical or ceremonial purposes (Ecoscape, 2018). The study also extended fauna species, where those animals were used either as food, or in some instances for wax (bees) or even as indicators of seasonal conditions. A list of these species, their potential cultural use, within the MDE is provided in Table 53 (flora) and Table 54 (fauna). The majority of the species are commonly found across the Pilbara region, associated with multiple vegetation communities and landforms.

Ecoscape (Ecoscape, 2018) noted that approximately 40% of the flora species within their study area were potentially of cultural significance to traditional owners. Plants contain an array of alkaloids, essential oils, steroids, terpenes and tannins, sugars, complex carbohydrates and elements such as iron, selenium and silica (Ecoscape, 2018). Additionally, flora species can be used to make tools, including fire-sticks, digging sticks, spears, boomerangs, netting, shields, hooks, traps etc. A variety of flora species are also utilised for healing and ceremony, whilst some species have a similar effect to tobacco or are used in curing ailments.

Additional ethnobotanical information was gathered during consultation with the PKKP on site in May 2018. Some descriptions of the better documented plants and their uses include (These plant species are in bold text in Table 53.

- Spinifex (*Triodia spp.*) seed was collected and processed using grinding stones to make damper, and leaves were woven into fishing nets. The mesh size of nets was set to let smaller fish through and only capture larger individuals to ensure an ongoing resource. Spinifex resin was also collected (particularly where termites had already consolidated the resin) and used as a universal superglue, particularly for fastening the heads of axes and other tools to handles.
- Bush Dettol (*Stemodia grossa*) used for a multitude of purposes, including topical disinfectant. Most medicinal plants are used in multiples, but usually initially boiled and either drunk or the affected area bathed.
- Bloodwood (*Corymbia hamersleyana* and possibly *C. deserticola*) sap was collected and used to numb toothache by rubbing on gums, also for heart conditions and cancer.
- Ash from burnt Snakewood (*Acacia xiphophylla*) leaves used as a narcotic.

- Heated seed pods from Caustic Bush (*Grevillea pyramidalis*) used in ritual skin scarification.
- When Emu Bush (unspecified *Eremeophila sp./spp.*) are flowering, hunting of emu is off-limits as the males are raising chicks.
- Corkwood from *Hakea lorea* and/or *Hakea chordophylla* used sunscreen.

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Table 53: Culturally Significant Flora species recorded from the MDE from Ecoscape (2018)

Botanical Name	Common Name	Use	Conservation Status
Acacia adsurgens		Edible seeds, witchetty grubs in roots	-
Acacia ampliceps	Salt wattle	For healing and ceremony	
Acacia ancistrocarpa	Fitzroy wattle	Edible seeds, for healing and ceremony	-
Acacia aneura (and variants)	Mulga	Edible galls, used for making spears, woomeras, clubs, digging sticks, sandals	Potentially sheet flow dependent, northern limit, however no sheetflow dependent vegetation occurs within the MDE.
Acacia arida	Arid wattle	For healing and ceremony	-
Acacia atkinsiana	Atkin's wattle	Edible galls, good for finding edible grubs	-
Acacia bivenosa	Two-nerved wattle	Good for finding edible grubs, used for making houses, brooms,	-
Acacia citrinoviridis	Jam tree	Used for making spears, woomeras	-
Acacia colei (and variants)	Cole's Wattle	Edible gum, used for making hunting spears	-
Acacia coriacea subsp. *pendens*	Leather-leaved wattle	Edible seed, used for making spears and boomerangs	-
Acacia cowleana	Halls Creek Wattle	Edible seeds, wood used for artifacts	
Acacia dictyophleba	Sandpaper wattle	Used to make houses, brooms,	-
Acacia exilis (exigua)		Edible seeds	-
Acacia inaequilatera	Camel bush	Edible seeds, seeds burnt and used to make body paint, used for healing and ceremony	-
Acacia maitlandii	Maitlands Wattle	Edible gum	-
Acacia monticola	Gawar	Used for making spear points	-

Botanical Name	Common Name	Use	Conservation Status
Acacia pachyacra		Edible seeds	
Acacia pruinocarpa	Gidgee	Edible gum	-
Acacia pyrifolia (and variants)	Kanji	Edible gum, edible seeds	-
Acacia stenophylla		Edible plant, seeds	
Acacia synchronicia	Barbi bush	Used for making spears, clubs, axe handles, fence posts	-
Acacia tenuissima		Edible seeds	-
Acacia tetragonophylla	curara	Edible seeds, used for making boomerangs	-
Acacia trachycarpa	Minni-ritchi	Used for making spears, clubs, axe handles	-
Acacia tumida var. *pilbarensis*	Pindan wattle	Used for making hunting spears	-
Acacia victoriae	Bramble wattle	Edible seeds	
Acacia wanyu	Wanyu	Used for making boomerangs	-
Acacia xiphophylla	**Snakewood**	**Edible seeds, gum, roots, good for finding edible grubs, used for making boomerangs**	**-**
*Aerva javanica**	Kapok bush	Seed heads used for pillow stuffing	Introduced species
Amaranthus interruptus	Native Amaranth	Edible seeds	
Amaranthus mitchellii	Boggabri weed	Seeds ground to make damper	
Amaranthus viridis	Green Amaranth	Edible leaves and shoots	
Amyema sanguinea var sanguinea		Edible fruit	-
Aristida contorta	Bunched kerosene grass	Used to start fires, hair lotion	-
Aristida inaequiglumis	Feathertop Threeawn	Edible seeds	

Botanical Name	Common Name	Use	Conservation Status
Boerhavia coccinea	Tar Vine	Edible roots	
Brachychiton acuminatus	Kurrajong	Edible seeds	
Bulbostylis barbata		Edible Seeds	
Calandrinia sp.	Parakeelya	Edible root	-
Capparis lasiantha	Wild passionfruit, Split jack	Edible Plant,	-
Capparis mitchellii	Wild orange	Edible Plant, fruit	-
Capparis spinosa	Caper bush	Edible Plant, for healing and ceremony	-
Capparis umbonata	Wild orange	Edible plant	-
Carissa lanceolata	Conkerberry, wild currant	Edible plant,	-
Cenchrus setigerus	Birdwood grass	Fire starter	Introduced species
Chrysopogon fallax	Golden Beard Grass	Edible seeds	
Citrullus colocynthis		Edible fruit	
Cleome viscosa	Tickweed	For healing and ceremony	-
Clerodendrum tomentosum var *lanceolatum*	Lolly bush	Used to make smoking pipes, for healing and ceremony	-
Codonocarpus cotinifolius	Cork hopbush, Native poplar	For healing and ceremony	-
Commelina ensifolia	Wandering Jew	Edible roots	
Corchorus walcotti	Wooly Corchorus	Bark from the stem used to make twine	
Corymbia deserticola	**Bloodwood**	**Good for finding honey**	
Corymbia hamersleyana	**Bloodwood**	**Edible galls, honey, lerp, healing and ceremony.**	
Corymbia opaca	Desert bloodwood	Good for finding edible grubs, edible gall, gum used for healing	-

Botanical Name	Common Name	Use	Conservation Status
Crotalaria cunninghamii	Green birdflower	Strips used to make sandals	-
Cucumis melo	Wild cucumber	Edible plant	-
Cullen leucanthum		Used for making hunting spears	-
Cymbopogon ambiguus	Scent grass	For healing and ceremony	-
Cynanchum floribundum	Native pear	Edible Plant, Edible leaves	-
Cynanchum viminale	Caustic vine	For healing and ceremony, sap used to stimulate breat milk flow and heal sores.	
Cyperus bifax	Downs nutgrass	Edible nuts	
Cyperus bulbosus	Bush onion	Edible roots	
Dactyloctenium radulans	Button Grass	Seeds used to make flour	
Dodonaea lanceolata	Yellow hop bush	Medicinal use	
Dodonaea viscosa subsp. *Spatulata*	Native hops	For healing and ceremony	-
Duperreya commixta	Bush bean	Edible plant	
Dysphania kalpari	Rats tail	Seeds ground to make damper	-
Dysphania rhadinostachya	Crumbweed	Edible seeds	-
Enchylaena tomentosa	Barrier saltbush	Edible fruit	-
Eragrostis dielsii *Eragrostis eriopoda* *Eragrostis falcate* *Eragrostis leptocarpa* *Eragrostis setifolia*	Lovegrass	Edible seeds	
Eremophila canaliculata		For healing and ceremonty	

Botanical Name	Common Name	Use	Conservation Status
Eremophila cuneifolia	Emu bush	Used to soak swollen feet. Shampoo, soap.	
Eremophila fraseri	Turpentine Bush	Healing and ceremony, Soap	
Eremophila latrobei	Warty Fuchsia Bush	Medicinal use, sweet drink	
Eremophila longifolia	Berrigan	Edible nectar	
Eriocholoa pseudoacrotricha	Perrenial cupgrass	Edible seeds	
Erythrina vespertilio	Yulbah	Used to make necklaces, shields, coolamons	
Eucalyptus camaldulensis	River gum	Good for finding edible grubs, for healing and ceremony	Groundwater dependant vegetation
Eucalyptus gamophylla	Twin-leaf mallee	Good for finding honey	-
Eucalyptus leucophloia	Snappy gum	Good for finding honey, lerp or honeydew, used to make spears, shields, hitting sticks	-
Eucalyptus victrix	Blackheart gum	Good for finding edible grubs, lerp	-
Eucalyptus xerothermica	Pilbara box	Lerp or honeydew	-
Eulalia aurea		Leaves used in smoke therapy	
Euphorbia australis	Caustic weed	Medicinal use	
Exocarpos sparteus	Broom Ballart	Edible fruit	
Ficus brachypoda	Rock Fig, Wild fig	Edible plant	-
Ficus platypoda	Rock Fig	Edible plant	-
Ficus virens	Albayi		
Gastrolobium grandiflorum	Wallfower poison	Herb (*Poison risk)	-

Botanical Name	Common Name	Use	Conservation Status
Gossypium robinsonii	Desert rose, wild cotton	Used for making spears, dancing sticks, sandals	-
Grevillea berryana		Edible nectar	
Grevillea juncifolia	Honeysuckle grevillea	For healing and ceremony, edible nectar	-
Grevillea pyramidalis	**Caustic bush**	**Yellow paint from bark, edible nectar**	**-**
Grevillea wickhamii	Wickham's grevillea	Edible nectar, edible gum, edible fruit	-
Hakea lorea	**Honey hakea**	**Edible flower or nectar, for healing and ceremony**	**-**
Heliotropium tenuifolium	Mamukata	Edible seeds	
Heteropogon contortus	Bunch Speargrass	Medicinal, insect repellent	
Ipomoea costata	Native yam	Edible root	-
Ipomoea muelleri	Morning glory	Edible root	-
Ipomoea pes-caprae	Wild potato	Edible root	-
Isotoma petraea	Rock Isotome	Similar to tobacco	
Lepidium phlebopetalum	Veined Peppercress	Edible Greens	
Lepidium platypetalum	Native mustard bush	For healing and ceremony	-
Marsdenia australis	Bush banana, Silky pear	Edible fruit, Edible leaves,	-
Melaleuca argentea	Cadjeput, paperbark	Water, good for finding honey, used for making yandies, shields, spears, houses, firesticks	Groundwater dependant
Melaleuca eleuterostachya	Desert paperbark	Lerp or honeydew	-
Melaleuca glomerata	Tea-tree	Used to make shade houses, brooms	-
Melaleuca lasiandra	Paperbark	Edible nectar, bedding, tablecloth, wrap meat to keep flies away	

Botanical Name	Common Name	Use	Conservation Status
Nicotiana benthamiana	Wild tobacco	For healing and ceremony	-
Nicotiana occidentalis	Wild tobacco	For healing and ceremony	-
Oxalis corniculata	Yellow Wood Sorrel	Edible greens	
Paspalidium rarum		Edible seeds	
Panicum effusum	Hairy Panic Grass	Edible plants and seeds	
Petalostylis labicheoides	Cassia	Used for making hunting spears	-
Porana commixta (Duperreya commixta)	Bush bean	Edible plant	
Portulaca intraterranea *Portulaca oleracea* *Portulaca pilosa*	Pigweed, Djanggara	Ground to make damper	-
Psydrax latifolia	Conkleberry, native plum	Edible plant	-
Psydrax suaveolens	Wild currant	Edible plant	-
Pterocaulon sphaeranthoides	Apple Bush	For healing and ceremony	-
Ptilotus drummondii	Narrowlead mulla mulla	Herb	-
Ptilotus exaltatus (nobilis)	Mulla mulla	For healing and ceremony	-
Ptilotus obovatus	Cotton bush	For healing and ceremony	-
Rhyncharrhena linearis	Bush bean	Edible plant,	-
Santalum lanceolatum	Northern Sandalwood	Edible plant,	-
Santalum spicatum	Sandalwood	Edible plant,	-
Sarcostemma vimonale subsp. *Austral (Cynanchum viminale* subsp. *australe)*	Caustic vine	For healing and ceremony	-
Scaevola spinescens	Currant Bush	Edible plant	-

Botanical Name	Common Name	Use	Conservation Status
Scaevola parvifolia subsp. *Parvifolia*	Fan flower	Edible fruit	-
Senna artemisioides	Silver cassia	Good place to find grubs	-
Senna notabilis	Cockroach bush	Good place to find grubs	-
Sesbania cannabina	Sesbania pea	Used for making shields, yandies	-
Sesbania formosa	Whit Dragon Tree	Used for making shields, yandies	-
Sida platycalyx	Lifesaver Burr	Edible seeds	
Solanum centrale	Desert raisin	Edible fruit	-
Solanum horridum	Wild gooseberry	Edible plant, use the leaves for washing	-
Solanum phlomoides	Wild tomato	Edible plant	-
Solanum diversiflorum	Bush tomato	Edible plant	-
Solanum chippendalei	Bush tomato	Edible fruit	-
Solanum lasiophyllum	Flannel bush/bush tomato	Edible plant,	-
Stemodia grossa	**Vicks Bush**	**For healing and ceremony, fish poison**	**-**
Stemodia viscosa	Pagurda	Medicinal use	
Stylobasium spathulatum	Pebble bush	Edible seeds	
Swainsona formosa	Sturt's desert pea	Edible nectar	-
Templetonia egena	Round Templetonia	Medicinal use	
Tinospora smilacina	Snakevine	Edible tuber	-
Trachymene oleracea (*Tachymene oleracea* subsp. *oleracea* identified at site – subsp *Rye* is Priority 1 but not identified in surveys of project area)	Lace flower	Used for making drinking straws	-

Botanical Name	Common Name	Use	Conservation Status
Trianthema triquetrum	Red Spinach	Edible seeds and greens	
Tribulus suberosus	Cork Hopbush	Leaves used to stun fish	
Trichodesma zeylanicum	Northern bluebell	Used to make firesticks	-
Triodia epactia* and *Triodia pungens	**Soft spinifex**	**Used to make wax, fishing nets, houses, seeds ground to make damper**	**-**
Triodia wiseana	**Limestone spinifex**	**Spines used in fishing. Seeds ground to make damper**	
Typha sp.	Bulrush	Edible root	-
Ventilago viminalis	Supplejack	Similar to tobacco	
Vigna lanceolata	Maloga vigna	Root used for fire starters	
Waltheria indica		Edible fruit	
Yakirra australensis		Edible seeds	

Bold text denotes plant species that are discussed in Section 4.9.5 as being specifically mentioned by PKKP representatives during an on site visit in May 2018.

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Table 54: Culturally significant fauna species recorded from the Eliwana MDE from Ecoscape 2018

Common Name	Species Name	Conservation Status		
		EPBC	BCA	DBCA
Mammals				
Short Beaked Echinda	*Tachyglossus aculeatus*			
Euro	*Osphranter robustus*			
Red Kangaroo	*Osphranter rufus*			
Rothschilds Rock Wallaby	*Petrogale rothschildi*			
Western Pebble Mound Mouse	*Pseudomys chapmani*			P4
Cat	*Felis catus*			
Dingo	*Canis familiaris*			
Birds				
Emu	*Dromaius novaehollandiae*			
Stubble Quail	*Coturnix pectoralis*			
Brown Quail	*Coturnix ypsilophora*			
Black Swan	*Cygnus atratus*			
Plumed Whistling Duck	*Dendrocygna eytoni*			
Australian wood Duck	*Chenonetta jubata*			
Pink-eared Duck	*Malacorhynchus membranaceus*			
Grey Teal	*Anas gracilis*			
Pacific Black Duck	*Anas superciliosa*			
Common Bronzewing	*Phaps chalcoptera*			
Flock Bronzewing	*Phaps histronica*			

Common Name	Species Name	Conservation Status		
		EPBC	BCA	DBCA
Crested Pigeon	*Ocyphaps laphotes*			
Spinifex Pigeon	*Geophaps plumifera*			
Australian Pelican	*Pelecanus conspicillatus*			
Australian Bustard	*Ardeotis australis*			
Galah	*Eolophus roseicapilla*			
Little Corella	*Cacatua sanguinea*			
Australian Ringneck	*Barnardius zonarius*			
Budgerigar	*Melopsittacus undulatus*			
Reptiles				
Flat-Shelled Turtle	*Chelodina steindachneri*			
Long-nosed Dragon	*Gowidon longirostris*			
Centralian Blue-tongue	*Tiliqua multifasciata*			
Various Monitors	*Varanus species*			
Stimsons Python	*Antaresia stimsoni*			
Pilbara Olive Python	*Liasis olivaceus barroni*	VU	S3	VU
Amphibians				
Main's Frog	*Cyclorana maini*			
Western Water Holding Frog	*Cyclorana occidentalis*			
Centralian Burrowing Frog	*Platyplectrum spenceri*			
Fish				
Hyrtls Catfish	*Neosilurus hyrtlii*			

Common Name	Species Name	Conservation Status		
		EPBC	BCA	DBCA
Spangled Perch	*Leiopotherapon unicolor*			
Invertebrates				
Long Horn Beetle (larvae)	*Bardistus cibarius*			
Witchetty Grub (larvae)	*Enoxyla leucomochla*			
Processionary Caterpillar	*Ochrogaster lunifer*			
Native Bees (honey)	*Tertragonula spp.* *Austrplebeia spp.*			
Termites	*Isoptera*			
Grasshoppers, crickets and locusts	*Orthoptera*			
Beetles (larvae)	*Coleoptera*			
Ants	*Hymenoptera*			
Scale insects (lerps)	*Hemiptera: Coccoidea*			

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4.9.5.1 Non-Indigenous Heritage

In Western Australia, the *Heritage of Western Australia Act 1990* provides for the conservation of places identified to have significance to the cultural heritage of the State. Under the Act, places identified as meeting the criteria outlined in Section 47 are placed onto the State Register of Heritage Places. Places of Commonwealth heritage significance are protected under Part 15 of the EPBC Act and include World Heritage properties, National Heritage places and Commonwealth Heritage places.

Searches of the following databases were undertaken to identify cultural heritage values relevant to the Proposal:

- inHerit: searchable, online database of the Western Australian Register of Heritage Places
- Heritage registers maintained by the Shire of Ashburton
- Australian Heritage Database: searchable, online database of places on the following lists:
    - World Heritage List
    - National Heritage List
    - Commonwealth Heritage List
    - Register of the National Estate

These searches did not identify any sites listed on the National Heritage or Commonwealth Heritage lists within the MDE. The closest site of interest is Duck Creek Gorge, which is located 10 km to the south-west of the MDE. The gorge is listed as an Indicative Place on the Register of the National Estate, classified as a geological monument (Place No. 4405).

4.9.6 Potential Impacts

Activities which have the potential to impact social surroundings include:

- Impacts to Aboriginal heritage places.
- Prevention or change to access to an Aboriginal heritage place.
- Changes to the attributes of the environment which may impact on Aboriginal heritage places or the future enjoyment of the environment for cultural or recreational purposes.
- Unauthorised access to heritage places.

4.9.7 Assessment of Impacts

This section discusses impacts to social surroundings as a result of the proposal.

Pastoral Stations

The Proposal will result in reduction of the available area on the Mount Stuart, Hamersley, Rocklea and Cheela Plains pastoral stations, and therefore may have economic impacts on these stations. The MDE will intercept:

- 16,438 ha of Mount Stuart Pastoral Lease (of a total approximate area of 343,880 ha) representing 5%
- 835 ha of Hamersley Pastoral Lease (of 26,650 ha) representing 3%
- 2,514 ha of Rocklea Pastoral Lease (of 362,240 ha) representing0.6%
- 8,203 ha of Cheela Plains Pastoral Lease (of 185,463 ha) representing 4.4%.

Population Centres

The MDE, including the associated access road, is located at least 10 km from the closest homesteads, and at least 50 km from the closest town. Accordingly, no impacts to human health or amenity at residential receptors is anticipated as a result of the dust, noise or visual impacts from the Proposal.

Recreation and Tourism

No direct impacts to national parks or other recreational or tourism features will occur as a result of the Proposal. Potential indirect impacts to Duck Creek, including Duck Creek Gorge, as a result of surface or groundwater impacts are addressed in Section 4.4.6 of this document.

Native Title/Aboriginal Heritage or other Cultural Values

Archaeological and ethnographic heritage surveys completed to date have identified 642 archaeological and five ethnographical heritage places within the MDE.

Impacts related to heritage may result largely due to clearing and earthworks associated with construction and operation of the Proposal and include:

- Impacts to Aboriginal heritage places;
- Prevention or disruption to access to an Aboriginal heritage place; and
- Changes to the attributes of the environment which may impact an Aboriginal heritage place.

- Disturbance to vegetation and fauna habitat which may change the ability of traditional owners to use the land for tools, bush tucker or medicine.

Fortescue has conducted extensive consultation with traditional owners and their representatives in relation to the identification and management of identified heritage places, including a visit on-country with representatives from the PKKP community. Where the Proposal cannot avoid impact to Aboriginal sites or potential Aboriginal sites, Fortescue will make applications under s18 of the Aboriginal Heritage Act, requesting ministerial consent to use the land for Purpose.

With regards to the other significant places identified within the MDE, the proposed disturbance to Duck Creek is limited to a potential creek crossing. There are no indirect impacts to Duck Creek from light, noise, dust, changes to surface water flow or groundwater abstraction.

With regards to Eagles Nest, Fortescue has consulted with representatives of the PKKP and have agreed that there will be no disturbance from mining to this area until the heritage or other values of this area are fully understood and further consultation on this area has been undertaken.

Given the distance of the mining activities to significant places outside the MDE, indirect impacts as a result of noise, vibration and dust emissions are not anticipated to impact these places, or impact the amenity of traditional owners accessing these places. Based on the impacts to surface water and groundwater discussed in Section 4.4.6, impacts to significant places outside the MDE are not anticipated.

Disturbance of flora and vegetation for the Proposal will result in impacts to species used for cultural purposes. However, the species identified as having cultural use are generally common across the Pilbara region. The two culturally significant flora species that are listed by the DBCA as having conservation status (i.e. Priority listed) were not identified within the MDE, and will not be impacted by the Proposal. Whilst access to the MDE will be restricted during mining, Fortescue will negotiate with the PKKP in good faith an access protocol according to the terms of the Land Access Agreement between Fortescue and PKKP.

Non-indigenous Heritage

The risk of impact to European heritage places is considered to be low, as no sites were identified within the MDE. The closest receptor, being Duck Creek Gorge, will not be directly or indirectly disturbed by the Proposal.

4.9.8 Mitigation

Fortescue has applied the mitigation hierarchy to the Proposal in relation to social surroundings. Mitigation measures include:

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Avoidance

- Disturbance to places of archaeological or ethnographic significance will be avoided where practicable.

Minimisation

- Disturbance to places of archaeological or ethnographic significance will be minimised, planned and managed in consultation with traditional owners and the DPLH.
- Fortescue will continue to consult with the relevant native title groups and obtain approval under Section 18 of the *Aboriginal Heritage Act 1972* as required, prior to the disturbance of any heritage sites under the meaning of the *Aboriginal Heritage Act 1972*. Heritage places will be managed in accordance with the Management of Aboriginal Cultural Heritage, Fortescue Project Areas, Revision 2 100-GU-HE-0003.
- In relation to amenity impacts, Fortescue will minimise dust emissions, as far as practicable, through implementation of the Fortescue Mine and Rail Dust Management Plan 45-PL-EN-0030, which includes the following requirements.
- Use of water carts on high traffic areas.
- Incorporation of dust control measures into project design.
- Progressive rehabilitation.
- Ambient dust monitoring where appropriate.
- Noise and vibration will be managed in accordance with the Mine and Rail Noise Management Plan 100-PL-EN-0028.
- Fortescue will develop and review closure strategies in consultation with key stakeholders, in accordance with the Eliwana *Mine Closure Plan EW-PL-EN-0001.*

Rehabilitation/Revegetation

- Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Native Title groups.

Corporate Social Responsibility Actions

- Fortescue mitigates impact of approved works by recording, removing and relocating cultural heritage material in partnership with relevant native title groups, and in accordance with legislative requirements and any ministerial or regulatory consent conditions.
- Fortescue may agree to additional mitigation strategies in consultation and partnership with relevant native title groups.
- As part of previous projects, Fortescue has contributed to community services and facilities, regional development and local procurement of goods and services (Fortescue, 2008).

- Fortescue has a target to achieve spending of 10 % of total procurement with Aboriginal businesses by 2021 (Fortescue, 2017f). In FY17, Fortescue spent approximately A$200 million with 54 Aboriginal businesses. Since its inception in 2011, Fortescue's Billion Opportunities initiative has awarded 244 contracts, sub-contracts and new works worth A$1.95 billion to 105 Aboriginal-owned businesses and joint ventures (Fortescue, 2017f).
- Aboriginal people currently make up 15.8 % of Fortescue's workforce. Fortescue has a target of achieving an employment rate of 20 % for Aboriginal people across Fortescue by 2020 (Fortescue, 2017f).
- Training and employment of Aboriginal people is undertaken through the Fortescue funded Vocational Training and Employment Centre (VTEC) in South Hedland and Roebourne (Fortescue, 2011b). Training programs include driver training and licence support, mobile plant operator courses, industrial skills and administrative training, financial management and health/wellbeing courses and support – all designed to prepare students for successful employment. Since the establishment of VTEC in 2006, Fortescue has provided training and employment opportunities and support to more than 1,500 Aboriginal people (Fortescue, 2017f).

4.9.9 Predicted Outcome

Based on the percentage of the pastoral stations to be intercepted by the Proposal, no significant impact to these stations are anticipated. Fortescue will continue to consult with the pastoral station holders to ensure impacts are managed, as far as is practicable.

No impacts to population centres, recreation or tourism values, or non-Aboriginal heritage are anticipated to occur as a result of the Proposal.

Fortescue is committed to minimising impacts on Aboriginal heritage places in all of its project areas which includes wherever possible, avoidance of impacts on Aboriginal heritage places.

Where the Proposal cannot avoid impact to Aboriginal heritage, Fortescue will consult with the traditional owners to maximise community engagement and heritage management outcomes, and to meet legislative and contractual requirements and, where required, make applications under s18 of the *Aboriginal Heritage Act 1972*, requesting ministerial consent to use the Land for Purpose. Fortescue will comply with the Aboriginal Heritage Act and any approval conditions set by the Minister for Aboriginal Affairs at all times during construction and operation of the Proposal.

Where appropriate, Fortescue will work with the traditional owners, heritage professionals and the regulatory body to minimise and mitigate and the impact by undertaking additional research, investigate recording/analysis, salvage and storage of cultural material.

It is anticipated that places outside the mine disturbance footprint will remain unaffected due to the implementation of comprehensive heritage management processes contained within the LAAs between Fortescue and the native title groups.

With respect to cultural use of flora, while the Proposal will may prevent access to some areas of the MDE during operations, the Proposal is not anticipated to impact access to culturally significant flora species on a regional scale. Further, Fortescue will ensure ongoing cultural use of the area is considered in its closure objectives for the Proposal.

4.10 Air Quality

Air quality was identified as an environmental factor relevant to the Project in the Environmental Scoping Document (EPA, 2017). The following sections provide an environmental impact assessment for this factor.

Fortescue has utilised air emission data gathered from its existing iron ore mining and processing operations at the Solomon Mining Hub and Christmas Creek operations to estimate the potential impact of the Proposal.

4.10.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2016c) lists the objective for air quality as follows:

> *To maintain air quality and minimise emissions so that environmental values are protected.*

4.10.2 Policy and Guidance

The Environmental Factor Guideline: Air Quality (EPA, 2016l) is relevant to this factor. This guideline provides an outline of how air quality is considered by the EPA in the environmental impact assessment (EIA) process. Relevant matters discussed in Guideline include the following:

- application of the mitigation hierarchy to avoid and minimise emissions, where possible;
- characterisation of potentially harmful emissions and the pathways by which they may be released to air;
- the application of technology appropriate to the potential environmental impacts and risks
- the significance of the likely change to air quality as well as the environmental values affected by those changes, in the context of existing and predicted cumulative impacts

Fortescue has specifically considered this guidance in the following ways:

- identification of emissions from the proposal with the potential to impact air quality;
- Undertake characterisation and estimation of greenhouse gas emissions associated with the Proposal; and
- Provide description of proposed management.

The following guidance documents were also relevant in the consideration of impacts to air quality:

- Guidance Statement No. 12: Minimising Greenhouse Gas Emissions (EPA, 2002);
- National Environment Protection Council Act 1994 (Cth) and National Environment Protection Measure for Ambient Air Quality (Air NEPM);
- National Greenhouse and Energy Reporting Act 2007; and
- National Environment Protection (National Pollutant Inventory) Measure (NPI).

4.10.3 Surveys and Studies

Fortescue currently reports emissions in accordance with the requirements of NGER and NPI for its operating sites. The reports are prepared internally, audited by an external party and submitted to the relevant regulators. Fortescue's historical NPI reporting data can be found by visiting the NPI website at http://www.npi.gov.au/npi-data/search-npi-data and NGER reports at the following website http://www.cleanenergyregulator.gov.au/NGER/.

Using data from current operations at the Solomon and Christmas Creek iron ore mines to Fortescue undertook a benchmarking exercise estimate the air quality emissions relevant to the Proposal.

To understand the potential risks of exposure to dust from fibrous minerals Fortescue has analysed historical exploration drilling data to determine if the presence of fibrous minerals could impact air quality during implementation of the Proposal.

4.10.4 Receiving Environment

Greenhouse gas emissions contribute to a changing climate on a global scale. The effects of the changing climate are predicted to be significant for Western Australia (EPA, 2016l).

The Pilbara region experiences significant ambient dust levels due to the semi-arid landscape. Background particulate dust monitoring at Fortescue's Port Hedland operations indicate many occurrences annually where naturally occurring dust exceeds the National Environment Protection Measure for Ambient Air Quality (Air NEPM) criteria.

The nearest sensitive receptor to the Eliwana operations is the proposed Eliwana accommodation camp.

Exposure to fibrous minerals poses a risk to employees at the Proposal who are involved in geological exploration mining operation and earthmoving activities.

4.10.5 Potential Impacts

Air emissions can affect both environmental receptors and human health if not managed correctly. The proposed operations at Eliwana have the potential to produce air emissions in the form of dust (including asbestos) and Greenhouse Gas Emissions.

Proposal activities which have the potential to impact air quality include:

- Electricity generation;
- Diesel combustion by fixed and mobile plant and equipment;
- Excavation, handling and processing of iron ore and waste material (including potentially fibrous mineral materials);
- Wheel generated dust from the movement of vehicles and equipment on unsealed roads; and
- Windblown dust from disturbed areas and material stockpiles.

4.10.6 Assessment of Impacts

Fortescue has utilised data collected at existing Fortescue operations to estimate the greenhouse gas emissions associated with the Proposal. Estimation techniques developed for the NPI and NGER reporting were utilised where applicable.

Dust and fibrous mineral impacts have also been assessed for the Proposal.

4.10.6.1 Gaseous Emissions to Air

The Proposal is estimated to require 122,640 Megawatt hours (MWh) of electricity per annum. The Proposal has assessed a number of options for the supply of electricity including:

1. High voltage transmission from the existing natural gas fired turbine at the Solomon Iron Ore Mine;
2. On site gas turbine generation (natural gas supplied from the Fortescue River Gas Pipeline (FRGP));
3. On site gas turbine generation (natural gas supplied from the Goldfields Gas Pipeline (GGP)); and
4. On site diesel fired power station.

The generation of electricity via the combustion of natural gas or diesel will result in the production of greenhouse gas emissions (tonnes carbon dioxide equivalent tCO_2e) and the emission of other pollutants including Volatile Organic Compounds (VOC's), Oxides of Nitrogen (NO_x) and particulate matter.

An estimate of the emissions from each power supply option has been made using data from Fortescue's existing operations. The current data has been sourced from Fortescue's reports submitted in accordance with the NGER and NPI legislation for the 2017 financial year. A summary of the emission estimates for each power supply option are provided in Table 55 below.

Table 55: Summary of Electricity Supply GHG Emissions

Scenario	Option 1 – 132kV Overhead Transmission Line from Solomon (Scope 2 emissions)	Option 2 – Onsite Gas Fired Power Station – Gas – FRGP	Option 3 Onsite Gas Fired Power Station – Gas – GGP	Option 4 – Onsite Diesel Fired Power Station
Benchmark Power Station	Solomon Gas Turbine	Solomon Gas Turbine	Solomon Gas Turbine	Christmas Creek Power Station
Benchmark Power Station	Solomon Gas Turbine	Solomon Gas Turbine	Solomon Gas Turbine	Christmas Creek Power Station
Annual Average Consumption (MWh) (Benchmark FY17 Consumption (MWh))	122,640 (273,263)	122,640 (273,263)	122,640 (273,263)	122,640 (222,759)
Benchmark tCO2e/MWh	0.628	0.628	0.628	0.929
Estimated Annual Emission (tCO2e) (Benchmark Emissions (tCO2e))	76,982.50 (171,530)	76,982.50 (171,530)	76,982.50 (171,530)	114,025.62 (207,112)
Benchmark Power Station	Solomon Gas Turbine	Solomon Gas Turbine	Solomon Gas Turbine	Christmas Creek Power Station
Benchmark Power Station	Solomon Gas Turbine	Solomon Gas Turbine	Solomon Gas Turbine	Christmas Creek Power Station
Annual Average Consumption (MWh) (Benchmark FY17 Consumption (MWh))	122,640 (273,263)	122,640 (273,263)	122,640 (273,263)	122,640 (222,759)
Benchmark tCO2e/MWh	0.628	0.628	0.628	0.929
Estimated Annual Emission (tCO2e) (Benchmark Emissions (tCO2e))	76,982.50 (171,530)	76,982.50 (171,530)	76,982.50 (171,530)	114,025.62 (207,112)

Scenario	Option 1 – 132kV Overhead Transmission Line from Solomon (Scope 2 emissions)	Option 2 – Onsite Gas Fired Power Station – Gas – FRGP	Option 3 Onsite Gas Fired Power Station – Gas – GGP	Option 4 – Onsite Diesel Fired Power Station
Estimated LoM Emission (tCO2e)	1,847,579.97	1,847,579.97	1,847,579.97	2,736,614.97
Estimated VOC (kg) (Benchmark VOC kg)	3,660 (8,154)	3,660 (8,154)	3,660 (8,154)	37,414 (67,957)
Estimated NO_x (tonne) (Benchmark NO_x tonne)	915 (2,039)	915 (2,039)	915 (2,039)	884 (1,606)
Estimated Particulates (PM_{10}) kg (Benchmark Particulates (PM_{10}) kg)	13,215 (28,313)	13,215 (28,313)	13,215 (28,313)	46,483 (84,431)

Fortescue estimates the GHG emissions associated with electricity generation to be identical for the three options utilising a natural gas turbine. The estimated emissions for gas turbine generated electricity is 76,982.50 tCO_2e whilst the estimated emissions for Option 4 (diesel power station) are significantly higher at 114,025.62 tCO_2e.

The emissions associated with Option 1 (high voltage transmission) would be considered a Scope 2 emission because the electricity is generated at a second facility and would be consumed by the Eliwana Project. Emissions for the alternative 3 options would be considered Scope 1 emissions as the power stations would be located at the Eliwana Project.

Estimates of the emission of VOC's, NO_x and particulates associated with the production of electricity were calculated using the relevant NPI emission reports for the benchmark sites. A summary of the results is provided in Table 55. The estimate for the diesel power station produces the largest annual emissions of VOC's and particulates of 37,414 kg and 46,483 kg respectively. Whilst the natural gas combustion option produces an annual NO_x emission of 915 tonnes compared to the diesel power station option of 894 tonnes.

4.10.6.2 Mobile and Fixed Plant Diesel Combustion

The proposal will result in emissions from diesel combustion used in fixed and mobile plant and equipment including (but not limited to):

- Mining and earthmoving equipment;
- Light vehicles;

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- Generators; and
- Lighting plants.

In order to estimate the emissions associated with the Proposal, data from Fortescue's existing operations at the Solomon Iron Ore Mine for the financial year 2017 were utilised. The Solomon Iron Ore Mine was chosen as a benchmark as the operations are similar to the Proposal (i.e. open cut mining using traditional drill, blast, load and haul methods, use of automated earthmoving fleet, similar ore processing, similar terrain and operating conditions).

The Solomon operations reported the 2017 financial year emissions in accordance with the NGER and NPI legislation. A summary of the emission estimate associated with diesel combustion are provided in Table 56 below.

Table 56: Summary of fixed and mobile plant emissions

Parameter	Solomon (FY17 reported)	Eliwana (Estimate)
Total Material Movement (t)	211,352,645	103,000,000
Mining Diesel Consumption (L)	119,287,511	58,415,000
Mining diesel intensity (L/t)	0.56	0.56
Total Emissions (tCO2e)	324,651	158,289
Emissions intensity (tCO2e/t)	0.00154	0.00154
VOC's (tonne)	157.5	77.1
NO_x (tonne)	3,721.8	1,822.6
Particulates (PM_{10}) tonnes	195.6	95.8

Fortescue estimates the Solomon operations had a diesel intensity of 0.56 litres per tonne of material moved. Total material movements (ore and waste mined) estimated for Eliwana are 103 Million tonnes per annum. This equates to 58.4 Million litres of diesel required. Combustion of this diesel in a comparable fleet of fixed and mobile equipment will result in an estimated GHG emission of 158,289 tCO_2e.

The estimated diesel consumption for the Project fixed and mobile equipment would result in an annual emission of 77.1 tonnes of VOC's, 1,822.63 tonnes of NO_x and 95.8 tonnes of particulates (PM_{10}).

4.10.6.3 Annual GHG Emissions

The Australian government publishes the National Greenhouse Gas Inventory as part of the commitments made under the Kyoto Protocol. For the 2015 inventory year the Australian greenhouse gas emissions were 537,850.52 Gt (1,000 tonnes) CO_2e within which Western Australia's contribution was 86,450.34 Gt CO_2e (Department of Environment; Energy, 2017c). The annual maximum emission of greenhouse gases estimated for the Proposal is 272.3 Gt CO_2e, this estimate uses electricity generation Option 4 as it is the largest emission estimate.

The estimate annual emission is equivalent to 0.05% of the nation's emissions and 0.31% of Western Australia's emissions. The estimate GHG emission results in an estimate emission intensity of 0.007 t CO_2e per tonne of iron ore produced. A summary of the estimated greenhouse gas emissions is provided in Table 57.

Table 57: Estimate of Total Greenhouse Gas Emissions

Source	Quantity
Power Generation	114,026
Fixed and Mobile Plant and Equipment	158,289
Total Estimated GHG Emissions (tonnes)	272,315
Total Estimated GHG Emissions Gt (000's tonnes)	272.3
Australia 2015 GHG Inventory (Gt)	537,850.52
% Australia 2015 GHG Inventory	0.05
Western Australia 2015 GHG Inventory (Gt)	86,450.34
% Western Australia 2015 GHG Inventory	0.31

Fortescue proposes to implement a revised version of the current *GHG Emissions and Energy Reporting Management Plan* (Fortescue, 2011a) during development of the Proposal. The plan outlines Fortescue processes to support the required greenhouse gas and energy reporting. The revised plan is located at Appendix 23.

4.10.6.4 Dust Emissions

The Proposal includes a number of processes with the potential to result in the generation of dust. In the assessment of environmental impacts, dust is more conventionally referred to as 'particulates' or 'airborne particulates'. Dust is made up of a number of different sized particles. Airborne particulate matter less than 50 micrometres (µm) in diameter are referred to as Total Suspended particulates (TSP). Finer particles less than 10 µm and 2.5 µm in diameter are referred to as PM_{10} and $PM_{2.5}$ respectively (Heggies, 2010).

Most airborne particulates likely to originate from the proposed operations are greater than PM_{10} and are more associated with nuisance rather than public health impacts. The larger particles tend to settle back to the ground within a short range (less than 300 m) from the source (Heggies, 2010).

Activities associated with the Proposal which may potentially cause dust emissions are similar to those of the existing Fortescue mining operations and include:

- clearing of vegetation;
- topsoil recovery and placement;

- blasting;
- ground disturbance and mining, including removal of overburden and ore;
- material stockpiling;
- vehicle movement;
- ore processing and transport.

These activities can result in impacts to such as reduction in air quality leading to:

- Safety impacts such as reduced visibility when driving;
- Health impacts from inhalation in dust particles;
- Nuisance build-up of dust on clothing, vehicles and outdoor areas.

Dust may also interfere with physiological processes of flora and vegetation such as:

- Photosynthesis; and
- transpiration and respiration.

In extreme cases dust deposition can smother and kill vegetation and lead to increased incidence of plant pests and diseases.

Vegetation damage from dust deposition can result in degradation of fauna habitat leading to loss or fragmentation of foraging areas and may expose fauna to increased risk of predation. This reduction in vegetation cover can restrict the movement of animals within their established foraging and breeding habitat.

Fortescue currently estimates fugitive emissions of particulate matter from its current operations as required for the annual NPI reporting. An estimate of the fugitive particulate matter (PM_{10}) emissions for Eliwana was derived from the emission calculated for the Solomon operations for the FY17 reporting period. As fugitive emissions are associated with ground disturbing activities, earthmoving operations, material stockpiles and roads the estimate was calculated using the area of disturbed ground currently at Solomon and estimated for Eliwana. A summary of the fugitive particulate estimate is provided in Table 58.

Table 58: Estimate of Fugitive Particulate Emissions

	Solomon (FY17 NPI Report)	Eliwana (Estimate)
Area of Disturbance	4078	8560
Fugitive Particulate Matter (PM_{10}) tonnes	18,325	38,461

Fortescue estimates that the Project would produce a fugitive particulate matter (PM_{10}) emission of 38,461 tonnes per annum. Fortescue considers this to be a highly conservative estimate based on the entire Project footprint being disturbed simultaneously. In all likelihood the Project would be developed progressively, and a proportion of disturbance rehabilitated to reduce the fugitive dust emission.

4.10.6.5 Fibrous Materials

Exploration drilling activities within the Proposal have intersected mineral material containing fibrous material including potentially asbestos materials. Fibrous minerals have been intersected in both the Brockman and Marra Mamba and iron formations. The Joffre and Dales Gorge members of the Brockman formation are the major sources of fibrous material intersections. Fibrous materials intersected have been identified as riebecktite, griqualardite and tigers eye.

Fibrous minerals present a human health and environmental contamination risk. Fortescue manages potential mineral fibre exposure at its existing operations through the implementation of its *Fibrous Minerals Management Procedure*.

The procedure will be implemented during the development and operation of the Eliwana Iron Ore Mine and given appropriate management Fortescue considers the impacts associated with fibrous minerals to be minimal.

4.10.6.6 Cumulative Impacts

Fortescue does not consider the Proposals estimated greenhouse gas emissions to significantly increase the contribution of Western Australia's emissions to the national greenhouse gas inventory.

Given the location of the proposed operations and distance to the nearest sensitive receptors Fortescue does not consider that dust generated during implementation of the Proposal poses a significant environmental risk.

4.10.7 Mitigation

Fortescue has applied the mitigation hierarchy to the Project in relation to air quality. Mitigation measures include:

Avoidance

- Mine planning that where possible avoids disturbing known deposits of fibrous materials.

Minimisation

- The Eliwana Project proposes to utilise the latest available technology in the combustion of natural gas or diesel for power generation;
- Automated mining equipment has shown operate more efficiently than manned machinery at Fortescue's nearby Solomon Operations and will be utilised at Eliwana;
- The *Mine and Rail Dust Management Plan 45-PL-EN-0030* identifies specific management measures to minimise dust generation during construction and operation, including:
    - haulage distances will be minimised through the use of overland conveyors to transport ore to the OPF and stockyard storage area;
    - the incorporation of dust control measures into project design;
    - the use of water carts on high traffic areas (e.g. access roads, temporary camps and laydown areas);
    - progressive rehabilitation of disturbed areas to minimise potential for dust generation;
    - minimisation of vegetation clearing;
    - optimisation of vehicle movements;
    - daily visual inspections of construction areas to ensure dust control management measures are implemented and effective; and
    - ambient dust monitoring where appropriate.
- the *Fibrous Minerals Management Procedure* identifies specific processes to identify and minimise the risks associated with exposure to fibrous materials.

Rehabilitation/Revegetation

- Revegetation of disturbed areas to minimise dust generation.

4.10.8 Predicted Outcome

Fortescue considers the Proposal is consistent with the EPA's objective for the Air Quality factor and that the factor can be managed within the requirements of the EP Act and regulations.

5. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The EPBC Act is administered by the DoEE and provides a legal framework for the protection and management of nationally and internationally important flora, fauna, ecological communities and heritage places, which are referred to as MNES. Specifically, the EPBC Act protects the following MNES:

- World heritage places
- National heritage places
- Wetlands of international importance
- Listed threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions
- A water resource, in relation to coal seam gas development and large coal mining development.

Pursuant to the EPBC Act, any proposed action that has or is likely to have a significant impact on a MNES requires approval from the Commonwealth Minister for the Environment.

Several fauna species listed as MNES under the EPBC Act have previously been located within the MDE. Fortescue referred the Proposal to the DoEE in August 2017 (EPBC 2017/8024). On 7 November 2017 the Proposal was determined to be a Controlled Action under the EPBC Act, with the controlling provision being identified as being listed threatened species and communities (Section 18 and 18A of the EPBC Act). The DoEE also determined that the proposal would be assessed as an accredited assessment by the State of Western Australia.

This chapter provides the formal environmental impact assessment for MNES.

5.1 Project Surveys

Terrestrial fauna surveys undertaken across the MDE and within the local area were highlighted in Section 4.7.3. These surveys included targeted surveys for key MNES species including Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python and Ghost Bat.

5.1.1 EPBC Protected Matters Search Tool

A search of the EPBC Act Protected Matters Search Tool was undertaken as part of the Consolidated Fauna Survey. The 10 EPBC Act listed threatened species identified by the search tool are listed in Table 59.

Table 59: MNES species that may occur within the Mine Development Envelope

Species	Common Name	Status	Records in Vicinity of the Proposal
Dasyurus hallucatus	Northern Quoll	Endangered	Recorded from two locations in the Mine Development Envelope
Pezoporus occidentalis	Night Parrot	Endangered	No records from the vicinity of the proposal. No suitable long unburnt spinifex habitat was recorded from the Mine Development Envelope.
Macrotis lagotis	Greater Bilby	Vulnerable	No records from the vicinity of the proposal. No suitable habitat identified in the region despite intense survey effort.
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	Vulnerable	Recorded from several locations within the Mine Development Envelope. Suitable habitat present for roosting and foraging.
Macroderma gigas	Ghost Bat	Vulnerable	Several records from the Mine Development Envelope.
Liasis olivaceus barroni	Pilbara Olive Python	Vulnerable	Two individuals recorded from the Mine Development Envelope. Suitable habitat available in rocky gorges, gullies and major creeks.
Apus pacificus	Fork-tailed Swift	Migratory	Recorded flying over the Mine development Envelope.
Plegadis falcinellus	Glossy Ibis	Migratory	No records in the Mine Development Envelope. Suitable seasonal habitat present.
Pandion cristatus	Eastern Osprey	Migratory	One previous record, 20km from Mine Development Envelope. No suitable habitat present.

Species	Common Name	Status	Records in Vicinity of the Proposal
Charadrius veredus	Oriental Plover	Migratory	No records from the Mine Development Envelope. No suitable habitat present.

5.2 Threatened Fauna

Of the species listed in Table 59, the following species have been recorded within the MDE (Figure 55).

- Northern Quoll (*Dasyurus hallucatus*)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)
- Ghost Bat (*Macroderma gigas*)
- Pilbara Olive Python (*Liasis olivaceus barroni*)
- Fork-tailed Swift (*Apus pacificus*)

These species are considered in the following sections. The Fork-tailed Swift is not discussed further as it is an itinerant visitor to the area and spends almost all its existence on the wing and there does not rely on any habitat within the MDE.

Also discussed in the following sections is the Night Parrot, which has been included by the DoEE as a controlling provision, although there are no records in the MDE for this species and suitable habitat is not considered to be present.

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Legend to Fauna Habitat Mapping

- All other values
- Drainage Line/River/Creek (Major)
- Drainage Line/River/Creek (Minor)
- Gorges/Gullys
- Hills/Ranges/Plateaux
- Non Compliant Description
- Plain (shrubland)
- Plain (stony/gibber)
- Rocky Escarpments (Ridges/Mesa/Cliffs/Outcrops/Breakaways)
- Significant Fauna Habitat (Northern Quoll)
- Significant Fauna Habitat (Pilbara Leaf-nosed Bat)
- Significant Fauna Habitat (Pilbara Olive Python)
- Woodland (Open/Closed)

SERPENTINE CREEK

DUCK CREEK

Eliwana

PINARRA CREEK

BOOLGEEDA CREEK

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Ghost Bat
- Northern Quoll
- Pilbara Leaf-nosed Bat
- Pilbara Olive Python

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

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Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.032_r2

Date: 21-Aug-18
Size: A3L
Revision: 1
Confidentiality: 1

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Figure 55
MNES within
Mine Development Envelope

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5.2.1 Northern Quoll

The Northern Quoll (*Daysurus hallucatus*) is listed as Endangered under the EPBC Act. Although the species once occurred across Northern Australia, it is now restricted to the Pilbara and Kimberley regions of Western Australia and a few discrete populations in the Northern Territory and Queensland (Department of Environment; Energy, 2017a).

5.2.1.1 Survey Effort

Targeted survey effort within the MDE consists of:

- Thirty-nine (39) cage traps over three nights in 2011, totalling 100 trap nights and a total of 38 nights of motion camera (Ecoscape, 2012b)
- Fifteen (15) trapping sites totalling 651 trap nights in 2012 and 16 Motion cameras deployed at 23 sites for a total recorded time of 1,822 hours (Ecologia Environment, 2015)
- Fifty-nine (59) motion cameras at nine long term Northern Quoll sites for a total of 3,592 hours and a further 58 motion cameras set at 11 sites for four nights for a total of 232 hours (Ecoscape, 2017b)

The survey effort for Northern Quoll exceeds survey guidance for this species and the results from the surveys may be considered definitive in terms of the size and temporal presence and abundance of the local Northern Quoll population, as detailed in Table 15 of Ecoscape's survey report (Appendix 18).

5.2.1.2 Habitat

The Northern Quoll occupies a variety of habitats where it occurs, including rocky areas, eucalypt forests and woodlands, rainforests, sandy lowlands, shrublands, grasslands and deserts (Department of Environment; Energy, 2017a). However, Northern Quoll generally utilise rocky habitats for denning habitat with surrounding vegetated habitats used for foraging and dispersal. In the Pilbara, Northern Quoll prefer Rocklea, Macroy and Robe land systems (Department of Environment; Energy, 2017a), with the highest quality habitat considered to be rugged, rocky areas in close association with permanent water (Cramer, et al., 2016).

Fortescue's surveying identified 6,182.2 hectares of suitable denning and foraging habitat within the MDE, consisting of

- 5,335.5 ha of Hills/Ranges/Plateaux used for foraging and dispersal;

- 539.5 ha of Drainage Line/River/Creek (Major) habitat used for foraging and dispersal; and
- 307.2 ha of Gorges/Gullies habitat, representing denning and foraging habitat.

Habitat for Northern Quoll is depicted in Figure 56.

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SERPENTINE CREEK
DUCK CREEK
Eliwana
PINARRA CREEK
BOOLGEEDA CREEK

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Northern Quoll
- Foraging and Dispersal Habitat

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

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Kilometres

Requested By: M.Dowling
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Figure 56
Northern Quoll Records and Habitat

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5.2.1.3 Local Population

Within the MDE, Northern Quoll was recorded from Gorges/Gullies and the Lower Slopes/Hillslopes habitat. Two individual Northern Quoll were recorded from motion cameras in 2017 (Ecoscape, 2017b). In addition, a potential, but unverifiable, Northern Quoll scat was located during the 2012 surveys (Ecologia Environment, 2015) in Gorges/Gullies habitat. Locations where Northern Quoll were recorded are shown in Figure 56. The time of year when the Northern Quoll were captured by motion camera indicates that the two quolls recorded in 2017 are likely to be males moving through the area in search of females (Ecoscape, 2017b).

Higher density populations of Northern Quoll are known to occur at Fortescue's Solomon Project (Ecoscape, 2017a) and populations are known to occur at Fortescue's Edge and Delphine project areas, located west of the MDE. Ecoscape (2017b) suggest that the individuals located in the MDE are likely to have originated from a population to the south and east and are likely to be individuals dispersing from areas of high density populations.

Fortescue highlights that the 2016/17 summer wet season provided favourable conditions for the expansion of Northern Quoll populations and given the paucity of records in the MDE, despite significant survey effort in previous seasons, the presence of the two individuals within the MDE in 2017 suggests they are transient individuals that are unlikely to represent a local resident population. Therefore, the MDE represents marginal Northern Quoll habitat and the species is only likely to be present in the local area following good seasonal conditions and will not persist on a long-term basis.

5.2.1.4 Threats

Threats to the conservation of Northern Quoll as outlined in Cramer, et al, (2016) and the National Recovery Plan (Hill & Ward, 2010) and relevant to the Pilbara population are discussed in Table 60. These threats are considered in the assessment of the impact of the Proposal to the Northern Quoll later in this Section.

Table 60: Threats to Northern Quoll

Threat	Discussion
Feral Predators	Within the Pilbara, the feral cat is the greatest threat to the Northern Quoll. Feral cats have previously been located within the Mine Development Envelope.
Changed Fire Regimes	Changes to fire regimes has a significant impact on vegetation structure. Too-frequent fires reduces vegetation cover, potentially exposing the species to a higher risk of predation and may reduce abundance of food. Studies have shown that whilst quoll can adapt to changes in available food sources, this may impact on their ability to reproduce (Hill & Ward, 2010).
Ingestion of Cane Toad	The cane toad is not present in the Pilbara and the Pilbara population has long been considered as stronghold of the species against the impacts from cane toads (Cramer, et al., 2016).

Threat	Discussion
Removal and Degradation of Habitat	The clearing associated with development projects such as the Eliwana Mine may reduce the denning and foraging habitat available to the species and fragment populations in the Pilbara.
Weeds	Presence of weeds could inhibit the movement of northern quoll or expose them to a higher risk of frequent and intense fire.

5.2.1.5 Relevant Policy and Guidance

Policy and guidance documents relevant to this species are:

- Threatened Species Scientific Committee (2005). Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*).
- National Recovery Plan for the Northern Quoll *Dasyurus hallucatus*. (Hill & Ward, 2010)
- Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by Cane Toads. (Commonwealth of Australia, 2011).
- Threat abatement plan for predation by feral cats (Commonwealth of Australia, 2015)
- Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses. (Department of Sustainability, Environment, Water, Population and Communities, 2012a)
- Survey Guidelines for Australia's Threatened Mammals (Department of Sustainability, Environment, Water, Population and Communities, 2011a)
- EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus (Department of Environment, 2016)
- Research priorities for the northern quoll (*Dasyurus hallucatus*) in the Pilbara region of Western Australia. (Cramer, et al., 2016)

The terrestrial fauna surveys and environmental impact assessment have taken these policy and guidance documents into consideration:

- Surveys targeting Northern Quoll were undertaken during periods in which Northern Quoll are most likely to be detected (May-July),
- A variety of methods including trapping and motion cameras have been used to detect Northern Quoll;
- Survey sites were selected based on preferred habitat type and included a range of habitats;
- The surveys have provided additional knowledge in accordance with the published research priorities for the species;

- Potential threats to the Pilbara Northern Quoll population as identified in guidance documents have been considered;
- The significance of the potential impacts to the species have been assessed using published guidance; and
- Management and mitigation address the recommendations in Table 2 of the Northern Quoll referral guideline.

5.2.1.6 Potential Impacts

Clearing for mining operations will result in the direct loss of denning, dispersal and foraging habitat for the Northern Quoll. The area of potential disturbance to habitat is presented in Table 61. The loss of habitat may result in the mortality of individual quolls or force the relocation of local individuals. However, given the species is present in very low numbers within the MDE, and that individuals present are unlikely to be resident, the impact to the species is likely to be insignificant.

Table 61: Potential habitat loss for the Northern Quoll

Habitat Type	Area within the MDE (ha)	Area potential disturbance (ha)	% habitat remaining
Hills/Ranges/Plateaux	5,335.5	944	82.4
Drainage/River/Creek (Major)	539.5	54.9	89.8
Gorges/Gullies	307.2	36	88.3

The Gorges/Gullies habitat represents critical denning habitat for the Northern Quoll. The potential loss of 11.7% of the available denning habitat is unlikely to have a significant impact on the ability of the species to successfully find suitable dens at times when they are present in the area.

The greater majority (95%) of suitable Northern Quoll habitat within the MDE consists of foraging and dispersal habitat. Based on all available evidence from terrestrial fauna surveys, the MDE represents marginal habitat for the species and the loss of 999 ha of foraging and dispersal habitat is unlikely to significantly impact on this species ability to forage and disperse in the local area.

Clearing of vegetation can also lead to associated impacts including habitat fragmentation and edge effects. Fragmentation can lead to the isolation of one habitat area from another. Linear type infrastructure can act as a barrier to fauna movements between isolated patches of habitat. Fragmentation can also lead to edge effects such as invasion by weeds, increase run-off and easier access by feral predators. Given the low population numbers in the area, the impact from habitat fragmentation and edge effects are likely to be minimal.

Alteration to Surface Water

Modification to surface water flows to accommodate mine and associated infrastructure may lead to changes in fauna habitat. However, reduced surface water flow is unlikely to significantly impact in the ability of Northern Quoll to utilise denning, foraging and dispersal habitat within the mine development envelope, particularly given the very small numbers of Northern Quoll present within the area at any time.

Vehicle Movement and Blasting

Vehicle and plant movements during construction and operation may result in the death or injury of individual Northern Quoll. Noise and vibration associated with blasting and vehicle movements as well as dust generation may deter Northern Quolls from using habitat in the MDE. Given the low numbers present, the impacts from this type of disturbance will be minimal. Fortescue highlights that Quolls continue to be recorded in close proximity to its operating sites, particularly at Solomon, where Northern Quolls are often recorded at its OPF and adjacent areas.

Feral Predators

The establishment or increase in the numbers of feral predators is a potential impact to Northern Quoll. Areas cleared for infrastructure and mining provides a means of ingress to the area by feral predators and inappropriate handling and storage of putrescible waste can attract feral animals to operations. The low numbers of Northern Quolls in the area suggests impacts from feral predators would be marginal, although an increase in feral animals may result in the area becoming unsuitable for Northern Quoll given the habitat is already marginal. Management of feral predators is discussed further in this Section.

Inappropriate Fire Regimes

The proposal has the potential to increase the frequency of fires in proximity to the mine area. Fires can be caused by:

- Sparks from grinding or welding;
- Inappropriate disposal of cigarette butts; or
- Ignition of flammable vegetation through sparks and radiated heat from vehicle exhausts.

As discussed earlier, more frequent fires can impact on the ability of Northern Quoll to continue to utilise the area. Management of fire during construction and operation of the Proposal is discussed further in this Section.

5.2.1.7 Proposed Management

Impacts to Northern Quoll are managed under Fortescue's *Conservation Significant Fauna Management Plan 100-PL-EN-0022*. The management actions outlined in the Plan align with best practice mitigation outlined in (Department of Environment, 2016) and are listed in Table 62.

Table 62: Mitigation Measures for Northern Quoll

Threat	Management Action from 100-PL-EN-0022
Habitat Clearing	• Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts to conservation significant fauna. • Design and locate borrow pits to minimise the potential impact on conservation significant fauna and associated habitat in accordance with the *Borrow Pit Management Plan 100-PL-EN-0018.* • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging in accordance with *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042.* • When conservation significant fauna species have been recorded within the impact area, ground-truth the area and similar habitats within the area, and where individual animals are present implement mitigation measures, including the relocation of fauna, prior to disturbance and in consultation with DBCA. • Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the Land Use Certificate Procedure and/or the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042.* • Conduct progressive rehabilitation of disturbed areas, particularly those areas with known conservation significant fauna and associated habitat, in accordance with the *Exploration Environmental Management Plan E-PL-EN-0002* or *Eliwana Mine Closure Plan EW-PL-EN-0001.*
Feral Predators	• Develop and implement a Feral Animal Program to effectively manage and control feral animals within Fortescue controlled sites to minimise impacts on conservation significant fauna. • Manage waste materials and on-site landfill facilities in accordance with the *Waste Management Plan 45-PL-EN-0014* to minimise potential impacts on fauna and the likelihood of increases in feral animal numbers.
Inappropriate Fire Regime	• When constructing a fire break or carrying out a prescribed burn where conservation significant fauna and habitat have been identified, adhere to the requirements outlined in the *Bushfire Management Plan 100-PL-EM-0009.*
Vehicle Movements and Blasting	• To minimise the potential for fauna injuries or deaths on haul and access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving.
Weeds	• Ensure all vehicles, plant and equipment, including trailered equipment, are clean, inspected and certified prior to entry into Fortescue controlled sites to prevent the degradation of priority fauna habitat in accordance with the *Weed Management Plan 100-PL-EN-1017.*

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5.2.1.8 Significance Test

A summary of the assessment of the proposal against the Significant Impact Guidelines 1.1 (Department of Environment, 2009) is provided in Table 63. The assessment takes into account the mitigation measures outlined above.

Table 63: Significance Test – Northern Quoll

Criteria for Endangered Species	Assessment of Significant Impact
Lead to a long-term decrease in the size of the population.	The proposal will result in the removal of 36 ha of denning habitat and 999 ha of foraging and dispersal habitat. However this is only a very small proportion of the mapped extent of denning, foraging and dispersal habitat within the mine development envelope. The species occurs in the area in very low numbers, and all available evidence suggests that it is likely that without significant summer rainfall, the Northern Quoll may not occur in the local area. Consequently, the project will not result in a long-term decrease in the size of the population.
Reduce the area of occupancy of the species.	The number of Northern Quolls that may inhabit the area are so low that determining an area of occupancy for the species in the local area is somewhat difficult. However, given the home range for a male northern quoll is considered to be more than 100 ha (Department of Environment; Energy, 2017a) the area of occupancy for the two quolls detected in 2017 would be over 200 ha. Given there remains available 5,147 ha of denning, foraging and dispersal habitat to such a low number of Northern Quolls post disturbance, including 89% of the original denning habitat extent, the proposal is highly unlikely to reduce the area of occupancy for Northern Quoll.
Fragment an existing population into two or more populations	The low numbers of Northern Quoll in the area suggest that there is unlikely to be a resident population within the Mine Development Envelope. Whilst there will be some fragmentation of habitat as a result of the proposal, this is unlikely to cause a dislocation between two or more populations.
Adversely affect habitat critical to the survival of a species	Disturbance to Gorge/Gullies habitat which may be used as denning habitat by Northern Quoll is minor. The low density of northern quoll in the local area suggests the habitat within the mine development envelope is marginal and may not represent critical habitat.
Disrupt the breeding cycle of a population	The two Quolls captured on motion camera within the mine development envelope are thought to be males dispersing from nearby populations to the south and east. It is unlikely that any female Quolls are resident in the area due to the very low number of Quoll detections despite extensive survey effort. The mine development envelope is unlikely to host a breeding population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	There will be a loss of denning and foraging habitat. However, extensive areas of potential denning and foraging habitat will remain post-disturbance. It is unlikely that the proposed clearing will result in a decline in Northern Quoll numbers in the local area.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered habitat	Management measures will be implemented to avoid the introduction of, or increase in invasive weed species and feral predators into the area. It is unlikely that the proposed action will result in the introduction of invasive species to the detriment of Northern Quoll.

Criteria for Endangered Species	Assessment of Significant Impact
Introduce disease that may cause the species to decline.	Management measures will be implemented to reduce the risk of invasive species being introduced. This management will include procedures to avoid introduction of feral animals which may bring disease into the area.
Interfere with the recovery of the species	The mine development envelope is unlikely to host a breeding population. Implementation of the project will not impact the recovery of the species.

Given the very low numbers of Northern Quoll in the MDE and that there is unlikely to be a permanent breeding population, the implementation of the proposal is unlikely to have a significant impact to the Northern Quoll.

5.2.1.9 Offsets

An environmental offset is not required for residual impacts to the Northern Quoll. Fortescue highlights that it is likely that a condition of any EP Act approval is likely to include the requirement for an offset for the loss of vegetation in good to excellent condition, including vegetation that may be habitat for the Northern Quoll.

5.2.2 Pilbara Leaf-nosed Bat

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as Vulnerable under the EPBC Act. *R. aurantia* are found in the Pilbara and Kimberley regions of Western Australia, as well as the Northern Territory and Queensland. The Pilbara population is recognised as a separate form of the species due to early taxonomic work, which recognised the Pilbara population as having a slightly smaller nose leaf and a different ultrasonic call frequency (Armstrong, 2002). More recent genetic studies have demonstrated that the Pilbara population has been genetically isolated from the Kimberley population for approximately 30,000 years and that it is worthy as consideration for conservation (Armstrong, 2006).

5.2.2.1 Survey Effort

A number of ultrasonic surveys have been conducted to locate Pilbara Leaf-nosed Bat within the MDE and surrounding areas.

- Western Hub Project: The Edge Vertebrate Fauna Survey (Biologic, 2014a). 35 multi-spectrum ultrasonic recording sites over 5 days during the first phase and a further 54 recordings from 20 locations during a targeted survey.
- Eliwana Vegetation, Flora and Fauna Assessment and Targeted Conservation Significant Flora and Fauna Survey (Ecoscape, 2012a). Three ANABAT® locations during a level 1 fauna survey.

- Eliwana and Flying Fish Project (Ecologia Environment, 2015). 52 SM2 recording sites over two phases, totalling 700 hours of acoustic recordings

Based on the results from these and other publicly available reports and database searches, a targeted survey for Pilbara Leaf-nosed Bat (and Ghost Bat - reported in section 5.2.3) was undertaken in 2017. This survey combined known *R. aurantia* call data, topography, and slope analysis, as well as documented flight speeds to determine possible roost locations both within and in the vicinity of the MDE. A demonstration of how target roost areas were developed in shown in Figure 12 of Appendix 18. The targeted survey involved multi-spectrum ultrasonic recorders at 36 sites within the target areas across two survey periods (February and April 2017) for a total of 176 hours.

In addition, during the Level 2 fauna survey in July 2017, a multi-spectrum ultrasonic recorder was placed at each trapping site to record bat calls for a total of 70 hours.

This survey effort combined with all other publicly available data, exceeds guidance on the survey of this species. The results from the 2017 surveys may be considered to represent an accurate representation of the presence of Pilbara Leaf-nosed Bat within the MDE and surrounding areas.

5.2.2.2 Habitat

In the Pilbara, *R. aurantia* is generally encountered in rocky areas that provide opportunity for roosting in caves or disused underground mines (Armstrong, 2001). For a cave or abandoned mine to be considered suitable roosting habitat, the cave must feature a stable microclimate that provides warm, humid conditions because of the species poor ability to maintain its heat and water balance (Armstrong, 2001). The availability of suitable roosts is considered to be the limiting factor to the species distribution in the Pilbara (Cramer, et al., 2016).

Although there are suspected diurnal roosts in the Pilbara, the actual number of confirmed roosts are few. Confirmed roosts include abandoned mines in the East Pilbara such as the Lalla Rookh, Bamboo Creek, Comet, Klondyke Queen and Copper Hills mines. Some of these mines are at risk of collapse and it is not known if previously recorded populations continue to exist. Other known roosts in the East Pilbara include Cave Gorge and Fortescue's North Star mine. In the Hamersley Range, confirmed roosts are known from Koodaideri and a cave on Red Hill station. Another known roost occurs in the Barlee Range, just south of the Pilbara Region.

Pilbara Leaf-nosed Bat has been recorded from 13 locations within the MDE in Gorges/Gullies, Hills/Ranges/Plateaux and Lower Slopes/Hillslopes habitat (Ecoscape, 2017b). Fauna habitats mapped within the MDE that represent Pilbara Leaf-nosed Habitat include:

- 304.2 ha of Gorges/Gullies habitat representing potential roosting habitat;
- 5,335.5 ha of Hills/Ranges/Plateaux representing potential foraging and nocturnal roost areas;

- 26,025 ha of Lower Slopes/Hillslopes representing possible foraging habitat; and
- 284 ha of Drainage Line/River Creek (Major) representing possible foraging habitat.

Locations where Pilbara Leaf-nosed Bat has been recorded within the MDE are presented in Figure 57. Given their potential foraging and dispersal range can be in the order of up to 20 km per night, almost any area within the MDE could be considered foraging and dispersal habitat.

Gorges/Gullies habitat for Pilbara Leaf-nosed Bat is shown in Figure 57.

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SERPENTINE CREEK
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BOOLGEEDA CREEK
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LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Pilbara Leaf-Nosed Bat
- Potential Roosting Habitat

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
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Figure 57
Pilbara Leaf-Nosed Bat Records and Habitat

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5.2.2.3 Local Population

The results of all Pilbara Leaf-nosed Bat ultrasonic records during 2017 surveys are listed in Tables 21 – 24 of Appendix 18. Significant to these results is the time stamp of when *R. aurantia* bat calls are recorded.

Pilbara Leaf-nosed Bat generally exit their diurnal roost within 10-20 minutes of civil twilight after sunset. In the Pilbara, civil twilight occurs approximately 20-25 minutes after sunset, depending on the time of year. Therefore, any *R. aurantia* ultrasonic call recorded within 35-40 minutes of sunset suggests that the individual must have been roosting very close to the recording device. Similarly, the sooner a call is recorded to sunrise, the more likely it is that the individual is close to a diurnal roost.

Ecoscape used a timeframe of one hour after sunset to indicate whether the recorded individual may have been roosting close to the recording device, noting that the individual could have exited the cave up to 30 minutes beforehand. Selecting the one hour timeframe allows for some delay in a bat exiting the roost, possibly due to the presence of a predator. Given the flight speed of *R. aurantia* has been estimated at 22 km/h (McKenzie & Bullen, 2009), upon being recorded 1 hour after sunset, a Pilbara Leaf-nosed Bat individual could have flown up to 10 km since exiting the cave at civil twilight. This demonstrates how calls recorded immediately after civil twilight are significant for predicting whether the location is used for diurnal roosting.

Within the MDE, Pilbara Leaf-nosed Bat has been recorded from 8 locations (Figure 57). The timing of all *R. aurantia* calls recorded is shown in Table 64.

Table 64: Record of Bat Calls within MDE

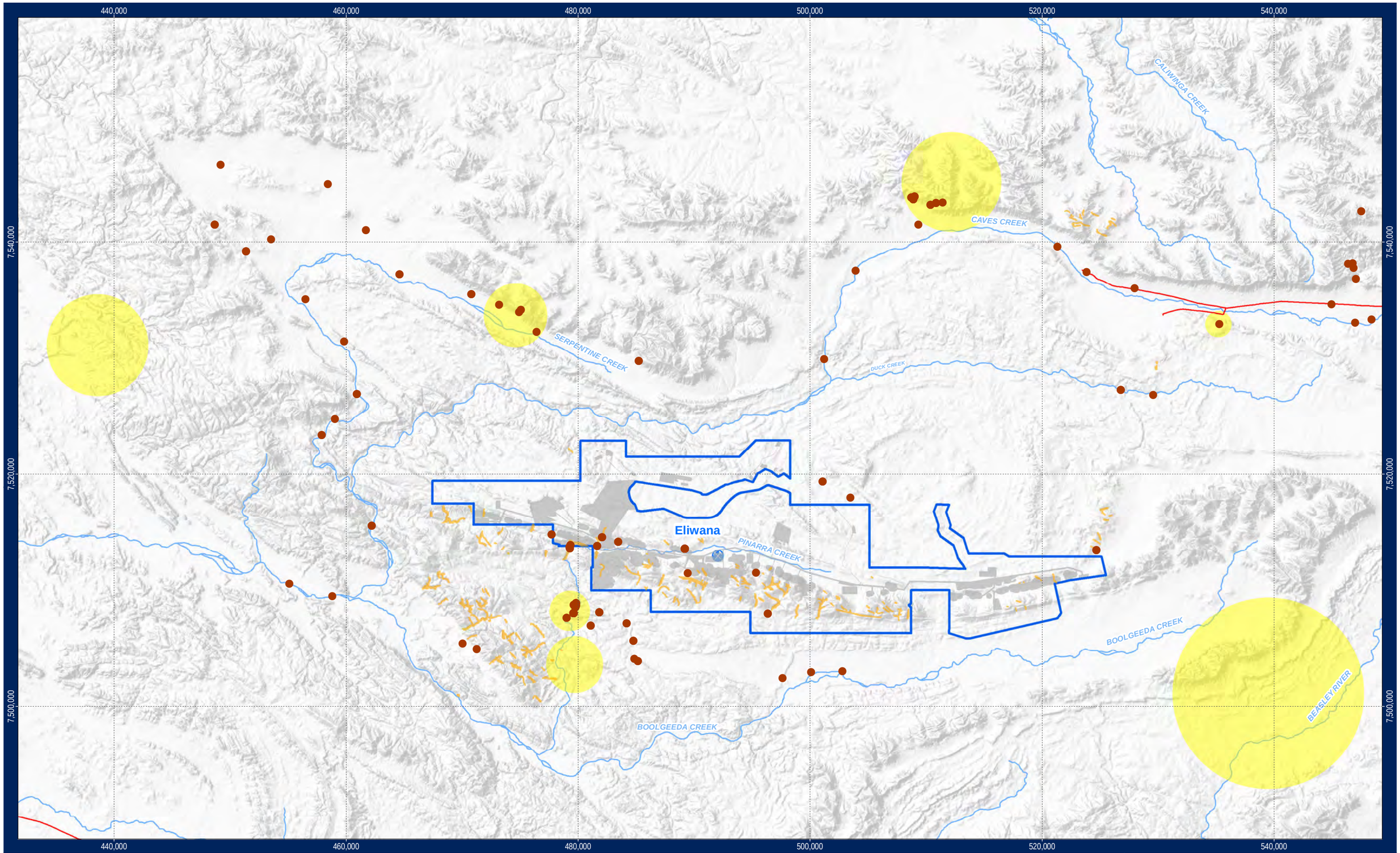
Locations	Date	Call Times	Sunset (Civil Twilight) Sunrise (Civil Twilight)
EDPE-BAT1-35	25/2/17	2234-0132 (2 calls)	1845 (1907); 0607 (0544)
EPDE-Targ-Bat16	19/7/17	2046-2055 (2 calls)	1747 (1811); 0651 (0627)
	20/7/17	1925-2350 (3 calls)	1747 (1811); 0651 (0627)
	21/7/17	2150-0253 (2 calls)	1748 (1812); 0651 (0627)
	22/7/17	2351-0109 (8 calls)	1748 (1812); 0651 (0627)
	23/7/17	2032-2258 (19 calls)	1749 (1812); 0650 (0626)
	24/7/17	1934-2054 (12 calls)	1749 (1813); 0650 (0626)
EPDE-BAT1-39	23/2/17	2338-0311 (4 calls)	1846 (1909); 0606 (0543)
EPDE-Targ-Bat06	20/7/17	0407 (1 call)	1747 (1811); 0651 (0627)
	23/7/17	0248 (1 call)	1749 (1812); 0650 (0626)
BAT-REC3	8/7/12	2058 (1 call)	1742 (1807); 0653 (0629)
BAT REC6	5/7/12	1830-1030 (13 calls)	1741 (1806); 0653 (0629)

Locations	Date	Call Times	Sunset (Civil Twilight) Sunrise (Civil Twilight)
	6/7/12	1830-10-30 (17 calls)	1742 (1806); 0653 (0629)
BAT-REC7	6/7/12	2219 (1 call)	1742 (1806); 0653 (0629)
BAT-REC14	6/7/2012	1839- 2235	1742 (1806); 0653 (0629)

Sunrise, sunset and civil twilight times from Geoscience Australia http://www.ga.gov.au/geodesy/astro/sunrise.jsp

Of these records, only one location recorded calls within one hour of sunset - Bat Rec 6. Based on the timing of the call, there may have been Pilbara Leaf-nosed Bat roosting within 3 km of this location during the 2012 surveys.

The most likely scenario from all *R. aurantia* call data available is that all Pilbara Leaf-nosed Bat recorded have originated from diurnal roost caves located outside the MDE. Ecoscape (2017b) has identified several potential roost locations to the south (Eliwana south), south-east (Brockman) and north (Mt Farquhar) of the MDE where ultrasonic call data suggests the location of a potential diurnal roost (Figure 58). Call records from these three areas include several examples of calls being recorded within 1 hour of sunset or sunrise. In particular, Ecoscape identified Cave M, located approximately 2km south of the MDE where the timing of call data suggested a small number of Pilbara Leaf-nosed Bat may have used the cave for diurnal roosting. No attempt was made to determine roosting using the sheeting method. None of the caves investigated within the MDE provided any evidence that the caves were used for diurnal roosting (Ecoscape, 2017b).



LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Pilbara Leaf-nosed Bat
- Potential Roosting Habitat
- Potential Roost Areas

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 5 10 15 20
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
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Figure 58
Pilbara Leaf-nosed Bat
Regional Roosts

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5.2.2.4 Threats

Threats to the Pilbara Leaf-nosed Bat, as outlined on the DoEE Species Profile and Threats Database (Department of Environment; Energy, 2016a) with relevance to the Proposal are discussed in Table 65. These threats are considered in the assessment of the impact of the Proposal to the Pilbara Leaf-nosed Bat later in this Section.

Table 65: Threats to Pilbara Leaf-nosed Bat

Threat	Discussion
Disturbance to roosts	Disturbance can take the form of destruction of the roost cave, noise and vibration from blasting and human entrance to roosts. Pilbara Leaf-nosed Bats forced to exit the roost are susceptible to the hot, dry conditions of the Pilbara and will quickly desiccate if there are no other suitable diurnal roosts within close proximity. No diurnal roosts are likely to be located within the mine development envelope.
Mine Development	Destruction of diurnal roosts due to the development of mines in the Pilbara threatens the survival of the Pilbara population. However, it is highly unlikely that there is a diurnal roost within the Eliwana mine footprint.
Road kills	Pilbara Leaf-nosed Bat forage within 1-3m of the ground and are attracted to light sources. It is possible that individuals may be struck by vehicles during night shift work.

5.2.2.5 Relevant Policy

- Survey Guidelines for Australia's Threatened Bats, EPBC Act survey guidelines 6.1 (Department of Sustainability, Environment, Water, Population and Communities, 2010)
- Research priorities for the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara Form) (Cramer, et al., 2016)

The terrestrial fauna surveys and environmental impact assessment have taken these policy and guidance documents into consideration:

- The Level 2 and targeted bat survey methodology aligns with the survey guideline;
- The survey and data supports the priorities as outlined in Cramer et al, (2016);
- Potential threats to the Pilbara Leaf-nosed Bat as identified in guidance documents have been considered; and
- The significance of the potential impacts to the species have been assessed using published guidance.

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5.2.2.6 Potential Impacts

Loss of roosting and foraging habitat through mine development

The proposal includes the clearing of 36 ha of gorges and gullies habitat, which is considered roosting habitat for the Pilbara Leaf-nosed Bat. However, no diurnal roosts are considered to occur within the MDE and 89% of this habitat type will remain post-disturbance.

All other areas within the MDE could be considered potential foraging and dispersal habitat. The clearing proposed within the MDE represents just 18% of the total envelope area, therefore Pilbara Leaf-nosed Bat will continue to forage and disperse through the area during operations and post-closure.

Vehicle Strike

It is possible that individual Pilbara Leaf-nosed Bat may be struck by vehicles driving around the project area at night. There are only five records of *R. aurantia* being struck by vehicles in the Pilbara (Department of Environment; Energy, 2016a) and this must be considered a very low risk.

Disturbance to a diurnal roost

As discussed there is unlikely to be a diurnal roost within the MDE. Blasting for mining is unlikely to disturb roosting Pilbara Leaf-nosed Bats in the areas suspected of hosting a diurnal roost given the large distances between the proposed mining areas and these suspected roost areas. Similarly, it is highly unlikely that Fortescue personnel will be required to work in areas suspected of hosting roost caves.

5.2.2.7 Proposed Management

Impacts to Pilbara Leaf-nosed Bat are managed under Fortescue's *Conservation Significant Fauna Management Plan 100-PL-EN-0022.* The management actions outlined in the Plan align with the recovery objectives and management research actions outlined in (Department of Environment, 2016) and (Cramer, et al., 2016) and are listed in Table 66.

Table 66: Management Actions for Pilbara Leaf-nosed Bat

Threat	Management Action from *100-PL-EN-0022*
Disturbance to Roost habitat	• Undertake targeted fauna surveys in accordance with applicable EPA and DoE guidance (outlined in Section 1.4 of this Plan) to determine distribution of conservation significant fauna. • Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat • Ensure staff and contractors are provided with appropriate training to ensure conservation significant fauna and associated habitat are protected • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging in

Threat	Management Action from *100-PL-EN-0022*
	accordance with the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042*. • Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the Land Use Certificate Procedure and/or the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042.* • Where construction or operational activities generate noise emissions10 that may result in significant impacts to conservation significant fauna, incorporate mitigation measures into planned activities in accordance with the *Chichester Operations Noise and Vibration Management Plan CB-PL-EN-0007*. • Direct lighting onto active construction and operational areas to minimise the potential for light overspill resulting in fauna disturbance, injuries or deaths. • Where populations of conservation significant fauna listed under the *Wildlife Conservation Act 1986* or the *Environment Protection and Biodiversity Conservation Act 1999* have been recorded in Fortescue controlled sites, develop and implement a Conservation Significant Fauna Monitoring Program in accordance with the *Conservation Significant Fauna Monitoring Guidelines 100-GU-EN-0034.*
Vehicle Strike	• To minimise the potential for fauna injuries or deaths on haul and access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving.

5.2.2.8 Significance Test

A summary of the assessment of the proposal against the Significant Impact Guidelines 1.1 (Department of Environment, 2009) is provided in Table 67. The assessment takes into account the mitigation measures outlined above.

Table 67: Significance Test: Pilbara Leaf-nosed Bat

Criteria for Vulnerable Species	Assessment of Significant Impact
Lead to a long term decrease in the size of the population	There is not likely to be a resident population of Pilbara Leaf-nosed Bat within the mine development envelope due to the likely absence of a diurnal roost cave. The proposed disturbance will not decrease the size of a population of this species.
Reduce the area of occupancy of the species	Pilbara Leaf-nosed Bat are thought to forage 10-20 km from their diurnal roost most times of the year. This suggests an area of occupancy per diurnal roost of approximately 1,250 km^2. The mine development envelope is likely to be at the margins of the home range of the populations located at suspected diurnal roost sites to the south, east and north. The development will not reduce the area of occupancy for this species.
Fragment an existing population into two or more populations	Armstrong (Armstrong, 2006) identifies female philopatry as moderating the flow of *R. aurantia* genetic material across the Pilbara. Males dispersing from roost to roost will continue to be able to move between roost areas south, south east and north of the proposed disturbance due to connected, undisturbed habitat.
Adversely affect habitat critical to the survival of a species.	Roosting habitat is considered habitat critical to the survival of the Pilbara Leaf-nosed Bat. Only 11% of the potential roosting habitat will be disturbed as a result of the project.
Disrupt the breeding cycle of an important population	There are no maternal/diurnal roost sites within the mine development envelope.

Criteria for Vulnerable Species	Assessment of Significant Impact
Modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline	Extensive areas of roosting and foraging habitat will remain after the proposal has been implemented.
Result in invasive species that are harmful to a vulnerable species becoming established in the habitat	Feral predators and weeds is not considered to be a threatening process for this species. However, the *Conservation Significant Fauna Management Plan 100-PL-EN-0022* includes management actions for feral predators.
Introduce disease that may cause the species to decline	No domestic animals will be permitted on site, minimising the risk of introducing disease to the area. There are no known disease risks for this species.
Interfere substantially with the recovery of the species.	Management actions critical for the recovery of this species include the identification and protection of diurnal roosts. Possible diurnal roosts occur to the south, south east and north of the development envelope, however there are unlikely to be any diurnal roost within the mine development envelope.

Given the lack of diurnal roosting caves in the MDE and the extensive areas of foraging and dispersal habitat that will remain after the proposal has been implemented, there is unlikely to be a significant impact to the Pilbara Leaf-nosed Bat.

5.2.2.9 Offsets

An environmental offset is not required for residual impacts to the Pilbara Leaf-nosed Bat. Fortescue highlights that it is likely that a condition of any EP Act approval is likely to include the requirement for an offset for the loss of vegetation in good to excellent condition, including vegetation that may be habitat for the Pilbara Leaf-nosed Bat.

5.2.3 Ghost Bat

The Ghost Bat (*Macroderma gigas*) is a recent addition to the EPBC Threatened Species list, having been added in 2016. Once widespread across much of Australia, the Ghost Bat is now restricted to the Pilbara, Kimberley, Northern Territory and Queensland, with genetic studies showing almost no movement between populations (Department of Environment; Energy, 2016c).

5.2.3.1 Survey Effort

The survey methodologies for Ghost Bat are the same as those used to locate Pilbara Leaf-nosed Bat. Therefore, the survey effort for Ghost Bat is the same as the effort expended for Pilbara Leaf-nosed Bat described in Section 5.2.2.

- Western Hub Project: The Edge Vertebrate Fauna Survey (Biologic, 2014a). 35 SM2 recording sites over 5 days during the first phase and a further 54 recordings from 20 locations during a targeted survey.

- Eliwana Vegetation, Flora and Fauna Assessment and Targeted Conservation Significant Flora and Fauna Survey (Ecoscape, 2012a). Three ANABAT locations during a level 1 fauna survey.
- Eliwana and Flying Fish Project (Ecologia Environment, 2015). 52 SM2 recording sites over two phases, totalling 700 hours of acoustic recordings

Ghost Bat has excellent sight and locate its prey using a combination of eyesight, large ears and echolocation system. The calls are short and multi-harmonic (Kulzner, et al., 1984) and as a result, Ghost Bat calls can be difficult to recognise in ultrasonic recordings.

5.2.3.2 Habitat

In the Pilbara, Ghost Bat occupy rocky habitat, roosting in caves, rock crevices and abandoned mines. Roosts are thought to maintain a steady temperature and high humidity (Department of Environment; Energy, 2016c). Due to their larger size, Ghost Bats are often found as single individuals, or small numbers in smaller caves with drier or cooler microclimates (Armstrong & Anstee, 2000). However, Ghost Bat is thought to gather in larger colonies within warm, humid roost caves to breed. Larger roost caves that support breeding are thought to be relatively uncommon in the Pilbara (Armstrong & Anstee, 2000). It is common to encounter both Ghost Bat and Pilbara Leaf-nosed Bat in the same cave due to similar roosting requirements.

A Ghost Bat population has been periodically monitored over an extensive period at Rio Tinto's West Angeles Mine. At West Angeles, a pregnant female was recorded from a cave in 1978 and the same cave has shown consistent usage by Ghost Bat at subsequent monitoring events, with bats recorded within the cave in 1978, 1998 and 2013, and evidence of recent usage in 2000, 2001, 2002, 2004 and 2013 (Biologic, 2014b). The repeated usage of this cave over such a long period of time points to the importance of maternity roost caves where they occur.

In the Pilbara, Ghost Bat forage across a variety of habitats within their nightly flight range. Based on studies in the Northern Territory, nightly foraging range for the Ghost Bat is inferred to be approximately 60 ha in a 1.9km radius from the roost location. There have been no studies into foraging range in the Pilbara but it is expected that foraging range would be dependent on the resources available. Biologic (2016) suggest that the foraging range for Ghost Bat in the Hamersley Ranges may be larger due to the use of multiple roost caves by individuals. The entire MDE could be considered foraging habitat for this species, with the Gorges/Gullies habitat considered possible roosting habitat.

5.2.3.3 Local Population

In the Pilbara, the Ghost Bat population is estimated to be between 1,300 and 2,000 individuals (Department of Environment; Energy, 2016c). The largest colonies are those recorded from

abandoned mines in the East Pilbara. Smaller colonies are known from caves in various ironstone terrains where caves form. It is common during targeted surveys to find evidence of roosting Ghost Bats in the form of scat piles and middens (mounds of uneaten prey).

Ghost Bats have been recorded from within the MDE. All known occurrences of Ghost Bat within the MDE, as depicted in Figure 59 are listed in Table 68.

Table 68: Ghost Bat Records in MDE

Date	Description
18/4/2013	Remains of Ghost Bat prey. This site considered to be a nocturnal roost site.
21/4/2013	Ghost Bat seen flying at Eliwana exploration camp
17/4/2012	Ultrasonic Call
15/4/2012	Ultrasonic Call

During the 2017 Level 2 and targeted bat surveys, no Ghost Bat calls were recorded within the MDE. Ghost Bat calls were detected at known roost sites outside the MDE where the species had previously been recorded. It is possible that Ghost Bat roost periodically within the MDE, however their numbers are likely to be few and a maternal roost is unlikely.

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

SERPENTINE CREEK
DUCK CREEK
Eliwana
PINARRA CREEK
BOOLGEEDA CREEK

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Ghost Bat
- Potential Roosting Habitat

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

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Figure 59
Ghost Bat Records and Habitat

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5.2.3.4 Threats

Threats to the Ghost Bat, as outlined on the DoEE conservation advice (Department of Environment; Energy, 2016c) with relevance to the proposal are discussed in Table 69. These threats are considered in the assessment of the impact of the Project to the Ghost Bat later in this Section.

Table 69: Threats to Ghost Bat

Threat	Discussion
Habitat loss (destruction of roosts from mining)	No known diurnal roost sites occur within the Mine Development Envelope, although individuals may potentially roost periodically within Gorge/Gullies habitat where climactic conditions allow.
Disturbance to roosts	Blasting or human entrance to known roosts may disturb the individuals roosting within the cave, exposing them to the dry external climate.
Collision with fences	'Substantial' numbers of Ghost Bats have been killed by flying into fences, particularly those with barbed wire (Armstrong & Anstee, 2000). The requirement for fences around project infrastructure has not been quantified but would be minimal and not likely to be linear, i.e. a cyclone fence encircling infrastructure for security or safety purposes.
Competition for prey with foxes and cats	Ghost bat may share prey species with feral carnivores. The impact from this threat on Ghost Bat is unknown. Management of feral animals is discussed in Section 7.3.2.3.

5.2.3.5 Relevant Policy

- Conservation Advice Macroderma gigas Ghost Bat (Department of Environment; Energy, 2016c)
- Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by Cane Toads. (Commonwealth of Australia, 2011).
- Survey Guidelines for Australia's Threatened Bats, EPBC Act survey guidelines 6.1 (Department of Sustainability, Environment, Water, Population and Communities, 2010)

The terrestrial fauna surveys and environmental impact assessment have taken these policy and guidance documents into consideration:

- The Level 2 and targeted bat survey methodology aligns with the survey guideline.
- The surveys have provided additional knowledge in accordance with the published research priorities for the species.
- Potential threats to the Ghost Bat as identified in guidance documents have been considered.
- The significance of the potential impacts to the species have been assessed using published guidance.

- Management and mitigation measures align with the conservation advice.

5.2.3.6 Potential Impacts

Loss of roosting and foraging habitat through mine development

The proposal includes the clearing of 36 ha of gorges and gullies habitat, which is considered potential roosting habitat for the Ghost Bat. However, no diurnal roosts are considered to occur within the MDE and 89% of Gorge/Gullies habitat type will remain post-disturbance.

All other vegetation within the MDE could be considered potential foraging and dispersal habitat. The clearing proposed within the MDE represents just 12% of the total envelope area, therefore Ghost Bat will continue to forage and disperse through the area during operations and post-closure.

Collision with fences and vehicles

It is possible that individual Ghost Bat may be struck by vehicles driving around the project area at night. Ghost Bat may also fly into fences while foraging. Fences may be required for safety and security reasons around critical infrastructure, however they are likely to be cyclone mesh type fences rather than linear wire type fences.

Disturbance to diurnal roosts

Blasting and human entrance to diurnal roosts have the potential to flush Ghost Bat into the open where they could be exposed to the hot, dry Pilbara climate. There is potential for individuals to occasionally roost within the MDE in Gorges/Gullies habitat, however a permanent diurnal roost that hosts a maternal colony is unlikely. It is highly unlikely that Fortescue personnel would enter a cave during mine operations. There are no known studies of the effect of blasting on Ghost Bat roosting behaviour.

5.2.3.7 Proposed Management

Impacts to Ghost Bat are managed under Fortescue's *Conservation Significant Fauna Management Plan 100-PL-EN-0022.* The management actions outlined in the Plan align with the recovery objectives and management research actions outlined in (Department of Environment; Energy, 2016c) and are listed in Table 70.

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Table 70: Management actions relevant for Ghost Bat

Threat	Management Action from 100-PL-EN-0022
Loss of Roost	• Undertake targeted fauna surveys in accordance with applicable EPA and DoE guidance (outlined in Section 1.4 of this Plan) to determine distribution of conservation significant fauna. • Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat • Ensure staff and contractors are provided with appropriate training to ensure conservation significant fauna and associated habitat are protected • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging in accordance with the Land Use Certificate Procedure. • Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the Land Use Certificate Procedure and/or the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042*. • Where populations of conservation significant fauna listed under the Wildlife Conservation Act 1986 or the Environment Protection and Biodiversity Conservation Act 1999 have been recorded in Fortescue controlled sites, develop and implement a Conservation Significant Fauna Monitoring Program in accordance with the *Conservation Significant Fauna Monitoring Guidelines 100-GU-EN-0034*
Collision with fences and vehicles	• To minimise the potential for fauna injuries or deaths on haul and access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving. • Where populations of conservation significant fauna listed under the Wildlife Conservation Act 1986 or the Environment Protection and Biodiversity Conservation Act 1999 have been recorded in Fortescue controlled sites, develop and implement a Conservation Significant Fauna Monitoring Program in accordance with the *Conservation Significant Fauna Monitoring Guidelines 100-GU-EN-0034.* • Where a fauna injury or death has occurred as a result of Fortescue Operations, investigate and report the incident in accordance with the *Incident Event Reporting Procedure 100-PR-SA-0011* and employ corrective actions in accordance with Section 9 of this Plan.
Disturbance to roosts	• Where construction or operational activities generate noise emissions10 that may result in significant impacts to conservation significant fauna, incorporate mitigation measures into planned activities in accordance with the *Chichester Operations Noise and Vibration Management Plan CB-PL-EN-0007*. • Direct lighting onto active construction and operational areas to minimise the potential for light overspill resulting in fauna disturbance, injuries or deaths.

5.2.3.8 Significance Test

A summary of the assessment of the proposal against the Significant Impact Guidelines 1.1 (Department of Environment, 2009) is provided in Table 71. The assessment takes into account the mitigation measures outlined above.

Table 71: Significance Test: Ghost Bat

Criteria for Vulnerable Species	Assessment of Significant Impact
Lead to a long term decrease in the size of the population	There is unlikely to be a permanent diurnal roost cave within the Mine Development Envelope. As a result, there is not likely to be a resident population of Ghost Bat within the Mine Development Envelope. The proposed disturbance will not decrease the size of a population of this species.
Reduce the area of occupancy of the species	The range of the Ghost Bat from a diurnal roost is considered to be approximately 60 ha, but in the Pilbara, this could be substantially larger given the productivity of the Pilbara is substantially less than the Northern Territory where this estimate was established. There is unlikely to be a permanent diurnal roost within the mine development envelope, suggesting that the area is likely to be foraging and dispersal habitat only, with occasional diurnal roosting as Ghost Bat move through the area. Therefore, whilst there may be a loss of foraging habitat for this species, approximately 82% of foraging habitat within the mine development envelope will remain post-disturbance and the area of occupancy for this species is unlikely to be significantly reduced.
Fragment an existing population into two or more populations	As the area is likely to be used for foraging and dispersal only, no resident population occurs within the mine development envelope. The proposal is unlikely to result in the fragmentation of a population of Ghost Bat into two or more populations.
Adversely affect habitat critical to the survival of a species.	The Gorges/Gullies habitat would be considered potential roosting habitat for the Ghost Bat. Only 36 ha of this habitat type will be disturbed by the proposal and 89% of this habitat type will remain after implementation of the proposal. Given the lack of records within the mine development envelope compared to the surrounding known roost locations, the Gorges/Gullies habitat is not likely to be significant habitat for Ghost Bat, but may be used for occasional roosting by individuals during foraging and dispersal.
Disrupt the breeding cycle of an important population	There is unlikely to be a breeding population of Ghost Bat within the mine development envelope. Known diurnal roost caves are located to the north and north-east of the proposal.
Modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline	The main threat to the decline of this species in the Pilbara is the loss of diurnal roosts either through mining or the collapse of abandoned mines. The proposal will not result in the loss of a permanent diurnal roost cave. There will be a loss of foraging habitat for the Ghost Bat, however there will remain extensive areas of foraging habitat for this species.
Result in invasive species that are harmful to a vulnerable species becoming established in the habitat	The cane toad is considered to be a threat to the survival of this species. The cane toad is unlikely to be introduced to the area as a result of the proposal. Fortescue's Conservation Significant Fauna Management Plan 100-PL-EN-0022 includes management actions for feral animals.
Introduce disease that may cause the species to decline	A population of Ghost Bat in Queensland appears to have been affected by a virus (Department of Environment; Energy, 2016c). The risk of introduction of disease to Ghost Bat at Eliwana is very low as there is unlikely to be a suitable transmission pathway.
Interfere substantially with the recovery of the species.	Conservation actions for the Ghost Bat are listed as (Department of Environment; Energy, 2016c): • Protect roost sites from mining, human disturbance and collapse • Replace barbed wire fences with single strand wire There is unlikely to be a permanent diurnal roost site in the mine development envelope. The proposal is unlikely to interfere with the recovery of the species.

Considering that there is unlikely to be a permanent diurnal roosting cave within the development envelope, there is unlikely to be a significant impact to the Ghost Bat as a result of the proposal.

5.2.3.9 Offsets

An environmental offset is not required for residual impacts to the Ghost Bat. Fortescue highlights that it is likely that a condition of any EP Act approval is likely to include the requirement for an offset for the loss of vegetation in good to excellent condition, including vegetation that may be habitat for the Ghost Bat.

5.2.4 Pilbara Olive Python

The Pilbara Olive Python (*Liasis olivaceus barroni*) is listed as Vulnerable under the EPBC Act and only occurs within the ranges of the Pilbara. The Pilbara Olive Python inhabits water courses and areas of permanent water in rocky gorges and gullies (Pearson, 2007). The Python is an excellent swimmer, and often hunts prey in water, feeding on rock wallabies, bats, ducks, pigeons (Department of Environment; Energy, 2008) depending on the size of the individual. During the cooler winter months, the python shelters in rocky caves and crevices. Towards the end of winter and early spring, male pythons leave their winter shelter and travel long distances in search of mates. For this reason, the python is often encountered in habitat that would not be considered critical habitat for the species.

5.2.4.1 Survey Effort

Within the MDE, the Gorges/Gullies habitat is considered the most suitable habitat for the Pilbara Olive Python. It is also likely to be found around permanent or semi-permanent pools in Drainage Line/River/Creek (Major) habitat during the wet season and potentially within the Hills/Ranges/Plateaux habitat. Hills/Ranges/Plateaux would not be considered critical habitat due to the absence of pools, but may be used for dispersal or winter shelter. The three pythons found within the MDE were found in Drainage Line/River/Creek (major) habitat, or in Gorges/Gullies habitat (Ecologia Environment, 2015). Critical habitat for Pilbara Olive Python is shown in Figure 60.

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

SERPENTINE CREEK
DUCK CREEK
PINARRA CREEK
BOOLGEEDA CREEK
Eliwana

LEGEND

- Fortescue Projects
- Major Drainage
- Mine Development Envelope
- Indicative Mine Footprints
- Pilbara Olive Python
- Suitable Habitat

Data Sources:
Pastoral Stations based on source from Landgate.
Towns, Roads, Drainage, Landgate.
SRTM, GA.
All other data, FMG, 2017.

N

0 2 4 6 8 10
Kilometres

Requested By: M.Dowling
Drawn By: S. Costello
Revised By: scostello
Approved By: P. Mastalir
Scale: 1:175,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 750EW_MP_EN_0010.037_r2

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Confidentiality: 1

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Figure 60
Pilbara Olive Python Records and Habitat

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5.2.4.2 Local Population

Two individual Pilbara Olive Pythons were sighted within the MDE in 2012 (Ecologia Environment, 2015). No Olive Pythons were sighted during targeted surveys in 2017. The low number of sightings of this species is not unexpected given there is only approximately 591 ha of habitat considered critical habitat within the 43,804 ha envelope. However, as male pythons are very mobile during the spring season it is possible that further Pythons could be encountered at any time. Larger areas of critical habitat for the Python occurs in Boolgeeda Creek, Duck Creek and Caves Creek to the south and north of the MDE. Fortescue consider that Pilbara Olive Python occurs in low numbers within the MDE and that individuals are likely using habitat within the area to disperse between the major creeks in the region during the mating season.

5.2.4.3 Threats

Threats to the Pilbara Olive Python, as outlined on the Department of Environment; Energy conservation advice (Department of Environment; Energy, 2008) with relevance to the proposal are discussed in Table 72. These threats are considered in the assessment of the impact of the Project to the Pilbara Olive Python later in this section.

Table 72: Threats to Pilbara Olive Python

Threat	Discussion
Predation by Feral Predators and increased competition for prey	Cats in particular may prey on juvenile pythons and they are likely to be particularly vulnerable when on the move during the mating season. Management of feral predators is discussed in section 7.2.4.3
Loss of habitat through mining	The intersection of iron ore deposits and critical habitat for Pilbara Olive Python often results in the destruction of habitat through mine development.
Road Kill	Pilbara Olive Pythons are often encountered basking on roads after dark during the mating season and during the wet season. Given the python's large size, running over a python in the dark can occur at night when vehicles are driving at high speed.

5.2.4.4 Relevant Policy

- Approved Conservation Advice for *Liasis olivaceus barroni* (Olive Python – Pilbara subspecies) (Department of Environment; Energy, 2008)
- Threat abatement plan for predation by feral cats (Commonwealth of Australia, 2015)
- Survey guidelines for Australia's threatened reptiles, EPBC Act survey guidelines 6.6 (Department of Sustainability, Environment, Water, Population and Communities, 2011b)

The terrestrial fauna surveys and environmental impact assessment have taken these policy and guidance documents into consideration:

- Targeted surveys utilised recommended survey techniques as published in the guidance

- The surveys have provided additional knowledge in accordance with the published research priorities for the species.
- Potential threats to the Pilbara Olive Python population as identified in guidance documents have been considered.
- The significance of the potential impacts to the species have been assessed using published guidance.
- Management and mitigation measures address threats posed to the conservation of the Pilbara Olive Python

5.2.4.5 Potential Impacts

Clearing of Habitat

As discussed, the MDE includes:

- 5,335.5 ha of Hills/Ranges/Plateaux habitat
- 284 ha of Drainage Line/River/Creek (Major) habitat; and
- 307.2 ha of Gorges/Gullies habitat;

The Drainage Line/River/Creek (Major) and Gorges/Gullies habitat may be considered critical habitat to the Pilbara Olive Python, whilst the Hills/Ranges/Plateaux may be used as winter shelter or dispersal habitat. The Proposal will result in the loss of 12% of Hills/Ranges/Plateaux habitat, 10% of Drainage Line/River/Creek (Major) habitat and 8.4% loss of Gorges/Gullies habitat.

Consequently, significant areas of habitat considered critical to the Pilbara Olive Python will remain post-disturbance. Fortescue notes that the python has been recorded in low numbers within the MDE and that much larger areas of significant habitat is located within Boolgeeda, Caves and Duck Creeks surrounding the MDE. As a result, Fortescue does not consider the loss of 90.9 ha of critical habitat to be significant.

Vehicle Strike

It is possible that Pilbara Olive Python may be run over by vehicles driving at night as pythons are known to bask on roads after dark and are generally on the move during the mating season. Fortescue's records show that since operations began at Cloudbreak in 2008, there have been four instances of Pilbara Olive Python being struck by vehicles across all Fortescue operating sites. Management measures to prevent road kill is discussed later in this Section.

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Increased Feral Predation

The development of the proposal has the potential to introduce, or increase the population of feral predators in the local area. Areas cleared for infrastructure and mining provide a means of ingress to the area by feral predators and inappropriate handling and storage of putrescible waste can attract feral animals to operations. Management measures to reduce feral predators are discussed below.

5.2.4.6 Proposed Management

Impacts to Pilbara Olive Python are managed under Fortescue's *Conservation Significant Fauna Management Plan 100-PL-EN-0022.* The management actions outlined in the Plan address the main threats to the Python outlined in the conservation advice (Department of Environment; Energy, 2008) and are listed in Table 73 below.

Table 73: Management Actions for Pilbara Olive Python

Threat	Management Action
Loss of Habitat	• Undertake targeted fauna surveys in accordance with applicable EPA and DoE guidance (outlined in Section 1.4 of this Plan) to determine distribution of conservation significant fauna. • Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat • Ensure staff and contractors are provided with appropriate training to ensure conservation significant fauna and associated habitat are protected • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging in accordance with the Land Use Certificate Procedure. • Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the Land Use Certificate Procedure and/or the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1042.* • Where populations of conservation significant fauna listed under the Wildlife Conservation Act 1986 or the Environment Protection and Biodiversity Conservation Act 1999 have been recorded in Fortescue controlled sites, develop and implement a Conservation Significant Fauna Monitoring Program in accordance with the *Conservation Significant Fauna Monitoring Guidelines 100-GU-EN-0034.*
Vehicle Strike	• To minimise the potential for fauna injuries or deaths on haul and access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving. • Where populations of conservation significant fauna listed under the *Wildlife Conservation Act 1986* or the *Environment Protection and Biodiversity Conservation Act 1999* have been recorded in Fortescue controlled sites, develop and implement a Conservation Significant Fauna Monitoring Program in accordance with the *Conservation Significant Fauna Monitoring Guidelines 100-GU-EN-0034*. • Where a fauna injury or death has occurred as a result of Fortescue Operations, investigate and report the incident in accordance with the *Incident*

Threat	Management Action
	Event Reporting Procedure 100-PR-SA-0011 and employ corrective actions in accordance with Section 9 of this Plan.
Feral Predation	• Develop and implement a Feral Animal Program to effectively manage and control feral animals within Fortescue controlled sites to minimise impacts on conservation significant fauna. • Manage waste materials and on-site landfill facilities in accordance with the *Waste Management Plan 45-PL-EN-0014* to minimise potential impacts on fauna and the likelihood of increases in feral animal numbers.

5.2.4.7 Significance Test

A summary of the assessment of the proposal against the Significant Impact Guidelines 1.1 (Department of Environment, 2009) is provided in Table 74. The assessment takes into account the mitigation measures outlined above.

Table 74: Significance Test: Pilbara Olive Python

Criteria for Vulnerable Species	Assessment of Significant Impact
Lead to a long term decrease in the size of the population	The proposal will remove approximately 90.9 ha of habitat considered critical to the Pilbara Olive Python and a further 944 ha of Hills/Ranges/Plateaux habitat that may be used for winter shelter and dispersal. However, approximately 85% of the mapped critical habitat within the development envelope will remain post-disturbance. Pilbara Olive Python may occur occasionally within suitable habitat, most likely during the annual mating season when pythons can range over a wide area. Given the low numbers of pythons detected within the Mine Development Envelope and the availability of suitable habitat post-disturbance, the proposal is unlikely to lead to a long term decrease in the size of the population.
Reduce the area of occupancy of the species	Pilbara Olive Python can be found over most of the Pilbara in suitable habitat and range over a wide area during the mating season. The proposal is unlikely to reduce the area of occupancy for this species.
Fragment an existing population into two or more populations	There is no evidence that a 'population' of Pilbara Olive Python reside within the Mine Development Envelope, although suitable habitat for the python may occur. There are also much larger areas of suitable habitat within the nearby Boolgeeda, Duck and Caves Creeks. The proposal is unlikely to fragment a population into two or more populations.
Adversely affect habitat critical to the survival of a species.	There will be a loss of 90.9 ha of habitat considered as critical habitat for the species a loss of 15% of this habitat type, with 500 ha of this habitat remaining post-disturbance. A further 944 ha of dispersal habitat will be disturbed, however, 87.9% (4,391 ha) of this habitat type will remain post disturbance.
Disrupt the breeding cycle of an important population	During the mating season, male pythons can range over a very wide area to find females. Whilst the proposal will result in the clearing of 7,900 ha of vegetation, this is just 18% of the development envelope area. Therefore, male pythons can continue to roam throughout the area in search of females.
Modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline	Given that 85% of the habitat mapped as critical habitat for python will remain post-disturbance, the Pilbara Olive Python will continue to have adequate availability of suitable habitat during operations and at closure.
Result in invasive species that are harmful to a vulnerable	Management measures will be implemented to avoid the introduction of, or increase in feral predators in the area. It is unlikely that the proposed action will

Criteria for Vulnerable Species	Assessment of Significant Impact
species becoming established in the habitat	result in the introduction of invasive species to the detriment of Pilbara Olive Python.
Introduce disease that may cause the species to decline	Management measures will be implemented to reduce the risk of invasive species being introduced. This management will include procedures to avoid introduction of feral animals which may bring disease into the area.
Interfere substantially with the recovery of the species.	The Pilbara Olive Python occurs within the mine development envelope occasionally as individuals. More suitable habitat is found outside of the proposed disturbance and therefore proposal is unlikely to interfere with the recovery of the species.

Considering that there are few individuals within MDE, that significant amounts of suitable habitat remain post-disturbance and that there are large amounts of critical habitat in nearby Boolgeeda, Caves and Duck Creeks, there is unlikely to be a significant impact to the Pilbara Olive Python as a result of the proposal.

5.2.4.8 Offsets

An environmental offset is not required for residual impacts to the Pilbara Olive Python. Fortescue highlights that it is likely that a condition of any EP Act approval is likely to include the requirement for an offset for the loss of vegetation in good to excellent condition, including vegetation that may be habitat for the Pilbara Olive Python.

5.2.5 Night Parrot

The Night Parrot (*Pezoporus occidentalis*) is Australia's rarest bird and was thought to be extinct across most of Australia until the discovery of a population in Queensland in 2013 (Department of Environment; Energy, 2016b). Since then the Night Parrot has been re-discovered in other parts of Queensland, Western Australia and South Australia.

5.2.5.1 Survey Effort

No targeted survey has been undertaken within the MDE for the Night Parrot. Terrestrial fauna surveys undertaken in 2011 and 2012 did not locate suitable habitat for this species and it was considered a very low possibility that the Night Parrot was present based on available habitat type. For this reason, there was no targeted survey undertaken in 2017. Opportunistic bird surveys and night spotlighting was undertaken during the fauna surveys within the MDE. Fortescue recognises that these survey methods are unlikely to result in the detection of the Night Parrot given its cryptic, nocturnal behaviour and life history, but highlights that the lack of suitable habitat within the local area suggests it is unlikely to be present.

5.2.5.2 Habitat

Prior to their re-discovery in Queensland, the habitat requirements for the Night Parrot were largely based on anecdotal observations and the few records of the species in museum collections. Historical habitat records are from spinifex grasslands and/or chenopod shrublands. The recent Queensland records are from areas of dense, long-unburnt spinifex that form large hummocks (Department of Environment; Energy, 2016b) (Murphy, et al., 2017).

Whilst there are certainly large areas of spinifex grasslands within the MDE , fire history in the area has resulted in few areas, if any, where spinifex has been left unburnt long enough to form the large dense hummocks the species appears to require for nesting and roosting (Ecoscape, 2017b). In particular, the most recent advice on this species suggests that a mosaic of fire ages is required such that the Night Parrot is able to move between areas of spinifex as other areas are burnt (Department of Environment; Energy, 2016b). Murphy et al (2017) also noted that birds regularly foraged in non-Triodia habitats with seed bearing annual grasses, but returned to the long-unburnt hummock grasslands to roost.

Recent radio tracking studies undertaken on the Queensland population suggest the Night Parrot can range up to 10 km from the roost location (Murphy, et al., 2017), with nightly foraging flight distances of up to 41 km in total and a foraging area of up to 3,000 ha. The data from this study also demonstrated that the population appears to be a resident population and did not appear to migrate to follow food resources, despite the area experiencing drought conditions (Murphy, et al., 2017).

5.2.5.3 Local Population

It is still uncertain as to whether there are any Night Parrot populations in the Pilbara. New survey techniques (listening for Night Parrot calls and attracting birds using call-playback) developed by Night Parrot researchers has significantly increased the probably of detection of the species during targeted surveys.

Fortescue considers that due to the lack of suitable areas of dense long-unburnt spinifex in the area, there is unlikely to be a local population of Night Parrot within the MDE.

5.2.5.4 Threats

Threats to the Night Parrot, as outlined on the Department of Environment; Energy conservation advice (Department of Environment; Energy, 2016b) with relevance to the proposal are discussed in Table 75. These threats are considered in the assessment of the impact of the Project to the Night Parrot later in this Section.

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Table 75: Threats to Night Parrot

Threat	Discussion
Predation by feral cats and foxes	It is generally thought that the decline of Night Parrot in Australia is largely due to predation by feral cats and foxes, with some historical anecdotal reports of cats preying on Night Parrots (Department of Environment; Energy, 2016b).
Impacts from pastoral grazing activities	There is no direct evidence for grazing impacting on Night Parrot, but the impacts of grazing on vegetation and degradation of water points in the pastoral region are well known.
Altered fire regimes	The requirement for long-unburnt spinifex grasslands with a mosaic of fire ages has been published in recent articles (Murphy, et al., 2017). In Queensland, analysis of aerial imagery shows some areas of spinifex that has been unburnt for at least 63 years. Within the mine development envelope, there are no areas of long-unburnt spinifex. Most fires in the Pilbara burn hot and out of control over very large areas. Without a mix of fire ages there is little opportunity for Night Parrot to move into unburnt spinifex following fire.

5.2.5.5 Potential Impacts

Loss of Habitat

Clearing for mining operations will result in the direct loss of vegetation that includes a Triodia grassland understorey. Fortescue consider that the fauna habitat type that most closely resembles the habitat in which Night Parrot have been recently recorded from in Queensland is the Plain (Stony/Gibber) habitat. The area of potential disturbance to this habitat is presented in Table 76.

Table 76: Habitats with grassland understorey within the MDE

Habitat Type	Area Mapped (ha)	Area Disturbed (ha)	% Remaining
Plain (Stony/Gibber)	11238.3	2,336.6	90.6%

There are no areas within the MDE that feature a chenopod shrubland. Ecoscape identified no areas of hummock grassland that had been unburnt for long periods to allow for large, dense Triodia hummocks to develop (Ecoscape, 2017b). Fortescue does not consider that any of the habitat within the MDE is suitable habitat for Night Parrot due to the frequent, hot fires that burn large areas of potential habitat in the Pilbara.

Increased Predation

The Night Parrot falls within the critical weight range for predation by foxes and there is historical records of night parrots being preyed upon by feral cats. The clearing for the proposal has the potential to increase the accessibility to the area by feral predators. Similarly, without appropriate management, putrescible waste can attract feral predators. Management of feral animals is discussed later in this Section.

Altered Fire Regimes

Frequent hot, uncontrolled wildfires result in hummock grasslands that do not have time to form the dense large hummocks required for Night Parrot roosting and nesting. Without controlled fire management, a mosaic of habitat of different fire history cannot be established. There is potential for activities undertaken during operations to cause bushfire. Fire management is discussed later in this Section.

5.2.5.6 Proposed Management

Impacts to Night Parrot are managed under Fortescue's *Conservation Significant Fauna Management Plan 100-PL-EN-0022.* The management actions outlined in the Plan address the main threats to the Night Parrot outlined in the conservation advice (Department of Environment; Energy, 2016b) and are listed in Table 77 below.

Table 77: Management Actions for Night Parrot

Threat	Management Action from *100-PL-EN-0022*
Loss of habitat	• Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts to conservation significant fauna. • Design and locate borrow pits to minimise the potential impact on conservation significant fauna and associated habitat in accordance with the *Borrow Pit Management Plan 100-PL-EN-0018.* • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging in accordance with the Land Use Certificate Procedure. • When conservation significant fauna species have been recorded within the impact area, ground-truth the area and similar habitats within the area, and where individual animals are present implement mitigation measures, including the relocation of fauna, prior to disturbance and in consultation with DPaW. • Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally impacted. Conduct clearing in accordance with a permit issued under the Land Use Certificate Procedure and/or the *Vegetation Clearing and Topsoil Management Procedure 100-PR-EN-1017.* • Conduct progressive rehabilitation of disturbed areas, particularly those areas with known conservation significant fauna and associated habitat, in accordance with the *Exploration Environmental Management Plan E-PL-EN-0002*, *Eliwana Mine Closure Plan EW-PL-EN-0001.*
Feral Predation	• Develop and implement a Feral Animal Program to effectively manage and control feral animals within Fortescue controlled sites to minimise impacts on conservation significant fauna. • Manage waste materials and on-site landfill facilities in accordance with the *Waste Management Plan 45-PL-EN-0014* to minimise potential impacts on fauna and the likelihood of increases in feral animal numbers.
Frequent Fires	• When constructing a fire break or carrying out a prescribed burn where conservation significant fauna and habitat have been identified, adhere to the requirements outlined in the Bushfire Management Plan (100-PL-EM-0009).

5.2.5.7 Significance Test

A summary of the assessment of the proposal against the Significant Impact Guidelines 1.1 (Department of Environment, 2009) is provided in Table 78. The assessment takes into account the mitigation measures outlined above.

Table 78: Significance Test: Night Parrot

Criteria for Vulnerable Species	Discussion
Lead to a long-term decrease in the size of the population.	It is highly unlikely that the Night Parrot is present within the development envelope due to the absence of dense, long-unburnt, spinifex hummock grasslands. The proposal will not lead to a long term decrease in the size of the Night Parrot population.
Reduce the area of occupancy of the species.	Area of occupancy for the Night Parrot is difficult to estimate given the lack of study and research on this elusive bird. Area of occupancy for an individual parrot has recently been estimated to be in the order of 3,000 ha given nightly flight range from the roost (Murphy, et al., 2017). The proposal will result in the removal of 2,336 ha of Stony Gibber Plain habitat that has the potential to support Night Parrot, if the area were not subject to frequent fires which prevent large, dense hummock grasslands from forming. Therefore, it is unlikely that the proposal will reduce the area of occupancy for the species.
Fragment an existing population into two or more populations	There is highly unlikely to be a population of Night Parrot in the local area due to the absence of suitable habitat.
Adversely affect habitat critical to the survival of a species	The area is not considered to be habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	There is highly unlikely to be a population of Night Parrot in the local area due to the absence of suitable habitat.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Habitat within the area is not suitable for Night Parrot due to the frequent hot fires that burn in the area. Stony Gibber plain habitat could be potential habitat if it were able to remain unburnt for long periods. However, 89% of this habitat type will remain post-disturbance.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered habitat	Management of feral animals by Fortescue (and other proponents in the local area) will ensure that feral predation is not increased as a result of the project.
Introduce disease that may cause the species to decline.	Fortescue does not allow domestic animals to be brought to site.
Interfere with the recovery of the species	Fortescue will take all management measures available to ameliorate the threats to this species through the implementation of the Conservation Significant Fauna Management Plan 100-PL-EN-0022

Considering that there is no suitable habitat for the Night Parrot within MDE, and that significant amounts of potential habitat will remain post-disturbance there is unlikely to be a significant impact to the Night Parrot as a result of the proposal.

5.2.5.8 Offsets

An environmental offset is not required for residual impacts to the Night Parrot. Fortescue highlights that it is likely that a condition of any EP Act approval is likely to include the requirement for an offset for the loss of vegetation in good to excellent condition, including vegetation that may be habitat for the Night Parrot.

5.2.6 Unpredictable or irreversible impacts to MNES

The impacts resulting from the implementation of the Eliwana Mine are quantifiable and have been sufficiently studied. Given the nature of the development, it is anticipated that the impacts to MNES resulting from this proposal are reversible and have been predicted with a high degree of confidence.

6. ENVIRONMENTAL OFFSETS

Environmental offsets are required in order to protect and conserve environmental and biodiversity values for present and future generations. Whilst offsets are no longer considered as an independent key environmental factor by the EPA (EPA, 2016c), it is expected that the application of offsets is examined in the context of each preliminary key environmental factor relevant to the Proposal. This section provides a summary of significant residual impacts and proposed offsets for the Proposal, within the context of current state and federal policy and guidance.

6.1 Relevant Policy and Guidance

The following EPA position and guidance statements set the framework for offsets:

- *WA Environmental Offsets Policy* (Government of Western Australia, 2011).
- *WA Environmental Offsets Guidelines*, August 2014 (Government of Western Australia, 2014).

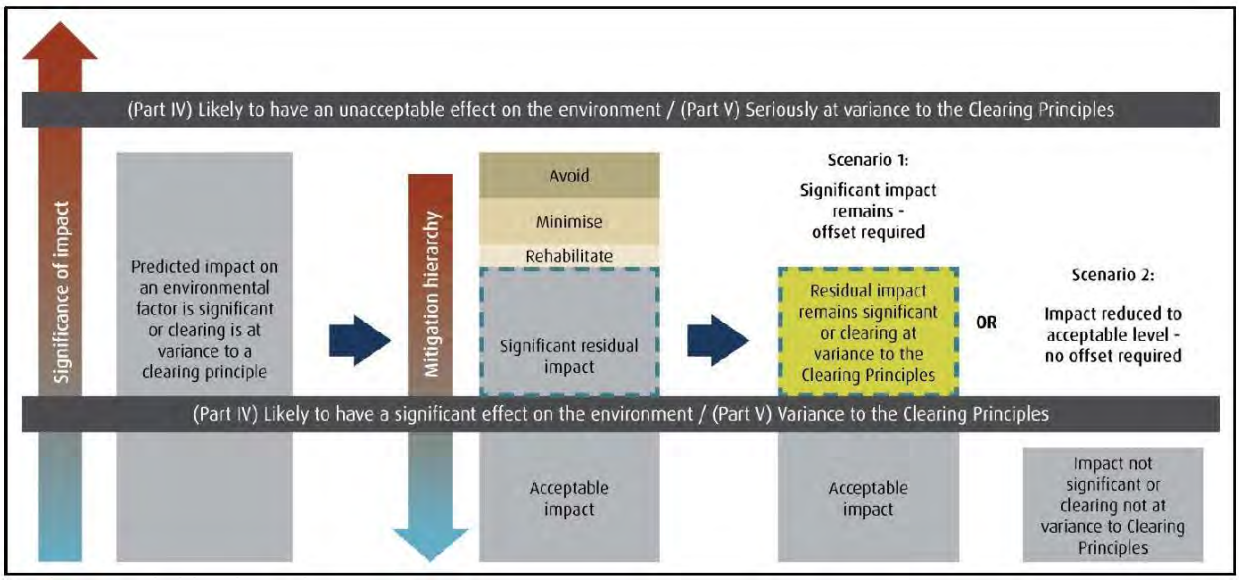
The following EPBC Act policy sets the framework for offsets that relate to MNES:

- *EPBC Act Environmental Offsets Policy* (Department of Sustainability, Environment, Water, Population and Communities, 2012b).

The *WA Environmental Offsets Policy* (Government of Western Australia, 2011) states that environmental offsets may only be considered once all other reasonable attempts to mitigate adverse impacts have been exhausted. The hierarchy of impact mitigation (Schematic 2) is described in the *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014). The management and mitigation measures for potential environmental impacts of the Proposal have been designed to take this hierarchy into consideration.

The *EPBC Act Environmental Offsets Policy* (Department of Sustainability, Environment, Water, Population and Communities, 2012b) outlines the Commonwealth government's approach to the use of offsets under the EPBC Act. The Policy defines offsets as 'measures that compensate the residual adverse impacts of an action on the environment'.

The policy states that avoidance and mitigation measures must be the primary strategy to manage significant impacts and that offsets do not reduce likely impacts but rather compensate for residual significant impacts.



Schematic Map 2: Impact Mitigation Hierarchy

Source: Government of Western Australia 2014.

6.2 Residual Impact Assessment to Determine Offset Requirements

The Proposal has the potential to affect vegetation, flora, habitat and fauna species of State and National environmental significance. An evaluation of the residual impacts for each environmental factor has been detailed for each specific factor (sections 4.4 - 4.10) and for MNES species (Section 5). This evaluation resulted in the requirement for financial offsets for the loss of vegetation in good to excellent condition and for the loss of vegetation considered representative of the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* PEC. For all other factors, including MNES species, the residual impact from the proposal is not considered to be significant enough to warrant an offset.

An assessment of the impact of the proposal to these environmental assets, the measures to avoid, mitigate and rectify these impacts and any significant residual impact is presented in Table 79.

The environmental assets potentially impacted by the Proposal were assessed against the residual impact significance model provided within the *WA Environmental Offsets Guidelines* (Government of Western Australia 2014).

In regard to the Proposal, the following aspects are considered to represent a significant impact to one of the assets described under the Environmental Factors above:

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Vegetation and Flora

- **Conservation Significant Flora**: no declared rare flora has been recorded or is expected to occur within the Proposal area. Nine species of Priority flora will experience some direct disturbance as a result of the proposal. Six of these priority species may also experience a decline from changes to existing surface water regimes.

- **Conservation Significant Vegetation:** no TECs protected under the EPBC Act or the EP Act have been recorded within MDE area. 41.4 ha of vegetation communities considered to be representative of the *Triodia* sp. Robe River assemblages of mesas of the West Pilbara PEC will be disturbed by the Proposal.

- **Remnant vegetation:** at a regional scale, clearing of vegetation does not result in the clearing of greater than 10% of the pre-European extent of any vegetation type. Impacts are higher at a local scale, however, only two vegetation types AtruTbt and ElAcTwTspr will be cleared below 30% of their current areal extent. However, other examples of communities analogous to ElAcTwTspr are known to occur and when considered together, the impact these communities is less than 70%.

- **Riparian Vegetation:** Some riparian vegetation will be disturbed by the proposal, particularly where open pits occur, resulting in fragmentation of vegetation within some drainage lines. In addition, approximately 19.8 ha of a vegetation community considered to be a GDE will be impacted by mine dewatering. A further 105 ha of a vegetation community that may be a potential GDE occurs within the drawdown extent, although it is unlikely that this community is reliant on groundwater.

  Additionally, 313.9 ha of riparian vegetation occurs in areas downstream of the proposed disturbance and may experience degradation as a result of reduced surface water flows. This degradation is reduced the further away from the mining area, as uninterrupted catchments contribute surface water flows to the main creek bed.

Subterranean Fauna

- **Troglofauna:** 16 species of troglofauna have only been recorded from within proposed mine pits. A risk assessment based on the characteristics of the species and habitat connectivity suggests there is only a moderate risk for three of the 16 species from the Proposal. The remaining 13 species are considered to be at low to moderate risk.

- **Stygofauna:** Nine species of stygofauna have only been recorded from within the area impacted by groundwater drawdown. Of these, two species are considered to be at high risk. Both of these species were regarded as potential high risk as they are known within a single aquifer compartment with significant drawdown where limited habitat is expected to remain below predicted drawdown and habitat quality is unknown at increasing depths.

Terrestrial Fauna

- **Habitat for fauna**: the proposal will impact habitat for a number of fauna species protected under the EPBC Act and WC Act. Impacts to significant habitat for these

species are limited to the following habitat types: Gorges/Gullies, Drainage Line/River/Creek (Major); Hills/Ranges/Plateaux. However, the impact is not considered significant.

- **SRE Invertebrates**: The proposal may result in the disturbance to a confirmed SRE species and its habitat. Fortescue will conduct additional surveys and investigate whether the species is a candidate for translocation before undertaking any disturbance at its known location. If the species cannot be located outside the disturbance footprint and translocation is likely to be unsuccessful, Fortescue will redesign the TSF to avoid the species known location.
- **Fragmentation of habitat**: Large areas of undisturbed habitat will remain surrounding the proposal area and ecological linkage can be restored after rehabilitation. Impacts to fauna and fauna habitat from fragmentation are not considered significant.
- **Increased Feral Animals**: Appropriate waste management and feral animal control will ensure that there will be no increase in feral predators as a result of the proposal.
- **Vehicle Strike**: Appropriate traffic management will ensure that impacts to fauna from vehicle interactions will not be significant.
- **Weeds**: Appropriate weed hygiene and control will ensure that there is unlikely to be any impact to fauna and fauna habitat from an increase in weed abundance.
- **Changes to Surface Water Regime**: There may be localised impacts to vegetation communities as a result of changes to surface water flows. This is not expected to have a significant impact to fauna species.
- **Altered Fire Regimes**: Appropriate work procedures will be employed to reduce the risk of fires starting from activities associated with the proposal. There is unlikely to be a significant impact to fauna or their habitat as a result of changes to fire frequency or intensity.

Overall Environment

- Approximately 7,879 ha of vegetation in good to excellent condition will be disturbed as a result of the Proposal. Impacts to Vegetation in good – excellent condition is not listed as an example of a significant residual impact which will or may require an offset in the Residual Impact Significance Model (Government of Western Australia, 2014), however, it has been highlighted as requiring offsets by the EPA in a number of publications including the *Strategic Advice on Cumulative environmental impacts of* development *in the Pilbara region* (EPA, 2014).

Table 79 provides a summary of the assessment of residual impact significance in accordance with the WA Environmental Offsets Guidelines (Government of Western Australia, 2014). The offsets listed here are draft in nature, and have been provided to the DWER and DoE for initial review and consultation.

The offset calculation methodology provided in the *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014) has not been undertaken as the Proposal will likely be subject to an offset rate per hectare. The current rates (subject to change) for the Hamersley IBRA sub-bioregion are $798 per hectare of vegetation in good – excellent condition and $1,596 per hectare for additional state significant values. These dollar amounts are indexed to CPI.

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Table 79: Environmental Offsets – Eliwana Mine Proposal

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
Vegetation Clearing									
Loss of vegetation in good to excellent vegetation	Minimise clearing through mine planning.	Site specific, progressive rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	Loss of 7,879 ha of vegetation in good to excellent condition.	Monetary offset contribution to the Pilbara Offset Fund.	N/A	An offset Ministerial Condition is suggested for the Proposal.	Permanent	In accordance with contemporary offset guidance as applicable.
Vegetation Clearing – Direct Disturbance to Conservation Significant Vegetation									
Clearing of *Triodia sp. Robe River assemblages of mesas of the West Pilbara* PEC	Minimise through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan.	The PEC is closely aligned to mesa formations which will be disturbed through mining. It is unlikely to be returned through rehabilitation.	Loss of 41.4 ha of vegetation considered representative of the PEC.	Monetary offset contribution to the Pilbara Offset Fund.	N/A	An offset Ministerial Condition is suggested for the Proposal.	Permanent	In accordance with contemporary offset guidance as applicable.

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
Vegetation Clearing – Direct Disturbance to Conservation Significant Flora									
Loss of local Priority flora populations (32 Species) in the Mine Development Envelope	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	No	NA	NA	NA	NA	NA
Indirect Impacts to Vegetation – Loss of vegetation from Groundwater Abstraction									
Indirect impacts to GDE vegetation type MaMgCyPv through dewatering resulting in lower water table	Minimise clearing through mine planning.	The sessation of dewatering and Site specific rehabilitation as per Eliwana Mine Closure Plan.	The GDE is reliant on groundwater that is likely to return to its original level post mining. It is likely a form of GDE will return post mining however the structure of the pre-mining GDE	Significant degradation of 19.6 ha of vegetation type MaMgCyPv that is reliant on groundwater	Monetary offset contribution to the Pilbara Offset Fund.	NA	An offset Ministerial Condition is suggested for the Proposal.	Dependent on water table rebound and recharge from rainfall events	In accordance with contemporary offset guidance as applicable.

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
			may be different.						
Indirect Impacts – Changes to community floristics from altered surface water regime									
Changes to surface water impacting vegetation health and structure. Impacts being localised and causing low residual impacts	Minimise clearing through mine planning	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	No	NA	NA	NA	NA	NA
Indirect Impacts – Fragmentation, Weeds and Altered Fire Regimes									
Minimal risk of degradation from fire and weeds to native vegetation.	Weed hygiene measures. Appropriate hot work procedures.	Site specific rehabilitation as per Eliwana Mine Closure Plan. Weed hygiene during closure.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	No	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
			Weed species unlikely to increase.						
Riparian vegetation community EvAcCcERIt will be fragmented by the construction of mine infrastructure.	Minimise clearing through mine planning	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	No	NA	NA	NA	NA	NA
Terrestrial Fauna									
Loss of individual *Antichiropus* 1021DNA02 and its habitat	Redesign the TSF if other management and mitigation measures are not successful.	Undertake further surveys to locate additional specimens outside of the disturbance footprint. Investigate whether the species can be translocated.	There is a high likelihood that additional specimens will be located in suitable habitat outside the disturbance footprint.	There will be no significant residual impact to *Antichiropus* 1021DNA02 as a result of Fortescue's stated commitments regarding this species	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
Loss of 7,900 ha of fauna habitat.	Minimise clearing through mine planning	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	Yes. Proposed offset for loss of vegetation in good to excellent condition.	See Vegetation Clearing				
Fragmentation of habitat impacting ecological linkage for fauna species; however being re-established post-disturbance via rehabilitation.	Minimise clearing through mine planning	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	No	NA	NA	NA	NA	NA
Vehicle Interactions with Conservation Significant No Fauna	Implementation of traffic management measures	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Traffic management will significantly reduce the risk to conservation	No	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
			significant fauna. Post closure the risk will be largely removed						
Weed infestations impacting fauna habitat.	Weed management during operation.	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation will result in vegetation growing on disturbed surfaces. However, this vegetation is unlikely to be representative of the original communities.	No	NA	NA	NA	NA	NA
Changes to surface water impacting vegetation health and structure. Impacts being localised and causing low residual impacts to fauna that utilise drainage	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan.		No	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
line/river/creek habitat.									
Altered fire regimes from implementation of the proposal.	Minimise clearing through mine planning	Site specific rehabilitation as per Eliwana Mine Closure Plan.		No	NA	NA	NA	NA	NA
MNES									
The Proposal will result in the loss of 36 ha of Northern Quoll denning habitat. There is not considered to be a significant residual impact for MNES species. Fortescue notes that the offset required for the loss of good to excellent condition will compensate for the loss of	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan. Consideration to be given to specific habitat requirements of MNES species.	Rehabilitation may be successful in returning habitat that is suitable for MNES species, particularly Northern Quoll.	No	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
critical MNES habitat									
The Proposal will result in the loss of 36 ha of Pilbara leaf-nosed Bat roosting habitat. There is not considered to be a significant residual impact for MNES species. Fortescue notes that the offset required for the loss of good to excellent condition will compensate for the loss of critical MNES habitat	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan. Consideration to be given to specific habitat requirements of MNES species.	Rehabilitation may be successful in returning habitat that is suitable for MNES species.	No	NA	NA	NA	NA	NA
The Proposal will result in the loss of 36 ha of Ghost Bat roosting	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan.	Rehabilitation may be successful in returning habitat that is	No	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
habitat. There is not considered to be a significant residual impact for MNES species. Fortescue notes that the offset required for the loss of good to excellent condition will compensate for the loss of critical MNES habitat		Consideration to be given to specific habitat requirements of MNES species.	suitable for MNES species.						
The Proposal will result in the loss of 90.9 ha of Pilbara Olive Python habitat MNES species are likely to utilise rehabilitated areas. There is not considered to be a significant	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan. Consideration to be given to specific habitat requirements of MNES species.	Rehabilitation may be successful in returning habitat that is suitable for MNES species.	No	NA	NA	NA	NA	NA

Existing Environmental Impact	Mitigation			Significant Residual Impact	Offset Calculation Methodology				
	Avoid	Rehab Type	Likely Success		Type	Risk	Likely Offset Success	Time Lag	Offset quantification
residual impact for MNES species. Fortescue notes that the offset required for the loss of good to excellent condition will compensate for the loss of critical MNES habitat									
Loss of Individuals	Minimise clearing through mine planning.	Site specific rehabilitation as per Eliwana Mine Closure Plan. Consideration to be given to specific habitat requirements of MNES species.	MNES species are likely to utilise rehabilitated habitat following closure.	No	NA	NA	NA	NA	NA

Fortescue has considered the six Principles outlined in the WA Environmental Offsets Policy (Government of Western Australia, 2011) and WA Environmental Offsets Guideline (Government of Western Australia, 2014) (Table 80).

Table 80: Principles for the use of Environmental Offsets

Principle	Consideration
1. Environmental offsets will only be considered after avoidance and mitigation options have been pursued. Environmental offsets address environmental impacts that remain after on-site avoidance and mitigation measures have been undertaken. Environmental offsets will not be considered in the absence of proposed strategies to avoid and mitigate environmental impacts. A degree of flexibility will be applied towards the use of environmental offsets. In determining the type of environmental offsets, emphasis will be placed on realising real and sustainable environmental outcomes through a combination of avoidance, mitigation as well as direct and indirect environmental offsets. Where possible, offsets will be considered early in the assessment and decision-making process to allow for greater transparency and certainty. The responsibility for imposing offset requirements remains with the relevant statutory decision-maker. For example, the Minister for Environment is responsible for proposals assessed by the Environmental Protection Authority, and the CEO of the Department of Environment and Conservation for clearing permits.	Fortescue has considered the siting of infrastructure to avoid high value environmental assets where practicable. Fortescue operates an EMS to manage and mitigate against the impacts to the environment. The environmental offsets proposed (payment to Pilbara offset fund) is required to offset significant residual impacts and will deliver a net environmental benefit in the Pilbara.
2. Environmental offsets are not appropriate for all projects. Environmental offsets are not appropriate in all circumstances. The applicability of offsets will be determined on a project-by-project basis. While environment offsets may be appropriate for significant residual environmental impacts, they will not be applied to minor environmental impacts.	For most environmental factors, environmental impacts are not significant and offsets are not required. The application of an offset for the loss of good to excellent vegetation and an area of the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* PEC is appropriate and will result in a net environmental benefit for the Pilbara.
3. Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted. Environmental offsets relate to the environmental value that is being impacted. In some instances, it may be necessary to offset a value with a similar, but not identical, value. Environmental offsets should be proportionate to the significance of the environmental value being impacted with a preference for cost-effective solutions.	The value of the offsets required is determined by the EPA. The scale of the offset is determined by the value of the environmental asset. In this instance, a higher offset payment is required for the loss of the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* PEC.
4. Environmental offsets will be based on sound environmental information and knowledge. Proposals for the use of environmental offsets should be underpinned by sound information and knowledge. The information should be credible and capable of scrutiny to support transparent and accountable decision-making.	The environmental studies undertaken in support of the Proposal meet EPA guidance and has improved local and regional environmental knowledge. The residual impact has been calculated using sound environmental data.

Principle	Consideration
5. Environmental offsets will be applied within a framework of adaptive management. An adaptive management framework should be applied in relation to environmental offsets to take account of the potential risks. The risks associated with environmental offsets include the uncertainty in predicting environmental impacts on biodiversity and managing any time-lag between establishing offsets and generating the anticipated benefits. Adaptive management should ensure there are mechanisms in place to take account of these risks and other potential unintended consequences which may arise.	Fortescue operates under an EMS where environmental management plans allow for adaptive management through regular monitoring of environmental impacts measured against threshold values. Where threshold values are at risk, Fortescue outlines adaptive management practices to ensure compliance.
5. Environmental offsets will be focussed on longer term strategic outcomes. Environmental offsets will be designed to be enduring, enforceable and deliver long term strategic outcomes. A flexible approach to the security, management, monitoring and audit of offsets will be adopted to ensure that anticipated environmental outcomes are realised. Responsibility for monitoring, auditing and compliance with set conditions to nominated agencies is ascribed in the EP Act and other State legislation. All environmental offsets that are included as part of a statutory approval will identify the agency responsible for monitoring its implementation, ongoing auditing and legislative basis.	Fortescue proposes to pay offset funds to the Pilbara Offset Fund to be established by the State Government. The Fund will deliver strategic land management outcomes for the Pilbara region. Fortescue also proposes a Translocation Proposal for the SRE species *Antichiropus* 1021DNA02 if avoidance and further surveys are not successful in reducing the level of impact to the species.

7. HOLISTIC IMPACT ASSESSMENT

This ERD provides a detailed assessment of the potential environmental impacts associated with the Proposal and the management strategies for each environmental factor. In this section, an assessment will be made regarding the key themes Land, Water and Air and how these interrelate (Table 81). The assessment will also demonstrate how the EP Act Principles have been considered.

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Table 81: Holistic Impact Assessment

Theme	Impact	Management and Mitigation	EP Act Principles
Land	Clearing of 7,900 ha of native vegetation. Of this, 99.7% is in good to excellent condition. This will result in the loss of 41.4 ha of a Priority Ecological Community and individual priority flora specimens. In addition, there will be fragmentation of vegetation within the area to be disturbed, particularly in valley drainage areas. Some vegetation within these fragments are likely to be impacted by loss of surface water run-off. There is likely to be some changes to vegetation health and structure downstream of the proposed disturbance as a result of less surface water flow. By contrast, there may be additional surface water flow at mine dewatering discharge points and this will result in increased vegetation density and may result in surface water being present for extended periods within these creekline systems. Groundwater abstraction for mine dewatering will result in the degradation of small areas of vegetation considered GDE. The area to be cleared is habitat for native fauna, including significant fauna species. However, the fauna habitat is common in the Hamersley region and based on extensive survey is considered marginal habitat for key species such as Northern Quoll, Pilbara Leaf-nosed Bat, Ghost Bat and Pilbara Olive Python. The proposal will also result in disturbance to a confirmed SRE millipede species and its habitat (*Antichiropus 1021DNA02).*	Mine planning will be reviewed during operations to ensure vegetation clearing will be minimised. Areas of significant vegetation have been identified and clearing of these communities will be strictly controlled through Fortescue's Land Use Certificate Procedure. Impacts to fauna managed through Fortescue's Significant Fauna Management Plan. Groundwater drawdown managed in accordance with the Groundwater Management Plan and RIWI Act licences. Closure strategies will be developed and reviewed in consultation with key stakeholders, to ensure there are no adverse impacts to environmental or heritage values, in accordance with the *Eliwana Mine Closure Plan.*	**Precautionary Principle** • Areas mapped as potential PEC are treated as PEC. • Assessment of impacts from groundwater drawdown assume worst case scenarios. **Intergenerational Equity** • Management and mitigation measures to reduce impact to the environment to as low as practicable. • Environmental Survey information has increased knowledge of the State's Flora and Fauna species, including increase in population size and expansion of extent of occurrence. • Mine Closure to restore ecological function following cessation of mining. **Improved valuation and pricing mechanism** • Offsets for loss of good to excellent vegetation will result in net environmental benefit. • Costs of mine closure have been included in planning for the proposal. **Conservation of biological diversity and ecological integrity** • Survey information provides a greater understanding of the natural environment allowing for more effective environmental management and reduced impacts.

Theme	Impact	Management and Mitigation	EP Act Principles
	The proposal will result in the removal of troglofauna habitat and disturbance to stygofauna habitat due to declining groundwater levels within 'compartments'. 16 troglofauna species and 9 stygofauna species have only been recorded from the proposed mining areas, however it has been demonstrated that there is good habitat connectivity between pits and it is unlikely that these species are restricted to the mining area. At closure, pit lakes will remain.		• Environmental management includes adaptive management
Water	Groundwater will be abstracted during operations for dry mining and operational water requirements. This will result in a reduction in groundwater levels within the Proposal area. However, as a result of the compartmentalised nature of the local aquifers, the extent of groundwater drawdown is limited. Recovery is expected over time following closure. Surplus water from mine dewatering may be discharged to creeklines downstream of the Proposal. Groundwater quality is somewhat brackish, but otherwise good and discharge will not pose a risk to surface water quality downstream. Discharge of surplus mine dewatering may increase vegetation density at the point of discharge although it is noted that these changes will not be permanent as the duration of discharge is limited to only some years during operations. Water that has been captured or stored for a period of time within mine voids and undergone some evapoconcentration may be discharged to	Surface and Groundwater quality, including discharge of surplus mine dewatering managed through site specific surface and groundwater management plans. Mine planning to be continually reviewed as new waste characterisation information is received. Options for management of AMD include avoidance or mining and encapsulation in waste rock dumps, as outlined in Fortescue's AMD Management Plan. Where water is to be discharged from mine voids during operations, water quality will be tested and water treated to agreed value. Water quality from Broadway West will be monitored. Closure strategies will be developed and reviewed in consultation with key stakeholders, to ensure there are no adverse impacts to environmental or heritage values, in accordance with the *Eliwana Mine Closure Plan.*	**Precautionary Principle** • Surface and groundwater impact assessments have assumed worst case scenario for mine dewatering and altered surface water regime. **Intergenerational Equity** • Modelling of impacts to water quality from pit lakes considers long-term scenarios. **Improved valuation and pricing mechanism** • Fortescue bears the cost of mine closure to ensure water quality is fit for purpose following closure. **Conservation of biological diversity and ecological integrity** • Creation of wetland downstream of Broadway West offsets the loss of GDE systems within the dewatering footprint. • Conservation programs funded by the Pilbara Offset Fund will improve the

Theme	Impact	Management and Mitigation	EP Act Principles
	the surrounding environment during operations depending on operational requirements. If this water is of unacceptable quality, it can be managed (diluted) so that an impact does not occur. At closure, pit lakes will remain. Where mine voids are within a floodplain there is a potential connection to surface water. Water quality within the disconnected mine voids (i.e. not in a floodplain, no pathway to impact the environment) is likely to deteriorate over time by evapoconcentration, however, water quality impacts are restricted to the area within individual groundwater compartments.		regional ecology of the Pilbara in the long-term. **Waste Minimisation** • Discharge of surplus mine dewater is considered an option of last resort. Mine dewatering will be used for operational purposes in the first instance where practicable.
Air	There will be discharges to air from dust and exhaust emissions from mining fleet. Fortescue's preference is for power to be delivered to site via powerlines from Fortescue's Solomon Power Station, however, if required a power station will be installed at site and this will result in additional exhaust emissions. Fibrous particles have been detected from exploration drilling however, as a result of Fortescue's management practices, the risk from fibrous particles is low.	Dust emissions will be managed in accordance with Fortescue's Mine and Rail Dust Management Plan. Fortescue will look for opportunities to reduce greenhouse gas emissions. Progressive rehabilitation to reduce dust emissions and decrease carbon footprint.	**Intergenerational Equity/Waste Minimisation** • Preference for power supply from Solomon's Gas Fired Power Station results in less greenhouse gas emissions.

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Hydrological Processes

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

The assessment has demonstrated that there will be a decline in groundwater levels associated with mine dewatering. This drawdown is mitigated by the compartmentalised nature of the local aquifers. The drawdown will impact on small areas of GDE vegetation, considered under the Flora and Vegetation Environmental Factor. Some ephemeral and/or semi-permanent pools have been identified within the MDE and these may be impacted by groundwater drawdown. These pools are minor and do not have the same environmental value as pools found within Duck Creek, which will not be impacted by the proposal.

There will be impacts to surface water drainage as a result of the Proposal. These impacts are limited to several kilometres downstream of the proposed disturbance and are not likely to have a significant impact on a more regional scale.

As a result, the Proposal can be implemented to meet the EPA's objectives for hydrological processes.

Inland Waters Environmental Quality

To maintain the quality of groundwater and surface water so that environmental values are protected.

The assessment has demonstrated that any impacts to groundwater quality will be confined to individual 'compartments'. This is as a result of mine voids forming pit lakes following closure. Groundwater inputs into these voids will degrade over time, particularly an increase in salinity. Where pit wall material is present with a potential for AMD, this may also result in a decline in water quality within the pit lake. The assessment suggests that pit lake water will not flow into the surrounding water table due to the compartmentalised aquifers.

Pits located in floodplain areas are likely to capture surface water. Closure management will be employed, where required, to ensure water quality of outflow is suitable for the receiving environment.

Surplus mine dewatering discharged to downstream environment will not be poor quality water and there is no risk to the receiving environment from poor water quality. Similarly, if there is a requirement to discharge water from mine voids during operations, the water will be tested to determine its quality and treated as necessary to ensure water quality thresholds are maintained.

Therefore, whilst the Proposal may pose a risk to surface and groundwater quality, these impacts are likely to be localised.

Fortescue considers that with careful monitoring and management, the Proposal can be implemented to meet the EPA's objectives for this factor.

Flora and Vegetation

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

The assessment has demonstrated that biological diversity and ecological integrity of the flora and vegetation within the MDE will be maintained through avoidance, minimising and mitigation of impacts. The significant residual impacts associated with the proposal are the loss of vegetation in good to excellent condition and the loss of vegetation considered to be representative of the *Triodia sp. Robe River assemblages of mesas of the West Pilbara* Priority 3 Ecological Community. Other impacts are not significant on a local or regional scale. The application of environmental offsets will result in the Proposal meeting the EPA's objective for this factor.

Terrestrial Fauna

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

The assessment has demonstrated that the fauna habitats within the MDE are common and that the area is likely to be marginal for significant fauna species such as Northern Quoll, Pilbara Leaf-nosed Bat, Ghost Bat and Pilbara Olive Python. There are no significant residual impacts associated with the Proposal. The loss of fauna habitat is considered in the loss of good to excellent vegetation under the Flora and Vegetation Environmental Factor. The Proposal can be implemented to meet the EPA's objective for this factor.

Subterranean Fauna

To protect subterranean fauna so that biological diversity and ecological integrity are maintained.

The assessment has demonstrated that impacts to troglofauna species are localised and that there is only a moderate risk to individual troglofauna species due to the extensive continuous habitat in the area. Similarly, impacts to stygofauna species from groundwater drawdown are localised to the individual compartmentalised aquifers. Groundwater levels will return to within 1-35 metres of baseline values following closure. This estimate will be further refined during operations. The Proposal can be implemented to meet the EPA's objective for this factor.

Social Surroundings

To protect social surroundings from significant harm.

The proposal will not impact to population centres, recreation or tourism values, or non-Aboriginal heritage. Fortescue is committed to minimising impacts on Aboriginal heritage places in all of its project areas which includes wherever possible, avoidance of impacts on Aboriginal heritage places. Fortescue will continue to work with the traditional owners, heritage professionals and the regulatory body to mitigate and minimise the impact by undertaking additional research, investigate recording and analysis and salvage and repatriation of cultural material. The Proposal can be implemented to meet the EPA's objectives for this factor.

Air Quality

To maintain air quality and minimise emissions so that environmental values are protected.

Fortescue considers that air quality can be managed under Part V of the EP Act. Greenhouse gas emissions will be reduced to as low as practicable and are regulated under Federal legislation. The Proposal can be implemented to meet the EPA's objectives for this factor.

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Appendices on CD

Appendix 1: Environmental Scoping Document

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Appendix 3: Eliwana Mine Proposal – Surface Water Impact Assessment (Fortescue, 2017a)

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Appendix 18: Eliwana Project Consolidated Vertebrate Fauna Survey (Ecoscape, 2017b)

Appendix 19: Short Range Endemic Invertebrate Fauna Survey of Eliwana and Flying Fish (Phoenix Environmental Sciences, 2014)

Appendix 20: Conservation Significant Fauna Management Plan 100-PL-EN-0022

Appendix 21: Western Hub Subterranean Fauna Assessment (Biologic, 2017)

Appendix 22: Ethnobotanical and Ethnozoological Values Desktop Assessment - Eliwana Project (Ecoscape, 2018)

Appendix 23: Greenhouse Gas Emissions and Energy Reporting Management Plan 100-PR-GH-0001



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