# 9. Terrestrial Fauna

Terrestrial fauna, including Short Range Endemic (SRE) fauna, was identified in the ESD (GHD 2019a) as an environmental factor relevant to the proposal.

This section describes the terrestrial fauna and habitats within the Development Envelope, provides an assessment of the potential impacts relating to the implementation of the proposal and has been prepared to satisfy the requirements of the ESD (GHD 2019a) and the EPA's objective for terrestrial fauna, including short range endemic invertebrate fauna.

## 9.1 EPA objective

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

For the purposes of EIA, the EPA defines terrestrial fauna as animals living on land or using land for all or part of their lives. Terrestrial fauna includes vertebrate and invertebrate groups.

## 9.2 Policy and guidance

### EPA Policy and Guidance

- *Statement of Environmental Principles, Factors and Objectives* (EPA 2018b)
- *Instructions on how to prepare an Environmental Review Document* (EPA 2018a)
- *Environmental Factor Guideline: Terrestrial Fauna* (EPA 2016h)
- *Technical Guidance Terrestrial Fauna Surveys* (EPA 2016i)
- *Technical Guidance Sampling methods for terrestrial vertebrate fauna* (EPA 2016j)
- *Technical Guidance: Sampling of short range endemic invertebrate fauna* (EPA 2016k).

### Other policy and guidance

- *Threat abatement plan for predation of feral cats* (Department of the Environment 2015)
- *WA Environmental Offsets Policy* (GoWA 2011)
- *WA Environmental Offsets Guidelines* (GoWA 2014)
- *Threat Abatement Plan for Predation by the European Red Fox* (Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008)
- *Survey Guidelines for Australia's Threatened Reptiles* (DSEWPAC 2011a)
- Survey *Guidelines for Australia's Threatened Mammals* (DSEWPAC 2011b)
- *Environmental Offsets Policy* (DSEWPC 2012)
- Relevant recovery plans, conservation advices and/or threat abatement plans for conservation significant species that are known to occur, or a likely to occur within vicinity of the Proposal.

## 9.3 Required work

The required work for the terrestrial fauna factor as stipulated in the approved ESD and its location within this ERD is documented in Table 9-1.

Table 9-1 Required work for Terrestrial Fauna

| Task No | Required work | Section |
|---|---|---|
| **Yogi Mine Project** | | |
| 45 | Historical reports and government databases will be reviewed to identify the environmental values and potential issues that may be present to refine survey design, and to characterise the potential terrestrial fauna of the area, identify likely habitats and any significant fauna that may be present | Section 9.4.1 |
| 46 | Conduct a Level 2 fauna survey over two seasons and one SRE survey in accordance with EPA Technical guidance - Terrestrial Fauna Survey (EPA 2016h) as well as those listed below, survey will include: | Section 9.4.1 |
| 46a | Delineating, describing and assessing fauna habitat quality | Section 9.4.2.1 |
| 46b | Opportunistic searches for terrestrial fauna and introduced fauna within and outside the Development Envelope that are known or likely to occupy the Development Envelope | Section 9.4.1 and 9.4.2.2 |
| 46c | Targeted surveys for conservation significant fauna within and in close proximity to the Development Envelope using methods suitable for each species. The requirement for a targeted survey will be based on the desktop assessment and habitats identified during the initial fauna survey | Section 9.4.2.2 |
| 46d | Fauna trapping, spot lighting (nocturnal searching), hand foraging (diurnal searching), acoustic surveys, and camera traps | Section 9.4.1 |
| 46e | Opportunistic searches for introduced fauna | Section 9.4.1 and 9.4.2.2 |
| 46f | Mapping fauna habitat and significant fauna locations and habitat, and introduced fauna | Figures Figure 9-1, Figure 9-2 (Section 9.4.2) |
| 46g | Describing the values and significance of fauna and fauna habitat that maybe directly or indirectly affected by the Proposal implementation during both construction and operation activities | Section 9.6.1 |
| 47 | Matters of National Environmental Significances being assessed as part of the accredited assessment will be specified. | Section 13 |
| 48 | Figure(s) will be provided illustrating the known recorded locations of conservation significant species, short-range endemic invertebrate species or other significant fauna and fauna habitat in relation to the Proposal | Figure 9-2 and Figure 9-3 |
| 49 | The extent of direct, indirect and cumulative impacts as a result of implementation of the Proposal will be described and quantified and assessed during both construction and | Section 9.6.1 |

| Task No | Required work | Section |
|---|---|---|
| | operations to fauna and SRE, taking into consideration the significance of fauna and SRE, and habitat. This will include noting whether these impacts are unknown, unpredictable or irreversible, or combination or contrary to that thereof | |
| 50 | The residual impacts from the Proposal will be predicted for fauna and SRE after considering and applying avoidance and minimisation measures | Section 9.8.1 |
| 51 | Management measures for the Proposal will be identified to ensure residual impacts to fauna and SRE are not greater than predicted. | Section 9.7 |
| 52 | An environmental management plan will be provided to address significant residual impacts to terrestrial fauna. The plan will describe management measures and monitoring to be undertaken (in terms of the mitigation hierarchy) to achieve predicted outcomes. Measures will be technically and practically feasible | GHD 2020d, Appendix C |
| 53 | The extent and significance of any significant residual impacts will be determined on the identified environmental values by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (GoWA 2014). Spatial data will be provided defining the area of significant residual impacts | Section 9.8.1 |
| 54 | Where significant residual impacts remain, an appropriate offsets package will be proposed, consistent with the WA Environmental Offsets Policy and Guidelines and where residual impacts relate to EPBC Act-listed threatened species and Communities the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Spatial data will be provided defining the area of significant residual impacts. | Section 9.8.3 |
| 55 | A mine closure plan will be provided, consistent with the DMIRS and EPA Guidelines. | GHD 2019c, Appendix D |
| 56 | The ERD will demonstrate and document how the EPA's objective for this factor can be met and how proposed offsets are consistent with the EPBC Act | Section 9.8.1 and 9.8.3 |
| **Pipeline Corridor** | | |
| 57 | Historical reports and government databases will be reviewed to identify the environmental values and potential issues that may be present to refine survey design, and to characterise the potential terrestrial fauna of the area, identify likely habits and any significant fauna that may be present. | Section 9.4.1 |
| 58 | A Level 1 fauna survey will be conducted in accordance with EPA Technical guidance - Terrestrial Fauna Survey (EPA 2016h), survey will include: | Section 9.4 |

| Task No | Required work | Section |
|---|---|---|
| 58a | Opportunistic searches for conservation significant fauna within and outside the Development Envelope that are known or likely to occupy the Development Envelope | Section 9.4.1 |
| 58b | Opportunistic searches for introduced fauna including hand foraging, spotlighting, and observational survey | Section 9.4.1 and 9.4.3.2 |
| 59 | Figure(s) will be provided illustrating the known recorded locations of conservation significant species, short-range endemic invertebrate species or other significant fauna and fauna habitat in relation to the Proposal | Figure 9-4 and Figure 9-5 (Section 0) |
| 60 | Matters of National Environmental Significances being assessed as part of the accredited assessment will be specified | Section 13 |
| 61 | An environmental management plan will be provided to address significant residual impacts to terrestrial fauna. The plan will describe management measures and monitoring to be undertaken (in terms of the mitigation hierarchy) to achieve predicted outcomes. Measures will be technically and practically feasible. | GHD 2020e, Appendix C |
| 62 | The extent and degree of any significant residual impacts on the identified environmental values will be determined by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (GoWA 2014). Spatial data will be provided defining the area of significant residual impacts. This will include noting whether these impacts are unknown, unpredictable or irreversible, or combination or contrary to that thereof. | Section 9.8.1 |
| 63 | Where significant residual impacts remain, an appropriate offsets package will be provided, consistent with the WA Environmental Offsets Policy and Guidelines and where residual impacts relate to EPBC Act-listed threatened species and Communities the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Spatial data will be provided defining the area of significant residual impacts | Section 9.8.1 |
| 64 | An environmental management and rehabilitation plan will be provided for the pipeline corridor. | GHD 2020e, Appendix C |
| 65 | The ERD will demonstrate and document how the EPA's objective for this factor can be met and how proposed offsets are consistent with the EPBC Act | Section 9.8.2 |

## 9.4 Receiving environment

This section has been prepared in alignment with the requirements of *Environmental Factor Guideline: Terrestrial Fauna* (EPA 2018f). The terrestrial fauna receiving environment of the pipeline and the mine area will be described separately to provide clarity, which is a reflection of the different nature, size and arrangement of each area.

### 9.4.1 Supporting fauna technical studies

A summary of the terrestrial fauna and SRE fauna surveys that have been completed within and in close proximity to the Proposal area are provided in Table 9-2. GHD completed several technical fauna studies as part of this environmental review, and these are also included in Table 9-2.

Table 9-2 Supporting terrestrial fauna technical studies

| *Report Title* Author (Month Year) | Targeted group | Location | Date | Summary | Survey area relevance to Proposal |
|---|---|---|---|---|---|
| *Vertebrate Fauna Assessment, Yalgoo Iron Project* ATA Environmental (2006) | Vertebrate Fauna | Leases P59/1397, E59/642 and P59/108 | June 2006 | Survey level: Level 1<br>The key findings included:<br>• One habitat type – scattered mulga<br>• The following conservation significant species may visit the general area:<br>o Gilled Slender Bluetongue (*Cyclodomorphous branchialis*)<br>o Peregrine Falcon (*Falco peregrinus*)<br>o Australian Bustard (*Ardeotis australis*) (no longer conservation significant)<br>o White-browed Babbler (western Wheatbelt subspecies) (*Pomatostomus superciliosus ashbyi*) - (no longer conservation significant)<br>o Major Mitchell's Cockatoo (*Cacatua leadbeateri*) (no longer conservation significant)<br>o Rainbow Bee Eater (*Merops ornatus*) - (no longer conservation significant)<br>o Fork-tailed Swift (*Apus pacificus*)<br>• An inventory of species noted during the site reconnaissance was not provided in this report. | The study area of this technical study does not intersect the MDE. The study area is adjacent to the southern 'tail' section of lease L 59/156, which is part of the MDE. |
| *Vertebrate Fauna Survey Yalgoo Iron Ore Project* Coffey Environments Pty Ltd (2008) | Vertebrate Fauna | Leases E59/642, M59/637 and P59/1397 | November 2007 February 2008 | Survey Level: Level 2 fauna survey inclusive of trapping program, avifauna, opportunistic survey and bat survey.<br>The key findings included:<br>• Two broad habitat types identified– Tall Shrubland and Tall Open Scrubland<br>• Degraded habitat due to sheep grazing<br>• The survey recorded 82 species of vertebrate fauna, however only one was noted to be of conservation significance (*Merops ornatus*, Rainbow Bee eater) (formerly migratory)<br>• However, the assessment also noted the potential presence of the following in the general area:<br>o Gilled Slender Bluetongue<br>o Australian Bustard<br>o Crested Bellbird (southern subspecies) (*Oreoica gutturalis gutturalis*) - (no longer conservation significant)<br>o White-browed Babbler (western Wheatbelt subspecies)<br>o Fork-tailed Swift<br>o Peregrine Falcon | The study area of this technical study does not intersect the MDE. The study area is adjacent to the southern 'tail' section of lease L 59/156, which is part of the MDE. |
| *Survey for Short Range Endemic Fauna for the Yogi Magnetite Project, Yalgoo, Western Australia* Invertebrate Solutions (2019b) | SRE Invertebrate Fauna | Leases M59/740, M59/637 and L 59/156 | October 2018 | Survey level: Level 2 single season SRE survey undertaken in accordance with EPA (2016f).<br>The key findings include:<br>• 12 potential SRE invertebrate species were recorded from the MDE.<br>• None are 'Confirmed' SRE species.<br>• Species determined to be "Possible" SRE taxa is mostly due to incomplete taxonomy and unknown species distributions with almost all the possible SRE species found at multiple locations indicating their distributions are wider than the current survey could determine. | The study area of this technical study is congruent with the MDE and also includes some sampling outside the MDE. |
| *Fauna Assessment* GHD (2020b) (Appendix B) | Vertebrate Fauna | MDE | August 2018 October 2018 | Location: Leases M59/740, M59/637 and L 59/156<br>Desktop assessment was completed to identify environmental values pertaining to the study area and to assist in refining survey design. Historical fauna reports provided by FIJV and government databases were reviewed. | The study area of this technical study is congruent with the MDE. |

| *Report Title* Author (Month Year) | Targeted group | Location | Date | Summary | Survey area relevance to Proposal |
|---|---|---|---|---|---|
| | | | January 2020 | Survey completed: Site reconnaissance in August 2018 and trapping program in October 2018 and January 2020 of terrestrial vertebrate fauna. Opportunistic fauna observations were also undertaken.<br>GHD completed two level 2 fauna surveys (October 2018 and January 2020) of the Yogi Mine in accordance with Terrestrial Fauna Surveys (EPA 2016i). Table 9-3 summarises the fauna survey effort over the two level 2 surveys. The key findings include:<br>• Six fauna habitats were recorded within the MDE.<br>• 153 species were recorded as part of the surveys, however only two species of conservation significance (the Western Spiny-tailed Skink and the Long-tailed Dunnart).<br>• Four conservation significant fauna species were identified to be or potentially to be within the MDE:<br>o Forked-tailed Swift<br>o Peregrine Falcon<br>o Western Spiny-tailed skink<br>o Gilled Slender Blue Tongue<br>o Long Tailed Dunnart | |
| *Pipeline Corridor Flora and Fauna Assessment* GHD (2020c) (Appendix B) | Vertebrate Fauna | PDE | November 2018 and January 2020 | Location: Pipeline Envelope Option 2 from the site access route on Geraldton- Mount Magnet Road to 30 km east of Mullewa, on Geraldton-Mount Magnet Road (the eastern portion).<br>A desktop assessment of publicly available information and government databases was completed to determine the fauna values of the survey area.<br>Survey completed: Site reconnaissance and trapping program in November 2018 of terrestrial vertebrate fauna. Opportunistic fauna searches were conducted throughout the survey area. GHD completed a single season Level 1 fauna survey of the eastern side of the PDE.<br>The key findings include:<br>• Eight broad fauna habitat types<br>• 68 fauna species were recorded as part of the surveys, with no conservation significant fauna identified<br>• Four species were identified to be potentially within the eastern PDE including:<br>o Malleefowl<br>o Gilled Slender Blue-tongue<br>o Western Spiny-tailed Skink<br>o Long-tailed dunnart.<br>A targeted Malleefowl assessment was undertaken from 20th-31st January 2020. Based on vegetation community assessment and mapping carried out by GHD botanists during the flora and vegetation survey over the length of the survey area, specific habitat types were identified as potentially suitable for Malleefowl mounds based on a combination of vegetation type, density and soil characteristics. . These habitats generally included relatively dense mixed shrublands or mallee woodlands on sandplains. Where these habitat areas intersected with the survey area, search areas were traversed on foot to detect Malleefowl Mounds. | The study area of this technical study is covers a limited extent of the eastern portion of the PDE, and does not include land within the PDE that is not public land. |

| *Report Title* Author (Month Year) | Targeted group | Location | Date | Summary | Survey area relevance to Proposal |
|---|---|---|---|---|---|
| *Western Pipeline Flora and Fauna Desktop Assessment* (GHD 2020a) (Appendix B) | Vertebrate Fauna | Western portion of the PDE | February 2020 | The desktop assessment reviewed publically available information (government databases) to determine the previously recorded flora and vegetation values in the western portion of the PDE. The study area included a 40 km buffer of the western portion of the PDE.<br>No wetlands (RAMSAR or of National importance, DBCA managed lands, ESAs, TECs/PECs intersect the western portion of the PDE. Nine 'avoidance areas' have been identified based on the prevalence of conservation significant flora and fauna and the priority status within certain areas of the western PDE. | Intersects with the western portion of the PDE |

Table 9-3 Terrestrial Fauna survey effort (GHD 2020b)

| Fauna Tapping sites | | | | Elliot traps | | Pit Traps | | Cage Traps | | Funnel traps | | Bat Detector | Birds search | Active search | Night search | Night Parrot |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sites – Phase 1** | **Easting** | **Northing** | **nights open** | **traps** | **trap nights** | **traps** | **trap nights** | **traps** | **trap nights** | **traps** | **trap nights** | **trap nights** | **minutes** | **minutes** | **minutes** | **nights** |
| Trap line 1- Chenopod | 484274 | 6879918 | 8 | 20 | 160 | 7 | 56 | 2 | 16 | 10 | 80 | 1 | 120 | 120 | 90 | 27 |
| Trap line 2- Riparian | 486206 | 6881483 | 8 | 20 | 160 | 7 | 56 | 2 | 16 | 10 | 80 | 1 | 100 | 120 | 60 | 9 |
| Trap line 3- Mulga Plain | 480887 | 6879188 | 8 | 20 | 160 | 7 | 56 | 2 | 16 | 10 | 80 | 4 | 80 | 60 | 80 | |
| Trap line 4- BIF Ridge | 479862 | 6878042 | 8 | 20 | 160 | 7 | 56 | 2 | 16 | 10 | 80 | 1 | 80 | 120 | 60 | |
| Trap line 5- Granite North | 482680 | 6883160 | 7 | 20 | 140 | 7 | 49 | 2 | 14 | 10 | 70 | 1 | 80 | 180 | 90 | |
| Trap line 6- Mulga Plain NE | 488185 | 6873034 | 7 | 20 | 140 | 7 | 49 | 2 | 14 | 10 | 70 | 3 | 80 | 120 | 120 | |
| Trap line 7- Mulga Plain E | 488049 | 6868296 | 7 | 20 | 140 | 7 | 49 | 2 | 14 | 10 | 70 | 1 | 120 | 90 | 120 | |
| Trap line 8- BIF Ridge | 481736 | 6875398 | 7 | 20 | 140 | 7 | 49 | 2 | 14 | 10 | 70 | 1 | 60 | 60 | 60 | |
| Trap line 9- Granite Central | 486892 | 6876040 | 7 | 20 | 140 | 7 | 49 | 2 | 14 | 10 | 70 | 2 | 80 | 120 | 60 | |
| Total –Phase 1 | | | | 180 | 1340 | 63 | 469 | 18 | 134 | 90 | 670 | 15 | 800 | 990 | 740 | 36 |

| Fauna Tapping sites | | | | Elliot traps | | Pit Traps | | Cage Traps | | Funnel traps | | Bat Detector | Birds search | Active search | Night search | Night Parrot |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sites – Phase 2** | **Easting** | **Northing** | **nights open** | **traps** | **trap nights** | **traps** | **trap nights** | **traps** | **trap nights** | **traps** | **trap nights** | **trap nights** | **minutes** | **minutes** | **minutes** | **nights** |
| Trap line 1- Chenopod | 484274 | 6879918 | 7 | 12 | 84 | 6 | 42 | 2 | 14 | 12 | 84 | 2 | 80 | 60 | 60 | |
| Trap line 2- Riparian | 486206 | 6881483 | 7 | 12 | 84 | 6 | 42 | 2 | 14 | 12 | 84 | 2 | 80 | 60 | 60 | |
| Trap line 3- Mulga Plain | 480887 | 6879188 | 7 | 12 | 84 | 6 | 42 | 2 | 14 | 12 | 84 | 2 | 80 | 60 | 60 | |
| Trap line 4- BIF Ridge | 479862 | 6878042 | 7 | 12 | 84 | 6 | 42 | 2 | 14 | 12 | 84 | 3 | 80 | 60 | 60 | |
| Trap line 8 BIF Ridge | 481736 | 6875398 | 7 | 12 | 84 | 6 | 42 | 2 | 14 | 12 | 84 | 3 | 80 | 60 | 60 | |
| Trap line 10 Riparian | 482057 | 6875540 | 7 | 12 | 84 | 6 | 42 | 2 | 14 | 12 | 84 | 2 | 80 | 60 | 60 | |
| Total – Phase 2 | | | | 72 | 504 | 36 | 252 | 12 | 84 | 72 | 504 | 14 | 480 | 990 | 360 | |
| **Total – Phase 1 and 2 combined** | | | | | **1844** | | **721** | | **218** | | **1174** | | **1220** | **1350** | **1100** | |

### 9.4.2 Mine development envelope

#### *9.4.2.1 Terrestrial fauna habitats*

Six broad habitat types were identified in the MDE: Banded Ironstone Formation (BIF) Ridgelines, Riparian/Creek line, Flood Plain, Chenopod Plain, Mixed Acacia Plain, and Granitic formations (GHD 2002b). These habitats are mapped in Figure 9-1 and described in Table 9-4.

Of the habitats identified, the following habitat types were noted to have higher conservation value:

- BIF Ridgelines
- Riparian Creek line
- Chenopod Plain
- Granitic formations.

**Quality of Habitat**

The conservation value of each habitat type has been rated based on condition, structural complexity, faunal diversity and habitat for conservation significant fauna (i.e. contains essential habitat for breeding and/or feeding). Habitat values for the six types are all considered moderate to high value. A very small amount of the proposal area contains disturbed habitat comprising of existing tracks, old fencing and historical cleared areas for stock water points. Habitat values have been described in Table 9-4.

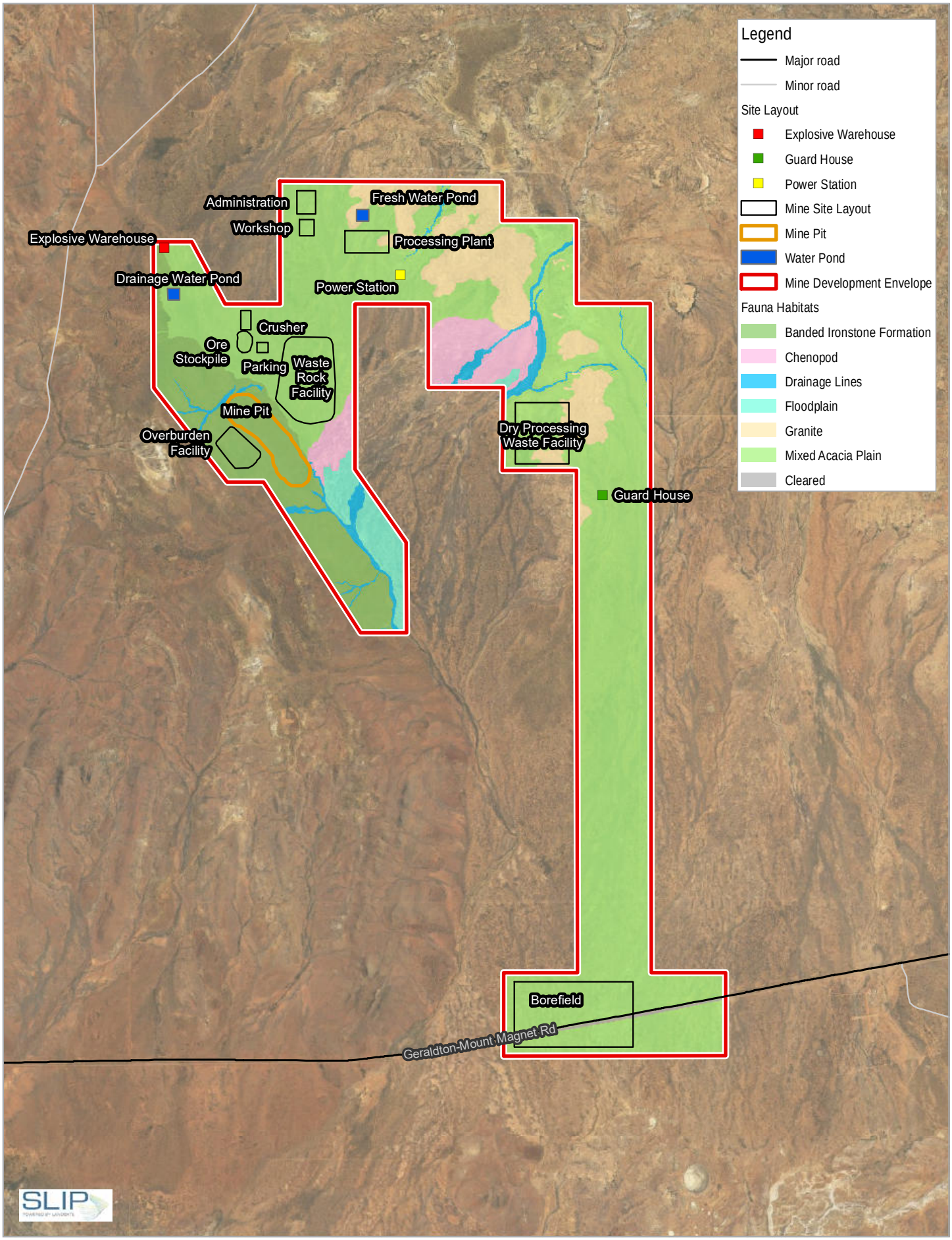
**Habitat linkages**

The mine development area forms part of a large continuous tract of habitat which retains high connectivity to the habitats directly adjacent. Although there are some signs of stress from drought, pastoralism (grazing, trampling of vegetation and soil compaction, clearing around artificial water sources), the majority of the site is uncleared and forms good habitat. Fences run through the proposal area, presenting some barriers to the movement of fauna.

Table 9-4 Fauna habitats of the Mine Development Envelope

| Habitat Type/ description | Extent in MDE (ha) | Possible Conservation Significant Fauna |
|---|---|---|
| **BIF Ridgeline**<br>Moderate value to high value<br>Open shrublands of *Acacia* sp., *Thryptomene* sp. *Eremophila forrestii, E. galeata* and *Ptilotus* sp. on low banded ironstone formation ridgelines. | 1,041.09 | Long- tailed Dunnart (*Sminthopsis longicaudata*) (habitat)<br>Gilled Slender Bluetongue (*Cylodomorphia branchialis)* (habitat)<br>Western spiny tailed skink (*Egernia stokesii badia*) (habitat)<br>Peregrine Falcon (*Falco peregrinus)* (foraging) |

| Habitat Type/ description | Extent in MDE (ha) | Possible Conservation Significant Fauna |
|---|---|---|
| **Riparian Creek line**<br>High Value<br>Tall shrublands: *Callistemon, Eucalyptus, Scaevola* with herbs and grassland along minor creeks and drainage lines | 215.22 | Gilled Slender Bluetongue (habitat)<br>Peregrine Falcon (hunting/foraging) |
| **Flood Plain**<br>Moderate Value<br>Mixed shrublands of *Acacia, Eremophila, Grevillia,* and *Hakea* on seasonally inundated floodplain. | 252.18 | Peregrine Falcon (hunting/foraging) |
| **Chenopod Plain**<br>High value<br>Low open heathland of *Atriplex, Maireana, Sclerolaena,* and scattered *Acacia* on fine sandy soils | 391.26 | Night Parrot (foraging )<br>Gilled Slender Bluetongue (habitat)<br>Peregrine Falcon (hunting/foraging) |
| **Mixed Acacia Plain**<br>Moderate value<br>Shrublands of mixed *Acacia* on plain on loam/clay soils | 5,470.71 | Gilled Slender Bluetongue (habitat)<br>Peregrine Falcon (hunting/foraging)<br>Long-tailed Dunnart (habitat) |
| **Granitic formations**<br>High Value<br>Scattered low shrublands of *Acacia, Eremophila, Grevillia, Hakea,* and *Borya* amongst granite outcropping | 825.48 | Western Spiny-tailed Skink (habitat)<br>Long-tailed Dunnart (habitat)<br>Gilled Slender Bluetongue (habitat)<br>Peregrine Falcon (foraging) |




Paper Size ISO A4

0 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

Terrestrial Fauna Habitats of the Mine Development Envelope

| | |
|---|---|
| Project No. | 61-37117 |
| Revision No. | 0 |
| Date | 05 Mar 2020 |

FIGURE 9-1

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-1_TerrFaunaHabMDE_rev0.mxd
Print date: 05 Mar 2020 - 08:34

Data source: GHD: Survey Area - 20180622, Fauna Habitats - 20181210; Landgate: Roads - 20181023, Imagery - Taken September 2012 - Accessed 20181210.. Created by: cgverzosa

#### 9.4.2.2 Terrestrial fauna diversity

The Level 1 and Level 2 surveys conducted by GHD (2019f) recorded the following fauna.

A total of 153 vertebrate fauna species, including 27 mammals, 83 birds, 39 reptiles and four amphibian species.

Twenty seven mammal species within the MDE, including seven introduced and 20 native mammals. The composition of native species includes nine bats, two native rodent, two macropod, four small dasyurids, Echidna and seven introduced mammals. Thirty-two Red Kangaroo were recorded (8.9% of total native mammal recordings) with twenty-six Spinifex Hopping Mouse (7.2% of total native mammal recordings). One mammal species of conservation significance (Long-tailed Dunnart) was identified.

Eighty-three bird species from 37 families were identified within the MDE. The most abundant species were the Zebra Finch with 77 records (5.2% of total bird recordings), Southern Whiteface with 66 records (4.5% of total bird recordings), Spiny-cheeked Honeyeater with 62 records (4.2% of total bird recordings), Crimson Chat with 53 records (3.6% of total bird records). No bird species of conservation significance were identified.

The Night Parrot (*Pezoporus occidentalis*) was specifically targeted for assessment utilising SM4 Accoustic Songmeters ® in suspected habitat areas (Chenopod Plain). The Chenopod plain within the MDE was relatively small and isolated in the environment and despite 4 units being deployed for a combined total of 54 nights (one site at a water point within the Chenopod) no evidence of Night Parrot was recorded.

A total of 39 reptile species were recorded during the field surveys from nine families. The most abundant species were Tree Dtella with 62 records (12.4% of total reptile recordings), Nicholl's Lerista with 62 records (12.4% of total reptile recordings) and Yellow Spotted Monitor with 43 records (8.6% of total reptile recordings). One species of conservation significance was identified during the survey: the Western Spiny-tailed Skink,

Four amphibian species were recorded in the MDE during the surveys from three families. Forty eight amphibian individuals were recorded with Central Burrowing Frog recording 30 individuals (62.5% of total amphibian recordings).

Seven introduced fauna species were observed, specifically Cattle (*Bos Taurus*), Goat (*Capra hircus*), Dog (*Canus familiaris*), Horse (*Equus caballus*), Cat (*Felis catus*), European Rabbit (*Oryctolagus cuniculus*), and the House Mouse (*Mus musculus*).

#### 9.4.2.3 Conservation significant terrestrial fauna

As part of the *Fauna Assessment* (GHD 2020b), a likelihood of occurrence and risk assessment was completed of conservation significant fauna identified during technical studies (summarised in Table 9-2), and included in search results from the EPBC Act Protected matters database, DBCA Threatened and Priority Fauna database and *Nature Map* database.

This assessment is based on species' biology, habitat requirements, the quality and availability of suitable habitat as determined during the field survey and records of the species in the MDE and locality. Species-specific searches of the DPaW NatureMap database with a buffer of 40 km was conducted in order to gather information about the broader regional occurrence of species to further inform the likelihood of occurrence assessment.

In total, including those recorded at the MDE, five species are likely to occur in the MDE. Table 9-5 summarises the species of conservation significance that are either known or considered likely to occur in the MDE. The parameters of assessment for this likelihood of occurrence assessment and the full likelihood of occurrence assessment are provided in the *Fauna Assessment* (GHD 2019c).

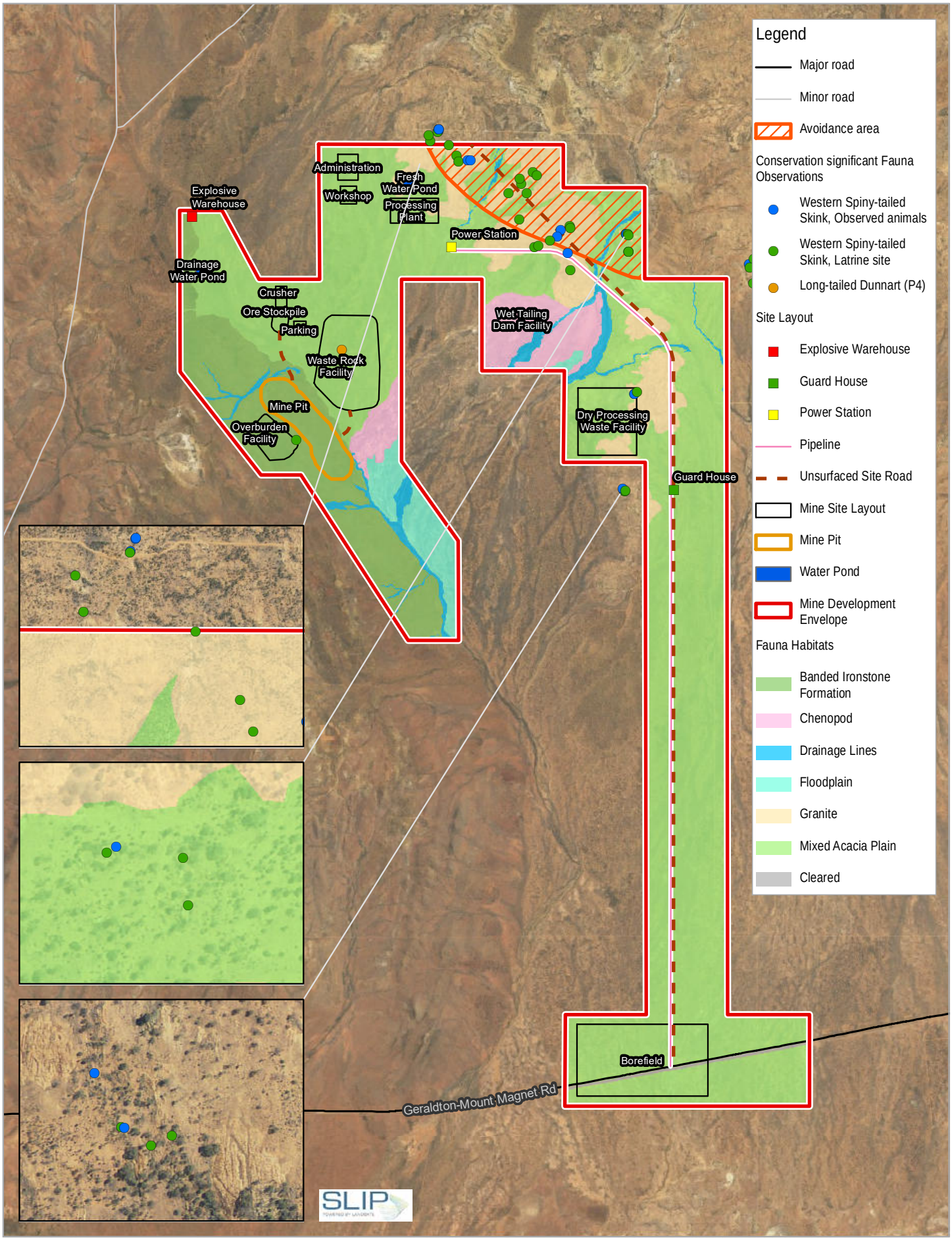
Species previously listed as conservation significant in historical reports but have subsequently had their conservations status removed are not included in this table. Some species identified in the Protected Matters Search tool are not realistically considered to occur in the MDE or are not terrestrial vertebrate species and have been excluded from the assessment.

The locations of where conservation significant terrestrial fauna species were identified during the field survey are presented in Figure 9-2.

Detailed information of the conservation significant terrestrial fauna identified is included in the *Fauna Assessment* (GHD 2020b, Appendix B).

Only two species of conservation significance was recorded within the MDE, the Western Spiny-tailed Skink (*Egernina stokesii badia*) and Long-tailed Dunnart (*Sminthopsis longicaudata*). The Western Spiny-tailed Skink (*Egernina stokesii badia*) was recorded in the BIF Ridgeline and Granitic formations fauna habitats and the Long-tailed Dunnart (*Sminthopsis longicaudata*) was recorded in the Mixed Acacia Plain fauna habitats (Figure 5, Appendix B).

Several additional rocky areas located in proximity to but beyond the boundary of the survey area were also searched to provide some local and regional context to skink occurrence and to assess these area as potential skink relocation sites. Potential skink relocation sites were assessed based on the presence of potentially suitable granite structure but lack of evidence of existing/resident colonies i.e. no scat latrines and no skinks. Table X provides a list of potential relocation sites. Based on the results of this survey, where possible, the mine layout will be modified to minimise impacts to these fauna habitats and appropriate mitigation measures will be employed prior to clearing to reduce direct impacts to conservation significant fauna species, as outlined in the EMP (GHD 2020d, Appendix C).




Paper Size ISO A4

0 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

# Location of Conservation Significant Terrestrial Fauna in the Mine Development Envelope

| | |
|---|---|
| Project No. | 61-37117 |
| Revision No. | 0 |
| Date | 06 Mar 2020 |

FIGURE 9-2

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-2_LocConSigTerrFaunaMDE_rev0.mxd
Print date: 06 Mar 2020 - 10:05

Data source: GHD: Survey Area - 20180622, Threatened Fauna - 20181210; Landgate: Roads - 20181023, Imagery - Taken September 2012 - Accessed 20181210.. Created by: cgverzosa

Table 9-5 Conservation significant terrestrial fauna likelihood of occurrence in the Mine Development Envelope

| Species | Suitable habitat within the MDE | Recorded in MDE | Distribution | Conservation Status BC Act (DBCA) [EPBC Act] | Likelihood of occurrence |
|---|---|---|---|---|---|
| **Birds** | | | | | |
| Fork-tailed Swift (*Apus pacificus*) | None specific to this exclusively areal species | No | Scattered populations throughout WA, including the Pilbara, Mid-west and Goldfields. | MI [MI] | **Unlikely**. Although this species may periodically occur in the region, the species is exclusively areal in nature and irregularly utilises terrestrial habitats. |
| Peregrine Falcon (*Falco peregrinus*) | Riparian Creek Line, BIF Ridgeline, Flood Plain, Mixed Acacia Plain, Granitic Formations | Yes | Seen occasionally anywhere in the south-west of WA. | S7 (SP) [none] | **Likely**. The species is known from the region, however use would be opportunistic and utilised for foraging purposes only. No breeding habitat is present in the MDE. |
| **Reptiles** | | | | | |
| Gilled Slender Bluetongue (*Cyclodomorphous branchialis*) | Riparian Creek Line, BIF Ridgeline, Mixed Acacia Plain and Granitic Formations | No | **Distribution** Lower west coastal regions on WA, between the Murchison and Irwin Rivers. A ground-dwelling lizard preferring to live amongst porcupine grass, leaf-litter, and under fallen timber and rocks. | VU [none] | **Likely**. The species is known from the region with records present east, west and south of the MDE. No specimens were recorded during the field surveys. |
| Western Spiny-tailed Skink (*Egernia stokesii* subsp. *badia*) | BIF Ridgeline and Granitic formations | Yes | Patchy distribution throughout arid and semi-arid areas of WA, with the subspecies in the Yalgoo to Cue area typically rock habitat dwelling, and requiring particular features such as crevices, overhangs and rock mounds. | VU [EN] | **Known**. The species was observed in Granite areas and one BIF location within the MDE. |

| Species | Suitable habitat within the MDE | Recorded in MDE | Distribution | Conservation Status BC Act (DBCA) [EPBC Act] | Likelihood of occurrence |
|---|---|---|---|---|---|
| **Mammals** | | | | | |
| Long-tailed dunnart (*Sminthopsis longicaudata*) | BIF Ridgeline, Granitic Formation | Yes | Throughout the Gibson Desert, Murchison, southern Carnarvon Basin and the Pilbara.<br>Utilises rugged, rocky areas including scree slopes, boulder and stony plateaus and breakaways environments, and adjacent stony plains with shrubs over spinifex grasslands from widely scattered localities in the arid zone. | P4<br>[none] | **Likely**. The species is known from the region with records present east, west and north of the MDE. No specimens were recorded during the field surveys. |

Key – S7 (SP) = Schedule 7, Special Protection under BC Act, Mi = Migratory under EPBC Act, S5 = Schedule 5, Migratory under international Agreement under BC Act, S3 (Vu) = Schedule 3, Vulnerable under BC Act, P1 = Priority 1 under DBCA, P2 = Priority 2 under DBCA.

Table 9-6 Potential relocation sites for the Western Spiny-tailed Skink

| Site ID | Comments on potential for skink relocation | Easting | Northing |
|---|---|---|---|
| 1 | Low granite outcrop, potential relocation site, within survey area | 485597 | 6880794 |
| 2 | Low granite outcrop, potential relocation site, within survey area | 485602 | 6881003 |
| 3 | Low granite outcrop, potential relocation site, within survey area | 486511 | 6876482 |
| 4 | Low granite outcrop, potential relocation site, within survey area | 483459 | 6883206 |
| 5 | Large extensive granite outcrop outside survey area, black form of Western Spiny-tailed Skink observed which may represent distinct genetic population from skinks recorded within survey area, therefore not suitable site for relocation | 489483 | 6880811 |
| 6 | Large extensive granite outcrop outside survey area, black form of Western Spiny-tailed Skink observed which may represent distinct genetic population from skinks recorded within survey area, therefore not suitable site for relocation | 489212 | 6880474 |

#### 9.4.2.4 Short range endemic invertebrates

Short range endemic (SRE) invertebrates are species with restricted distributions. The isolation of invertebrates in specific habitats or bioregions leads to endemism at various spatial scales. The vast majority of invertebrates are capable of dispersing substantial distances at some phase of their life cycle. Some groups, however, are susceptible to short-range endemism which describes endemic species with restricted ranges, arbitrarily defined in Western Australia as less than 10,000 $km^2$ (100 km x 100 km) (Harvey 2002, as cited in Invertebrate Solutions 2019). Taxa that have been more commonly found to contain SRE representatives include:

- Onychophorans (velvet worms)
- Crustaceans (Isopoda)
- Arachnids (mygalomorph spiders, pseudoscorpions, opiliones, scorpions, schizomids)
- Myriapods (millipedes and centipedes)
- Molluscs (land snails)
- Insects (hemipterans, grasshoppers, butterflies).

SRE invertebrate fauna taxa are generally found in sheltered, relatively mesic environments such as isolated habitats (e.g. boulder piles, isolated hills, dense patches of vegetation, gullies) and can include microhabitats within these environments such as deep leaf litter accumulation, large logs, under bark, cave areas and springs and permanent water bodies (Invertebrate Solutions 2019).

##### SRE fauna diversity

An SRE invertebrate fauna survey was completed by Invertebrate Solutions in October 2018 (2019b) of the MDE, and comprised a desktop assessment and field survey. The SRE field survey recorded 23 taxa of invertebrates from three classes, nine orders and 10 families that have the potential to contain SRE taxa. The most abundant species was *Arthrorhabdus mjobergi* with nine recordings and one each at nine locations (14% of total SRE invertebrate recordings). The SRE survey recorded a single 'Likely' SRE species and 14 'Possible' SRE invertebrate species from the Yogi Magnetite Project area. There were no 'Confirmed' SRE species recorded during the survey.

The majority of the species determined to be "Possible" SRE taxa is due to incomplete taxonomy and unknown species distributions. The single specimen that is considered a Likely SRE species was recorded from mixed acacia plains which are not restricted and unlikely to contain habitat isolates. Therefore it is not anticipated to be significantly affected by the development proposal. Almost all the possible SRE species were found at multiple locations during the survey indicating that their distributions are wider than the current survey could determine.

A summary of the SRE invertebrates identified during the field survey and through the desktop assessment is provided in Table 9-7. Figure 9-3 presents the SRE sampling locations within the MDE.

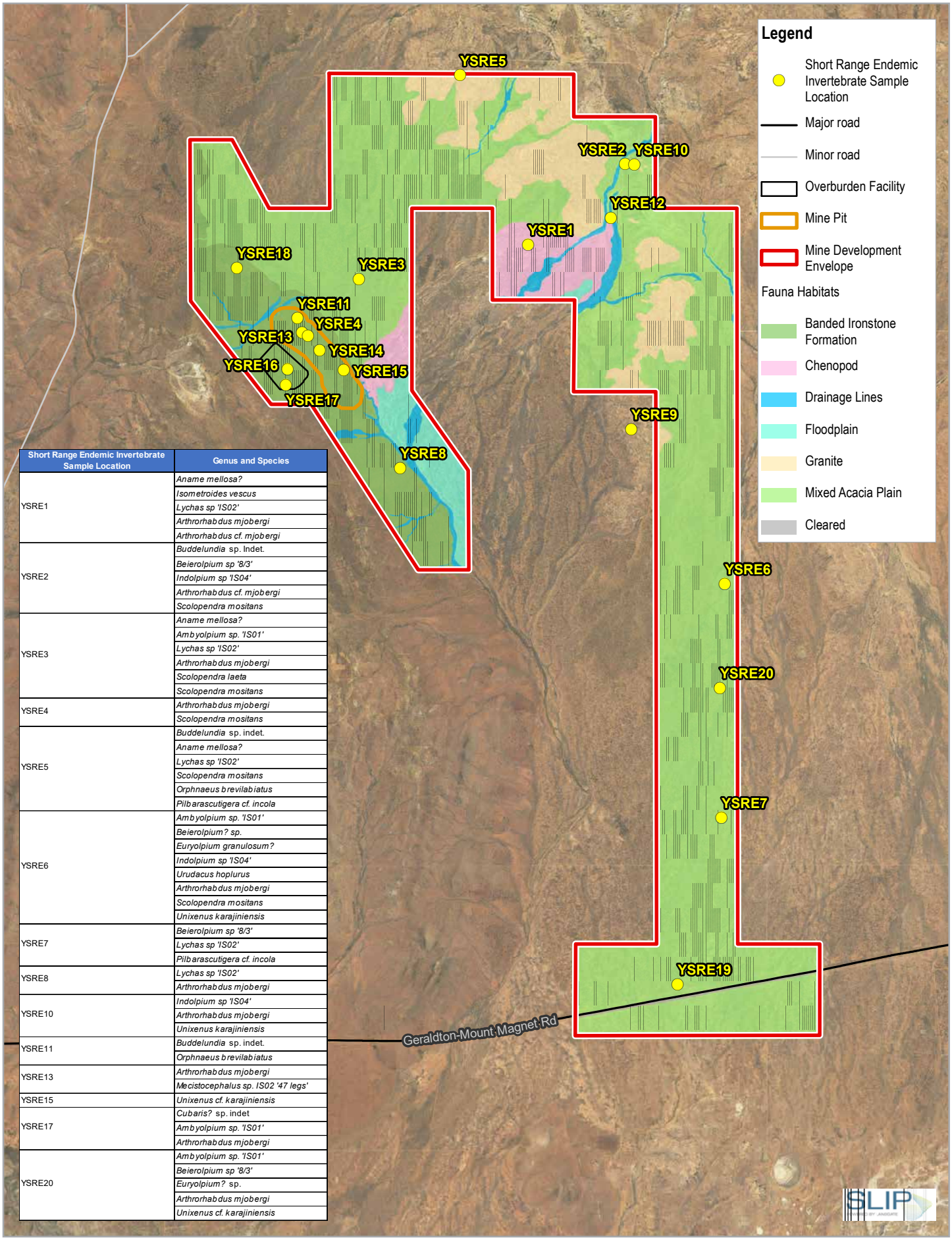
##### SRE fauna habitat

The highest value habitats for SRE species are the BIF ridges and the granite outcrop areas as they represent potential habitat isolates within the broader landscape, compared with the alluvial plains and riparian areas which are more widespread. It should, however, be noted that no confirmed SRE species were recorded during the survey and the majority of possible SRE species were recorded from multiple locations indicating that none are likely to be significantly affected by the proposal.

Table 9-7 Short range endemic invertebrate fauna within or in proximity to the MDE

| Class | Order | Family | Genus and species | Habitat | SRE Status | Proximity to the MDE | MDE sampling location/desktop |
|---|---|---|---|---|---|---|---|
| Crustacea | | | | | | | |
| Malacostraca | Isopoda | Armadillidae | *Buddelundia* sp. indet | Riparian creek lines, Granite, BIF Ridgeline | Possible (A) | Within MDE | YSRE2, YSRE5, YSRE11 |
| | | | *Cubaris?* Sp. | BIF Ridgeline | Likely | Within MDE | YSRE17 |
| Chelicerata | | | | | | | |
| Arachnida | Mygalomorphae | Actinopodidae | *Missulena* sp. | Unavailable | Possible (A) | Habitat present in MDE. Known records 250 km northwest. | Desktop only |
| | Pseudoscorpiones | Olpiidae | *Ambyolpium* sp. 'IS01' | Mixed acacia plain, BIF Ridgeline | Possible (A) | Within MDE | YSRE3, YSRE6, YSRE17, YSRE20 |
| | | | *Beierolpium* sp '8/3' | Riparian creek lines, Mixed acacia plain | Possible (A) | Within MDE | YSRE2, YSRE7, YSRE20 |
| | | | *Beierolpium*? sp. | Mixed acacia plain | Possible (A) | Within MDE | YSRE6 |
| | | | *Euryolpium? sp.* | Mixed acacia plain | Possible (A) | Within MDE | YSRE20 |
| | | | *Euryolpium granulosum*? | Mixed acacia plain | Possible (A) | Within MDE | YSRE6 |
| | | | *Indolpium* sp 'IS04' | Riparian creek lines, Mixed acacia plain | Possible (A) | Within MDE | YSRE2, YSRE6, YSRE10 |
| | | | *Indet* sp. | Unavailable | Possible (A) | Habitat present in MDE. Location of records not known. | Desktop only |
| | Scorpionida | Buthidae | *Lychas* sp 'IS02' | Chenopod, Mixed acacia plain, Granite, BIF Ridgeline | Possible (A) | Within MDE | YSRE1, YSRE3, YSRE5, YSRE7, YSRE8 |

| Class | Order | Family | Genus and species | Habitat | SRE Status | Proximity to the MDE | MDE sampling location/desktop |
|---|---|---|---|---|---|---|---|
| Myriapoda | | | | | | | |
| Chilopoda | Scolopendromorpha | Scolopendridae | *Arthrorhabdus* cf. *mjobergi* | Chenopod, Riparian creek lines | Possible (A) | Within MDE | YSRE1, YSRE2 |
| | Geophilomorpha | Mecistocephalidae | *Mecistocephalus* sp. IS02 *'47* legs' | BIF Ridgeline | Possible (A) | Within MDE | YSRE13 |
| | Scutigeridomorpha | Scutigeridae | *Pilbarascutigera* cf. *incola* | Granite, Mixed acacia plain | Possible (A) | Within MDE | YSRE5, YSRE7 |
| Diplopoda | Polyxenida: | Polyxenidae | *Unixenus* cf. *karajiniensis* | BIF Ridgeline, Mixed acacia plain | Possible (A) | Within MDE | YSRE15, YSRE20 |
| | Paradoxosomatidae | | *Antichiropus* `PM1` | Unavailable | Confirmed | Habitat present in MDE. Known records are within 20 km. | Desktop only |
| Key: Possible (A) indicated 'data deficient' possible SRE status | | | | | | | |




| Short Range Endemic Invertebrate Sample Location | Genus and Species |
|---|---|
| YSRE1 | *Aname mellosa?* |
| | *Isometroides vescus* |
| | *Lychas sp 'IS02'* |
| | *Arthrorhabdus mjobergi* |
| | *Arthrorhabdus cf. mjobergi* |
| YSRE2 | *Buddelundia* sp. Indet. |
| | *Beierolpium sp '8/3'* |
| | *Indolpium sp 'IS04'* |
| | *Arthrorhabdus cf. mjobergi* |
| | *Scolopendra mositans* |
| YSRE3 | *Aname mellosa?* |
| | *Ambyolpium sp. 'IS01'* |
| | *Lychas sp 'IS02'* |
| | *Arthrorhabdus mjobergi* |
| | *Scolopendra laeta* |
| | *Scolopendra mositans* |
| YSRE4 | *Arthrorhabdus mjobergi* |
| | *Scolopendra mositans* |
| YSRE5 | *Buddelundia* sp. indet. |
| | *Aname mellosa?* |
| | *Lychas sp 'IS02'* |
| | *Scolopendra mositans* |
| | *Orphnaeus brevilabiatus* |
| | *Pilbarascutigera cf. incola* |
| YSRE6 | *Ambyolpium sp. 'IS01'* |
| | *Beierolpium? sp.* |
| | *Euryolpium granulosum?* |
| | *Indolpium sp 'IS04'* |
| | *Urudacus hoplurus* |
| | *Arthrorhabdus mjobergi* |
| | *Scolopendra mositans* |
| | *Unixenus karajiniensis* |
| YSRE7 | *Beierolpium sp '8/3'* |
| | *Lychas sp 'IS02'* |
| | *Pilbarascutigera cf. incola* |
| YSRE8 | *Lychas sp 'IS02'* |
| | *Arthrorhabdus mjobergi* |
| YSRE10 | *Indolpium sp 'IS04'* |
| | *Arthrorhabdus mjobergi* |
| | *Unixenus karajiniensis* |
| YSRE11 | *Buddelundia* sp. indet. |
| | *Orphnaeus brevilabiatus* |
| YSRE13 | *Arthrorhabdus mjobergi* |
| | *Mecistocephalus sp. IS02 '47 legs'* |
| YSRE15 | *Unixenus cf. karajiniensis* |
| YSRE17 | *Cubaris?* sp. indet |
| | *Ambyolpium sp. 'IS01'* |
| | *Arthrorhabdus mjobergi* |
| YSRE20 | *Ambyolpium sp. 'IS01'* |
| | *Beierolpium sp '8/3'* |
| | *Euryolpium?* sp. |
| | *Arthrorhabdus mjobergi* |
| | *Unixenus cf. karajiniensis* |

Paper Size ISO A4

0 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

FI Joint Venture Pty Ltd
Environmental Review Document

Project No. 61-37117
Revision No. 0
Date 28 Feb 2020

## Short Range Endemic Invertebrate Sampling Locations

**FIGURE 9-3**

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-3_SRESamplingLocations_rev0.mxd
Print date: 28 Feb 2020 - 15:35

Data source: GHD: Survey Area - 20180622, Fauna Habitats - 20181210; Landgate: Roads - 20181023, Imagery - Taken September 2012 - Accessed 20181210.. Created by: cgverzosa

### 9.4.3 Pipeline development envelope

#### *9.4.3.1 Terrestrial fauna habitats*

The PDE is divided into two portions for the purpose of this report: the western and the eastern portions. The eastern portion is the approximately 80 km of the pipeline corridor, extending from the Yogi Mine Project to east of Mullewa and is the area covered area covered by the pipeline flora and fauna technical study (GHD 2020c). The eastern portion of the PDE is approximately 500 m wide, with only 250 m each side of the proposed pipeline accessible at the time of completing the survey. This area covers 4,654.86 ha. The western portion comprises approximately 145 km of the pipeline corridor, and broadly follows the Mt Magnet Road extending from the Geraldton port eastwards to the locality of Pindar. The western portion of the PDE is covered by a desktop assessment (GHD 2020). The western PDE is approximately 5 km wide, and covers approximately 72,145 ha.

The western portion of the PDE was assessed prior to completing the fauna assessment and it was determined that the western portion is substantially cleared and also intersects several pastoral or agricultural properties. Given the clearing in this portion, it is assumed that there does not exist any suitable fauna habitat of any value within the western portion of the PDE. Consequently, the western portion of the PDE was not covered by biological field assessments. However, a desktop assessment of the western portion of the PDE was undertaken (GHD 2020) (Appendix B) to identify clearing 'avoidance areas' based on the location of previously recorded threatened and priority fauna species.

Eight distinct habitat types were identified in the eastern portion of the PDE: Low outcrops (sometimes granite or quartz), Drainage line, Mallee over mixed shrubland on sandplain, Mixed shrubland on sandplain, Open Mulga woodland/shrubland on Clayey Soils, Claypan, Stoney plain and Acacia shrubland over shallow soils over granite (GHD 2020c). These habitats are mapped in Figure 9-4 and described in Table 9-8.

Of the habitats identified, the following habitat types were noted to have higher conservation value:

- Open Acacia Woodland/shrublands on Clayey Soils
- Riparian/creek line.

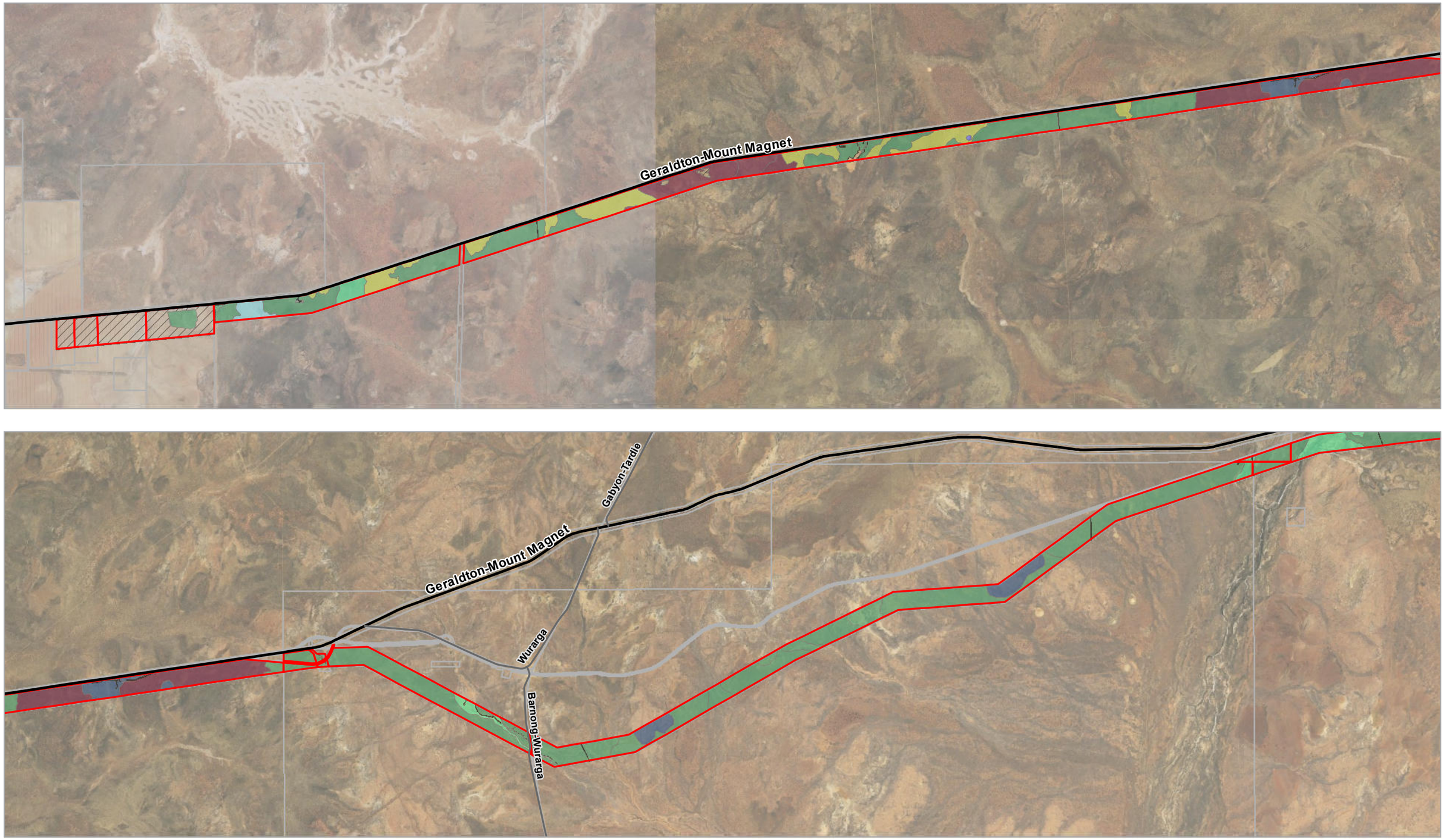
**Quality of Habitat**

The conservation value of each habitat type has been rated based on condition, structural complexity, faunal diversity and habitat for conservation significant fauna (i.e. contains essential habitat for breeding and/or feeding). Habitat values for the eight types are all considered high to moderate value, with the exception of Stony Plain and Acacia shrubland over shallow soils over granite. Parts of the MDE were also affected by historical gravel pits and a historical railway line. Habitat values have been described in Table 9-8.

**Habitat linkages**

The PDE habitats form part of a large continuous tract of habitat. The habitats have been affected some degree by tracks, grazing livestock and feral animals. While the structural complexity of some habitat types show stress signs of grazing and reduced water availability, the majority of the site is uncleared and represents good, intact habitat. The PDE intercepts pastoral stations and therefore, fences and dirt tracks create an artificial barriers for fauna moving between habitats.

This page has been left blank intentionally




Legend

Fauna Habitat Types

- Cleared
- Gravel Pit
- Open Mulga woodland/shrubland on Clayey Soils
- Drainage line
- Stony Plain
- Low outcrops
- Mixed Shrubland on Sandplain
- Mallee over mixed shrubland on Sandplain
- Chenopod Claypan
- Acacia shrubland over shallow soils over granite
- Major roads
- Minor roads
- Cadastral boundary
- Pipeline Development Envelope Survey Area

SLIP

Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

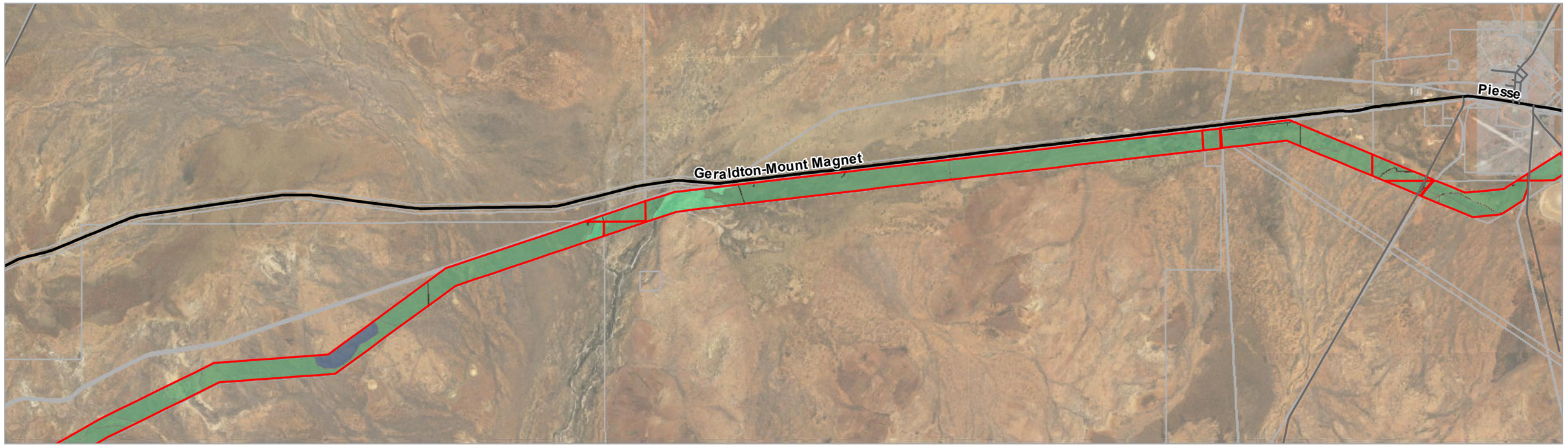
# Terrestrial Fauna Habitats of the Eastern Portion of the Pipeline Devlopment Envelope

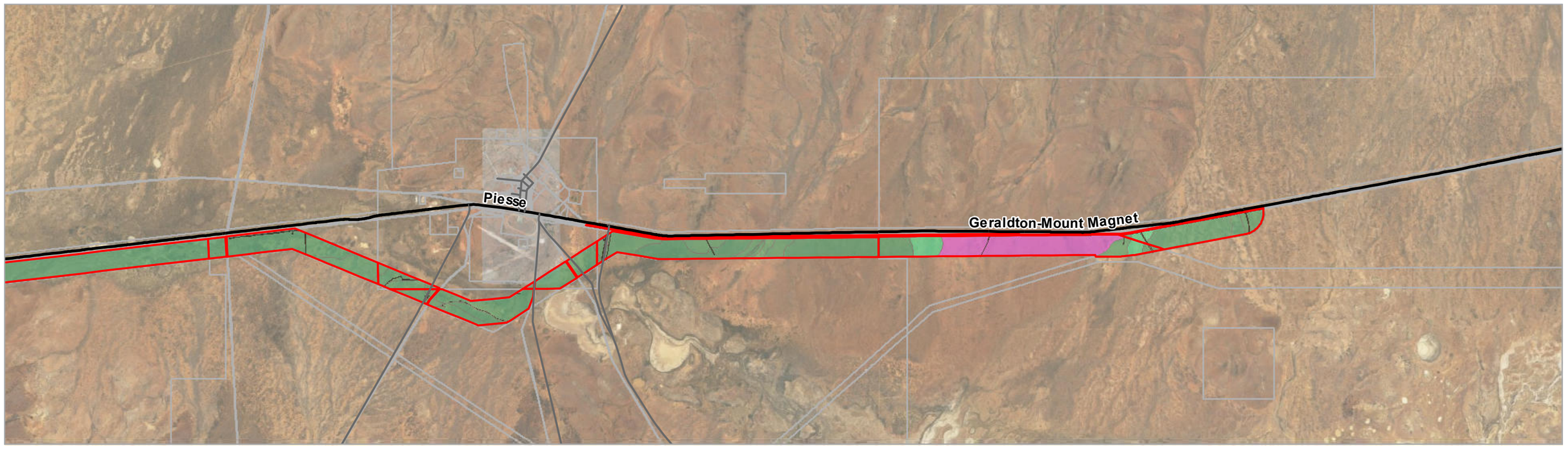
Project No. 61-37117
Revision No. 0
Date 05 Mar 2020

FIGURE 9-4
Page 1 of 2

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-4_TerrFaunaHabPDE_rev0_1of2.mxd
Print date: 05 Mar 2020 - 09:30

Data source: GHD: Vegetation Types - 20190129, Pipeline Option 2 - 20181018; Landgate: Road Network - 20181121, Cadastral Boundary - 20181121. Created by: cgverzosa




Legend

Fauna Habitat Types

- Cleared
- Gravel Pit
- Open Mulga woodland/shrubland on Clayey Soils
- Drainage line
- Stony Plain
- Low outcrops
- Mixed Shrubland on Sandplain
- Mallee over mixed shrubland on Sandplain
- Chenopod Claypan
- Acacia shrubland over shallow soils over granite
- Major roads
- Minor roads
- Cadastral boundary
- Pipeline Development Envelope Survey Area

SLIP

Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

Terrestrial Fauna Habitats of the Eastern Portion of the Pipeline Devlopment Envelope

Project No. 61-37117
Revision No. 0
Date 05 Mar 2020

FIGURE 9-4
Page 2 of 2

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-4_TerrFaunaHabPDE_rev0_2of2.mxd
Print date: 05 Mar 2020 - 09:34

Data source: GHD: Vegetation Types - 20190129, Pipeline Option 2 - 20181018; Landgate: Road Network - 20181121, Cadastral Boundary - 20181121. Created by: cgverzosa

Table 9-8 Fauna habitats of the eastern portion of the Pipeline Development Envelope

| Habitat Type/ Description | Extent in eastern portion of the PDE (ha) | Possible Conservation Significant Fauna |
|---|---|---|
| **Low granite outcrops**<br>Moderate Value to High Value<br>Low, dispersed shrublands comprising *Acacia*, *Eremophila*, *Grevillia*, *Hakea*, and *Borya* and an abundance of grasses and herbs. | 131.67 | Long- tailed Dunnart (habitat)<br>Gilled Slender Bluetongue (habitat)<br>Western spiny tailed skink (habitat)<br>Peregrine Falcon (foraging) |
| **Riparian Creek line**<br>Moderate Value<br>Sporadic and varied vegetation comprising *Acacia* species, *Allocasuarina obesa*, *Hakea* spp., *Grevillea* spp. overlying low shrubs of chenopod species and native grasses. | 189.25 | Long- tailed Dunnart (habitat) |
| **Mallee over mixed shrubland sandplain**<br>Moderate Value<br>Dominated by an upper storey of *Eucalyptus loxophleba*, *Acacia* in the middle storey and grasses and herbs in the understorey. | 277.35 | Peregrine Falcon (foraging)<br>Malleefowl (*Leipoa ocellata*) (habitat) |
| **Open Acacia Woodland/shrublands on Clayey Soils**<br>High value<br>Shrubland dominated by Acacia, Eremophila, and groundcover comprising native grasses and herbs. | 3140.32 | Peregrine Falcon (foraging)<br>Gilled Slender Bluetongue (habitat) |
| **Mixed Shrubland on Sandplain**<br>Low Value to Moderate Value<br>Dominated by *Acacia*, *Grevillea, Hakea* spp., *Callitris* spp. in the over storey and *Eremophila* spp. in the midstorey, and groundcover comprising clumps of native grasses and herbs. | 385.79 | Peregrine Falcon (hunting/foraging)<br>Malleefowl (habitat) |
| **Chenopod Claypan**<br>Moderate to High Value<br>Low heath dominated by *Frankenia pauciflora*, *Tecticornia* spp., Atriplex species and *Maireana* species overlying clayey sand mixture. | 1.36 | Gilled Slender Bluetongue (habitat)<br>Peregrine Falcon (foraging) |

| Habitat Type/ Description | Extent in eastern portion of the PDE (ha) | Possible Conservation Significant Fauna |
|---|---|---|
| **Stony Plain**<br>Low Value to Moderate Value<br>Forming part of the fringe of a BIF Ridgeline, this habitat comprises low scattered *Acacia* shrubs overlying *Atriplex* spp. and *Sclerolaena* spp. | 178.11 | Long- tailed Dunnart (habitat)<br>Peregrine Falcon (foraging) |
| **Acacia shrubland over shallow soils over granite**<br>Low Value<br>Medium shrubland characterised by *Acacia* species over *Eremophila clarkei* over a forblands. | 34.28 | Peregrine Falcon (foraging) |

#### 9.4.3.2 Terrestrial fauna diversity

A total of 68 fauna species were recorded from the PDE, including 53 birds, nine mammals and six reptiles (GHD 2020c). Of these five were introduced fauna species.

#### 9.4.3.3 Conservation significant terrestrial fauna

A likelihood of occurrence and risk assessment was completed of conservation significant fauna identified within the eastern PDE during technical studies (summarised in Table 9-2), and included in search results from the EPBC Act Protected matters database, DBCA Threatened and Priority Fauna database and *Nature Map* database. Figure 9-5 presents the locations of recorded conservation significant terrestrial fauna in relation to the eastern PDE as indicated by the desktop assessment. Four species of conservation significance were identified as likely within the eastern portion of the PDE and the results of this assessment are provided in Table 9-9.

Target searching for Malleefowl mounds was undertaken from 20th to 31st January 2020. Based on current vegetation community assessment and mapping carried out by GHD botanists during the flora and vegetation survey over the length of the survey area, specific habitat types were identified as potentially suitable for Malleefowl mounds based on a combination of vegetation type, density and soil characteristics. These habitats generally included relatively dense mixed shrublands or mallee woodlands on sandplains. It should be noted that the boundaries and spatial distribution of vegetation community and associated habitat type in a given area may not be static over time. This has relevance to the local and regional context of the survey area that has undergone significant historical (last 100 years) changes that have impacted on vegetation and habitat structure and distribution. These factors include but not limited to climate change, feral goats, fire, weeds, and ground disturbance. Consequently, the suitability of habitat in a given location for Malleefowl can change.

Where these habitat areas intersected with the eastern PDE, search areas were traversed on foot to detect Malleefowl Mounds. The search area included the location of the midline of the proposed pipeline with two field personnel spaced 20 to 30 metres and straddling the midline of the proposed pipeline. In areas where the vegetation density reduced ground visibility the personnel spacing of transects was reduced to 15 to 20 metres. This gave a total search area width of approximately 60 metres searched for all potentially suitable habitats of dense shrubland and mallee woodland.

Target searching involved visual assessment of remnant areas identifying breeding evidence (presence/absence of Malleefowl mounds), foraging evidence (scratching), droppings, current activity (via presence of prints) and any other signs of Malleefowl. For the purpose of this assessment, the NHT (2007) National manual for the Malleefowl monitoring system standards will be used to define mound size, use and age (GHD 2020c).

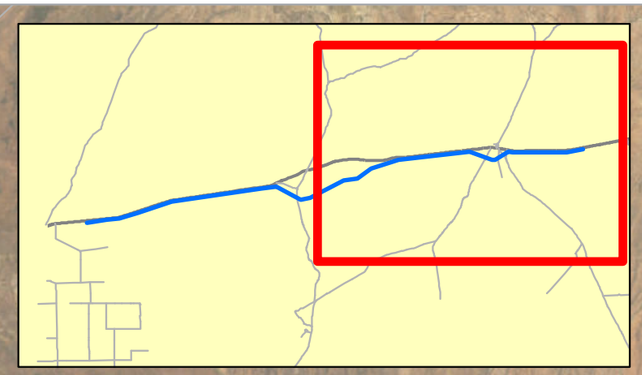
The presence of three very old Malleefowl mounds within the survey area indicate that historically active mounds occurred in this area. Historical habitat changes increased threatening processes for Malleefowl may account for current Malleefowl paucity. These may include feral predators, fire regimes changes, feral herbivore pressure (goats, rabbits) (GHD 2020c).

The desktop assessment completed for the western portion of the PDE (GHD 2020) included search results from the EPBC Act Protected matters database, DBCA Threatened and Priority Fauna database and *Nature Map* database. A likelihood of occurrence and risk assessment was also undertaken for the western portion of the pipeline development envelope (GHD 2020) (summarised in Table 9-10). The assessment found 12 species that were identified as known to have been previously recorded within the western PDE, most of these are coastal bird species. An additional 23 fauna species were identified as likely to occur. However, for the purposes of this assessment, the western portion is assumed to be entirely cleared or completed degraded vegetation, and therefore not representing suitable habitat for conservation significant fauna. However, some species, such as the Peregrine Falcon, may utilise the western portion of the pipeline envelope for foraging habitat. Figure 5-10 presents the location of the recorded conservation significant terrestrial fauna in relation to the western PDE as identified by the desktop assessment.

Legend

Fauna Conservation Status - Species

- Endangered - Shield-backed trapdoor spider
- Vulnerable - Malleefowl
- Vulnerable - Western spiny-tailed skink
- Migratory birds protected under an International Agreement - Fork-tailed swift
- Other specially protected fauna - Peregrine falcon
- Priority 4 - Western grasswren
- State Road
- Local Road
- Railways
- Pipeline Development Envelope



Geraldton Mt Magnet Rd

SLIP

Paper Size ISO A3

0 1 2 3 4 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Development Envelope

Conservation Significant Fauna in the Eastern Portion of the Pipeline Development Envelope

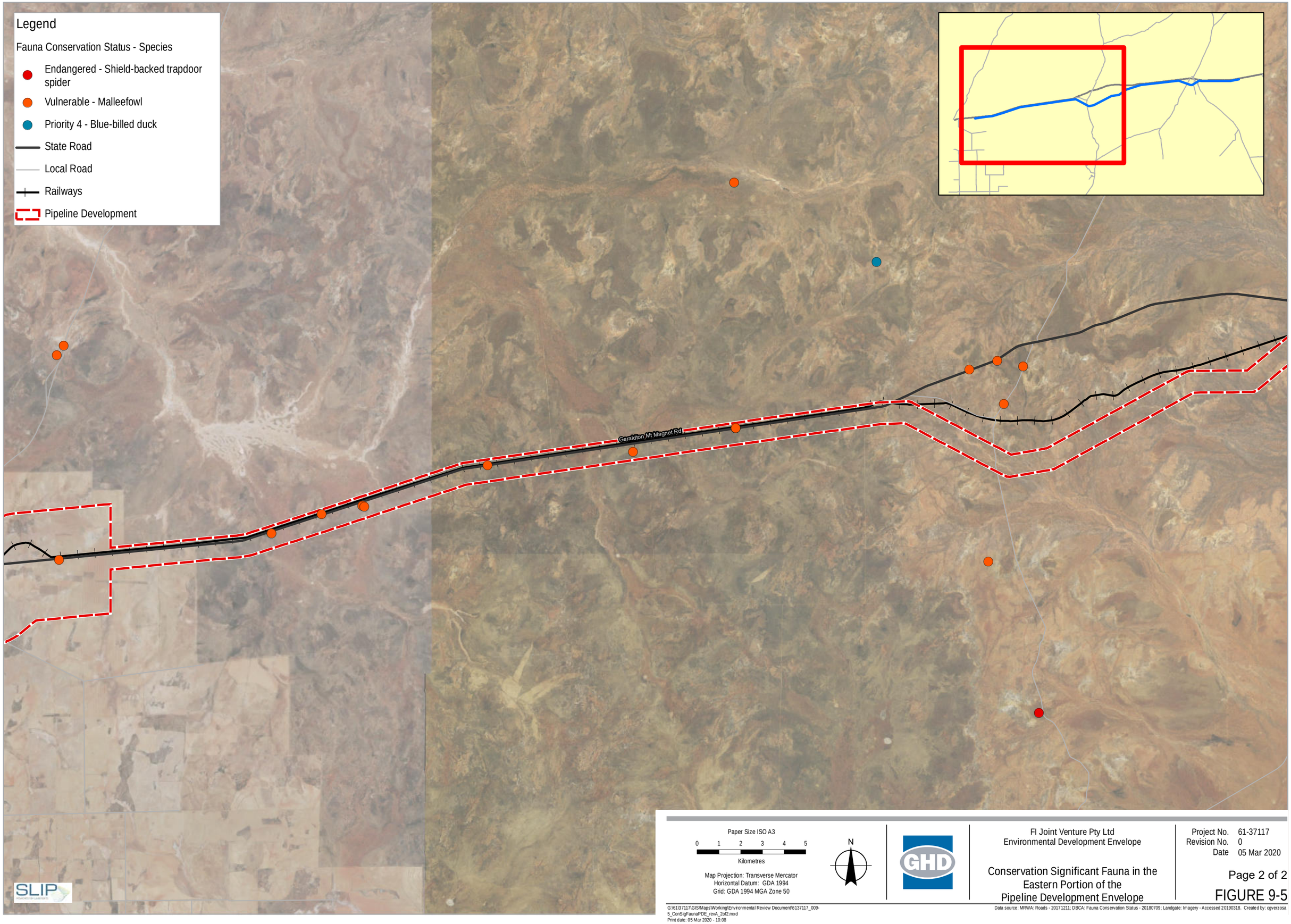
Project No. 61-37117
Revision No. 0
Date 05 Mar 2020



FIGURE 9-5

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-5_ConSigFaunaPDE_revA_1of2.mxd
Print date: 05 Mar 2020 - 10:07

Data source: MRWA: Roads - 20171211; DBCA: Fauna Conservation Status - 20180709; Landgate: Imagery - Accessed 20190318. Created by: cgverzosa




Paper Size ISO A3

0 1 2 3 4 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Development Envelope

Conservation Significant Fauna in the Eastern Portion of the Pipeline Development Envelope

Project No. 61-37117
Revision No. 0
Date 05 Mar 2020



FIGURE 9-5

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_009-5_ConSigFaunaPDE_revA_2of2.mxd
Print date: 05 Mar 2020 - 10:08

Data source: MRWA: Roads - 20171211; DBCA: Fauna Conservation Status - 20180709; Landgate: Imagery - Accessed 20190318. Created by: cgverzosa

Table 9-9 Conservation significant terrestrial fauna likelihood of occurrence and risk assessment of the eastern PDE

| Species | Suitable habitat within the PDE | Recorded in PDE | Distribution | Conservation Status<br>BC Act (DBCA)<br>[EPBC Act] | Likelihood of occurrence |
|---|---|---|---|---|---|
| **Birds** | | | | | |
| Malleefowl (*Leipoa ocellata*) | Mallee and shrublands sandplains habitat type, Mixed Shrubland on Sandplain | No | Semi-arid areas of Western Australia, from Carnarvon to south east of the Eyre Bird Observatory (south-east Western Australia). Occupies shrublands and low woodlands that are dominated by mallee vegetation, native pine Callitris woodlands, Acacia shrublands, Broombush vegetation or coastal heathlands | Vu<br>[Vu] | **Likely**. There are number of previous recent records (y 1999) within the MDE (DBCA 2018, as cited in GHD 2020c). There is suitable habitat within the PDE. |
| Peregrine Falcon (*Falco peregrinus*) | No breeding or roosting habitat present. Foraging habitat is present throughout. | No | Seen occasionally anywhere in the south-west of WA. | S7 (SP)<br>[none] | **Likely**. The species is known from the region, however use would be opportunistic and utilised for foraging purposes only. No breeding habitat is present in the MDE. |
| **Reptiles** | | | | | |
| Gilled Slender Bluetongue (*Cyclodomorphous branchialis*) | Low granite outcrops, Open acacia woodlands/shrubland on Clayey Soils, Chenopod Claypan | No | Lower west coastal regions on WA, between the Murchison and Irwin Rivers. A ground-dwelling lizard preferring to live amongst porcupine grass, leaf-litter, and under fallen timber and rocks. | VU<br>[none] | **Likely**. The species is known from the region with records present east, west and south of the MDE. However the nearest known record is 60 km west of the MDE (DBCA 2018, as cited in GHD 2020c). |
| Western Spiny-tailed Skink (*Egernia stokesii* subsp. *badia*) | Low granite outcrops | No | Patchy distribution throughout arid and semi-arid areas of WA, with the subspecies in the Yalgoo to Cue area typically rock habitat dwelling, and requiring particular features such as crevices, overhangs and rock mounds. | VU<br>[EN] | **Likely**. This species was recorded in an adjacent north MDE. There is limited area of suitable habitat in the central portion of the survey. The nearest recorded is 43 km east (DBCA 2018, as cited in GHD 2020c). |
| **Mammals** | | | | | |

| Species | Suitable habitat within the PDE | Recorded in PDE | Distribution | Conservation Status<br>BC Act (DBCA)<br>[EPBC Act] | Likelihood of occurrence |
|---|---|---|---|---|---|
| Long-tailed dunnart (*Sminthopsis longicaudata*) | Low granite outcrops<br>Riparian Creek line<br>Stony Plain | No | The Long-tailed Dunnart occurs throughout the Gibson Desert, Murchison, southern Canarvon Basin and the Pilbara. Its habitat includes rugged, rocky areas with hummock grasses, shrubs and tall open shrublands and woodlands. | P4 | Likely - The species is known from the region with records present east, west and north of the survey area. The nearest record is 15 km north of the survey area (GHD 2020c). |

Table 9-10 Conservation significant terrestrial fauna likelihood of occurrence assessment of the western PDE

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| **Birds** | | | | | | |
| *Actitis hypoleucos* | Common Sandpiper | MI | MI | Habitat for the Common Sandpiper is varied: coastal and interior wetlands – narrow muddy edges of billabongs, river pools, mangroves, among rocks and snags, reefs or rocky beaches. Avoids wide open mudflats. This species is widespread and scattered, common on the north and west coasts and uncommon in the south-east and interior (Morcombe 2004). | **Likely** Suitable habitat may be available to support this species, predominantly coastal shoreline or ephemeral salt lake areas with surface water or those which are seasonally inundated. | *Naturemap* PMST |
| *Apus pacificus* | Fork-tailed Swift | MI | MI | The fork-tailed Swift is a migratory species that follows large storm fronts and are almost exclusively areal species. In Western Australia, there are sparsely scattered records of the Fork-tailed Swift along the south coast, ranging from near the Eyre Bird Observatory and west to Denmark, in coastal and subcoastal areas between Augusta and Carnarvon, including some on nearshore and offshore islands. Scattered records are present in the Midwest region. Records are scattered throughout WA including the Pilbara, Kimberley, Wheatbelt, Gascoyne and deserts (Higgins 1999). | **Likely** This species has been recorded on multiple occasions north and south of the PDE, within the study area. | *Naturemap* PMST |
| *Arenaria interpres* | Ruddy Turnstone | MI | MI | In Australia, Ruddy Turnstones are widespread around the coast of the mainland and off-shore islands. They breed on the northern coasts of Europe, Asia and North America. They are found on coastlines around the world, when not breeding or on passage. They are found singly or in small groups along the coastline and only occasionally inland. | **Known** This species has previously been recorded within the western-most portion of the PDE. | *Naturemap* DBCA |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | They are mainly found on exposed rocks or reefs, often with shallow pools, and on beaches. In the north, they are found in a wider range of habitats, including mudflats (DAWE 2018). | | |
| *Calidria ferruginea* | Curlew Sandpiper | CR | CR &MI | Curlew Sandpipers mainly occur in areas with soft mud conditions, including intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are found inland less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. In WA, they are widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley Division, but are more sparsely distributed between Carnarvon and Dampier Archipelago (DAWE 2018). They are common on the Swan Coastal Plain, particularly near large drying lakes like Thompson and Forrestdale, and Peel Inlet. They are less common along the southern coast to Esperance (Nevill 2013). | **Likely** Suitable habitat may be available to support this species, predominantly coastal shoreline or ephemeral salt lake areas with surface water or those which are seasonally inundated. | *Naturemap* PMST |
| *Calidris acuminata* | Sharp-tailed Sandpiper | MI | MI | In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry (DAWE 2018). | **Likely** Suitable habitat may be available to support this species, predominantly coastal shoreline or ephemeral salt lake areas with surface water or those which are | *Naturemap* PMST |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | | seasonally inundated. | |
| *Calidris alba* | Sanderling | MI | MI | In Australia, the species is almost always found on the coast, mostly on open sandy beaches exposed to open sea-swell, and also on exposed sandbars and spits, and shingle banks, where they forage in the wave-wash zone and amongst rotting seaweed. Sanderlings also occur on beaches that may contain wave-washed rocky outcrops. Less often the species occurs on more sheltered sandy shorelines of estuaries, inlets and harbours (DAWE 2018). | **Known** This species has previously been recorded within the western-most portion of the PDE. | *Naturemap* DBCA |
| *Calidris melanotos* | Pectoral Sandpiper | MI | MI | In Australia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum (DAWE 2018). The bird can be seen on the Swan Coastal Plain but is rare to scarce on Lake Thompson, and as well on any freshwater wetland in the southwest with shallow, well-grassed margins. They are seen at Lake Warden, Esperance, and at Lake McLarty (Nevill 2013). | **Likely** Suitable habitat may be available to support this species, predominantly coastal shoreline or ephemeral salt lake areas with surface water or those which are seasonally inundated. | *Naturemap* PMST |
| *Calidris ruficollis* | Red-necked Stint | MI | MI | The Red-necked Stint breeds in north-eastern Siberia and northern and western Alaska. It follows the East Asian-Australasian Flyway to spend the southern summer months in Australia. It is found widely in Australia, except in the arid inland.(Birdlife 2018) In Australia, | **Known** This species has previously been recorded within the western-most | *Naturemap* DBCA |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | Red-necked Stints are found on the coast, in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores (Pizzey and Knight 2012). | portion of the PDE. | |
| *Calyptorhynchus latirostris* | Carnaby's Cockatoo | EN | EN | This species mainly occurs in uncleared or remnant native Eucalyptus woodlands and in shrubland or kwongan heathland dominated by Hakea, Banksia and Grevillea species. The species also occurs in forests containing Marri, Jarrah or Karri. Breeding usually occurs in the western Wheatbelt region of WA, with flocks moving to the higher rainfall coastal area to forage after the breeding season. Feeds on the seeds of a variety of native plants, including Allocasuarina, Banksia, Eucalyptus, Grevillea and Hakea, and some introduced plants (DSEWPaC 2012). | **Known** This species has previously been recorded within the PDE and is known to utilise the study area for foraging and potential breeding. | *Naturemap* PMST DBCA |
| *Charadrius leschenaultii* | Greater Sand Plover | VU | VU & MI | In Australia, the Greater Sand Plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west. In northern Australia, the species is especially widespread between North West Cape and Roebuck Bay in Western Australia; there are sparsely scattered records from the largely inaccessible area between Roebuck Bay and Darwin, but it often occurs in the Top End of the Northern Territory, including on Groote Eylandt. In the non-breeding grounds in Australasia, the species is almost entirely coastal, inhabiting littoral and estuarine habitats (DAWE 2018). | **Known** This species has previously been recorded within the western-most portion of the PDE. | *Naturemap* DBCA |
| *Charadrius mongolus* | Lesser Sand Plover | EN | EN & MI | Within Australia, the Lesser Sand-Plover is widespread in coastal regions, and has been recorded in all states. It mainly occurs in northern and eastern Australia, in south-eastern parts of the Gulf of Carpentaria, western Cape York Peninsula and islands in Torres Strait, and along the entire east coast, | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within | *Naturemap* |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | though it occasionally also occurs inland. It is most numerous in Queensland and NSW The species has also been recorded on Lord Howe Island, Norfolk Island and Christmas Island, Indian (DAWE 2018) | the western-most portion of the PDE. | |
| *Elanus scriptus* | Letter-winged Kite | P4 | | The Letter-Winged Kite inhabits open or sparsely wooded country and rests in Eucalyptus coolabah during the day. They nest in the cooler months when the rats often reach their peak, with nesting peaking in July. The nest is an open platform of sticks from herbage and shrubs. The Letter-Winged Kite occurs in the eastern arid zone of Australia but occasionally irrupts to all parts of the continent. Population cycles appear to be linked to those of the principal prey, the plague rat *Rattus villossimus*, which has population explosions following high rainfall (IUCN Redlist 2016). | **Likely** This species may opportunistically utilise the site for foraging. Closest known record approx. 16 km north of PDE. | *Naturemap* |
| *Falco peregrinus* | Peregrine Falcon | OS | | The Peregrine Falcon is seen occasionally anywhere in the south-west of WA. It is found everywhere from woodlands to open grasslands and coastal cliffs - though less frequently in desert regions. The species nests primarily on ledges of cliffs, shallow tree hollows, and ledges of building in cities. (Morcombe, 2004). | **Likely** This species may opportunistically utilise the study area. Closest known record approx. 13 km south of PDE. | *Naturemap* |
| *Hydroprogne caspia* | Caspian Tern | MI | MI | The Caspian Tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks. In offshore | **Likely** Suitable habitat may be available to support this species, predominantly areas with surface water or those which are seasonally inundated. | *Naturemap* PMST |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs (DAWE 2018). | | |
| *Leipoa ocellata* | Malleefowl | VU | VU | The Malleefowl generally occurs in semi-arid areas of Western Australia, from Carnarvon to south east of the Eyre Bird Observatory (south-east Western Australia). The Malleefowl is associated with long unburnt thick vegetation and occupies shrublands and low woodlands that are dominated by mallee vegetation, native pine Callitris woodlands, Acacia shrublands, Broombush vegetation or coastal heathlands. The breeding habitat is characterised by light soil and an abundant leaf litter, which is used in the construction of nesting mounds (Frith 1959; Marchant & Higgins 1993 in DAWE 2015). The nest is a conspicuous large mound of sand or soil and organic matter (Jones and Goth 2008 in DAWE 2015, Morcombe 2004). | **Likely** This species has been recorded within 100 m of the PDE. Suitable habitat may be present to support this species. | *Naturemap* PMST |
| *Limosa lapponica* | Bar-tailed Godwit | MI (& VU or CR at subsp. level) | MI (& VU or CR at subsp. level) | Bar-tailed Godwits arrive in Australia each year in August from breeding grounds in the northern hemisphere. Birds are more numerous in northern Australia Bar-tailed Godwits inhabit estuarine mudflats, beaches and mangroves. They are common in coastal areas around Australia. They are social birds and are often seen in large flocks and in the company of other waders (Birdlife Australia 2018). | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the western-most portion of the PDE. | *Naturemap* PMST |
| *Limosa lapponica menzbieri* | Northern Sibrian Bar-tailed Godwit | CR (& MI at sp. level) | CR (& MI at sp. level) | The bar-tailed godwit (both subspecies combined) has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria. In Tasmania, the bar-tailed godwit has mostly been recorded on the south-east coast. In South Australia it has mostly been | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the western-most | PMST |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | recorded around coasts from Lake Alexandrina to Denial Bay. In Western Australia it is widespread around the coast, from Eyre to Derby. Populations have also been recorded in the northern Australia, from Darwin east to the Gulf of Carpentaria. The bar-tailed godwit is a regular migrant to Christmas Island, Norfolk Island, Lord Howe Island. It has also been recorded on subantarctic islands such as Macquarie Island, Snares Islands, Auckland Islands and Campbell Islands ( DAWE 2018) | portion of the PDE. | |
| *Numenius madagascariensis* | Eastern Curlew | CR | CR & MI | The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, sometimes within the mangroves, and in coastal saltworks and sewage farms. In the south west, Eastern Curlews are recorded from Eyre, and there are scattered records from Stokes Inlet to Peel Inlet (Marchant & Higgins 1993). They are uncommon further south of Geraldton, but can be spotted in Alfred Cove, Peel Inlet and the Albany region (Nevill 2013). | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the western-most portion of the PDE. It may also occur where there is surface water throughout the rest of the PDE but is less likely the further east. | PMST |
| *Oxyura australis* | Blue-billed Duck | P4 | | The Blue-billed Duck is endemic to Australia, being found in the temperate wetlands of the south-east and south-west parts of the continent. The Blue-billed Duck is almost wholly aquatic, and is seldom seen on land. Non-breeding flocks, often with several hundred individuals, congregate on large, deep open freshwater dams and lakes in | **Known** This species has been previously recorded within the PDE. | *Naturemap* DBCA |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | autumn. The daylight hours are spent alone in small concealed bays within vegetation or communally in large exposed rafts far from the shore (Birdlife Australia 2019). | | |
| *Pandion cristatus* | Osprey | MI | MI | The breeding range of the Eastern Osprey extends around the northern coast of Australia (including many offshore islands) from Albany in Western Australia to Lake Macquarie in NSW; with a second isolated breeding population on the coast of South Australia, extending from Head of Bight east to Cape Spencer and Kangaroo Island. Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands (DAWE 2018). | **Likely** This species may be present along the coast and within near-coastal wetlands | *Naturemap* PMST |
| *Plegadis falcinellus* | Glossy Ibis | MI | MI | Within Australia, the Glossy Ibis is generally located east of the Kimberley in Western Australia and Eyre Peninsula in South Australia. The species is also known to be patchily distributed in the rest of Western Australia. The species is rare or a vagrant in Tasmania (DAWE 2018) | **Likely** Suitable habitat may be available to support this species, predominantly areas with surface water or those which are seasonally inundated. | *Naturemap* |
| *Pluvialis squatarola* | Grey Plover | MI | MI | In Australia, the Grey Plover has been recorded in all states, where it is found along the coasts, and it especially abundant on the western and southern coastlines, mainly between The Coorong and western beaches of the Eyre Peninsula in South Australia, and the coast of Western Australia between Albany and the northern Kimberley coast (DAWE 2018) | **Known** This species has previously been recorded within the western-most portion of the PDE. | *Naturemap* |
| *Rostratula australis* | Australian Painted Snipe | EN | EN | The Australian Painted Snipe has been recorded at wetlands in all states of Australia | **Likely** | PMST |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | (Barrett et al. 2003; Blakers et al. 1984; Hall 1910b). It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. It has been recorded less frequently at a smaller number of more scattered locations farther west in South Australia, the Northern Territory and Western Australia (DAWE 2018) | Suitable habitat may be available to support this species, predominantly areas with surface water or those which are seasonally inundated. | |
| *Stenula nereis nereis* | Australian Fairy Tern | VU | VU | Within Australia, the Fairy Tern occurs along the coasts of Victoria, Tasmania, South Australia and Western Australia; occurring as far north as the Dampier Archipelago near Karratha (DAWE 2018) | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the western-most portion of the PDE. | PMST |
| *Sterna dougallii* | Roseate Tern | MI | MI | In Australia, the subspecies gracillis occurs on much of the west, north and north-east coasts, from south-west Western Australia to south-east Queensland, with rare records from north NSW (DAWE 2018) | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the western-most portion of the PDE. | *Naturemap* |
| *Sternula albifrons* | Little Tern | MI | MI | The Australian breeding population can be divided into two major subpopulations: (1) a northern subpopulation that breeds across northern Australia, from about Broome in north-western Western Australia (where first recorded only in December 1995), through coastal Northern Territory (mainly from just west of Darwin to the Queensland border) to | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the | *Naturemap* |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | the Gulf of Carpentaria and eastern Cape York Peninsula (with an extended breeding season covering most of the year); and (2) an eastern subpopulation that breeds on the eastern and south-eastern coast of the mainland and northern and eastern Tasmania, occasionally extending as far west as western Victoria and south-eastern South Australia (and breeding in the austral spring-summer) (DAWE 2018) | western/coastal-most portion of the PDE. | |
| *Thalasseus bergii* | Crested Tern | MI | MI | Crested Terns occur singularly or in flocks in coastal areas, estuaries, inlets, islands and occasionally on large inland lakes or rivers. They are often seen perching with gulls on beaches, sand spits or jetties. Crested Terns are widespread from the south coast of Africa north to Asia, south to Australia and east to Polynesia. They also occur on many islands in the Indian and Pacific Oceans (DAWE 2018). | **Known** This species has previously been recorded within the western project footprint, near the coastline and offshore. | *Naturemap* |
| *Tringa brevipes* | Grey-tailed Tattler | MI & P4 | MI | Within Australia, the Grey-tailed Tattler has a primarily northern coastal distribution and is found in most coastal regions (Higgins & Davies 1996). The Grey-tailed Tattler is often found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide (DAWE 2018). | **Likely** Suitable habitat may be available to support this species, predominantly the shoreline within the western-most portion of the PDE. | *Naturemap* |
| *Tringa nebularia* | Common Greenshank | MI | MI | The Common Greenshank is found in a wide variety of inland wetlands and coastal habitats of varying salinity. It occurs in sheltered coastal areas typically with large mudflats and saltmarsh, mangroves or seagrass, including embayments, harbours, river estuaries, deltas and lagoons, but less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral | **Known** This species has previously been recorded within the western-most portion of the PDE. | *Naturemap* PMST |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats, and artificial wetlands. They occur around most of the coast from Cape Arid in the south to Carnarvon in the north-west (DAWE 2018), and are moderately common here given suitable habitat. They can be found in areas including Wannamal Lake, many Perth lakes, Alfred Cove, Peel Inlet, Vasse and Harvey Estuaries, and the Albany and Esperance regions (Nevill 2013). | | |
| *Tringa stagnatilis* | Marsh Sandpiper, little greenshank | MI | MI | The Marsh Sandpiper is found on coastal and inland wetlands throughout Australia. The Marsh Sandpiper lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks (DAWE 2018). | **Likely**<br>Suitable habitat may be available to support this species, predominantly the shoreline within the western-most portion of the study area as well as at inundated floodplains throughout the PDE. | *Naturemap* |
| **Invertebrates** | | | | | | |
| *Idiosoma nigrum* | Shield-backed Trapdoor Spider | EN | VU | Endemic to Western Australia. The species is known from three locations. One location consists of a number of severely fragmented populations in the central and northern wheatbelt. The second and third locations are at Jack Hills and Weld Range, two isolated populations approximately 200 km further north, in more arid areas. The shield-back spider typically inhabits clay soils of eucalypt woodlands and acacia vegetation, and relies | **Likely**<br>This species has been recorded within 200 m of the PDE. Suitable habitat may be present to support this species. | *Naturemap*<br>PMST |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| | | | | heavily on leaf-litter and twigs to build its burrow (DSEWPaC 2013). | | |
| **Mammals** | | | | | | |
| *Notamacropus irma* | Western Brush Wallaby | P4 | | The Western Brush Wallaby is found primarily in open forest or woodland, particularly favouring open, seasonally-wet flats with low grasses and open scrubby thickets. It is also found in some areas of mallee and heathland, and is uncommon in karri forest (Van Dyck and Strahan 2008). | **Likely** Suitable habitat may be present to support this species. | *Naturemap* |
| **Reptiles** | | | | | | |
| *Cyclodomorphus branchialis* | Gilled Slender Blue-tongue Skink | VU | | The Gilled Slender Bluetongue is found in the lower west coastal regions on WA, between the Murchison and Irwin Rivers. It is a ground-dwelling lizard of largely crepuscular and nocturnal habits. The species has little information available but is thought to sheltering by day in porcupine grass, leaf-litter, and under fallen timber (Cogger 2014). However the author has recorded the species under rocks and in loamy spoil heaps. | **Known** This species has previously been recorded within the central PDE. Suitable habitat is available to support this species. | *Naturemap*, DBCA |
| *Egernia stokesii badia* | Western Spiny-tailed Skink | VU | EN | The Western Spiny-tailed Skink (black form) was originally known from a limited number of sites on Austin Downs Station, east of Cue (e.g. Walga, Wurrah and Woolgerong Rocks). They were restricted to massive granite exposures ('whalebacks') with a variable cover of loose boulders and pockets of soil and low shrubland vegetation. These outcrops are separated by open low woodland and shrubland. The skinks live in narrow crevices and boulders and are observed most readily when they bask close to their refugia (DAWE 2016). Studys between 2006 and 2009 identified over 70 new locations in the Murchison region (Ecologia Environment 2010). | **Known** This species has previously been recorded within the central PDE. Suitable habitat is available to support this species. | *Naturemap* PMST DBCA |

| Taxon | Common name | Status | | Description | Likelihood of Occurrence | Source |
|---|---|---|---|---|---|---|
| | | WA | EPBC | | | |
| *Lerista yuna* | Yuna broad-blazed slider, skink | P3 | | The Yuna Broad-Blazed Slider is found in the semi-arid interior of the South West Division of WA, northeast and southeast of Yuna. It occurs in all habitats where the Lerista genus is found (Cogger 2014). | **Likely** Suitable habitat may be present to support this species. The closest known record is approx. 3.5 km north of PDE. | *Naturemap* |
| *Aspidites ramsayi (southwest subpop.)* | Woma python | | | The Woma inhabits woodlands, heaths and shrublands, often with spinifex. It occurs in the sub-humid and arid areas across Australia's interior with a separate sub-population occurring in the Wheatbelt and Goldfields of WA. The Woma shelters mainly in abandoned monitor and mammal burrows and in soil cracks (Wilson & Swan 2013). | **Known** This species has previously been recorded within the central PDE. | DBCA |

## 9.5 Potential impacts

Potential direct and indirect impacts to terrestrial fauna include the following:

- Direct:
  - Loss of up fauna habitat as a result of clearing vegetation (Section 9.6.1)
  - Displacement and death of fauna (Section 9.6.2)
- Indirect:
  - Habitat fragmentation (Section 9.6.3)
  - Habitat degradation from introduction and spread of environmental weeds (Section 9.6.4)
  - Alteration of fire regimes (Section 9.6.5
  - Introduction and spread of feral animals (Section 9.6.6).

## 9.6 Assessment of impacts

### 9.6.1 Loss of fauna habitat

#### *9.6.1.1 Mine development envelope*

The loss or degradation of native vegetation for mine development and construction of the mine 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. Table 9-11 quantifies the loss of habitat by habitat type for terrestrial vertebrate fauna. A total of 1,530 ha of moderate to high value habitat within the 8,230.09 ha MDE will be cleared.

The following conservative assumptions have been made when determining the extent of habitat loss:

- The pipeline route from Geraldton-Mount Magnet Road to the onsite power plant and processing plant is assumed to be 40 m wideRoads on the mine site are assumed to be 30 m wide.
- Cleared areas around proposed site infrastructure is 50 m for all features, with the exception of the explosives warehouse, guard house and power station which is assumed to be 100 m
- Maximum areas are calculated on the proposed mine layout and does not take into account the location of additional infrastructure that is likely to be required at the site.

Table 9-11 Terrestrial vertebrate fauna habitat loss due to clearing

| Habitat suitable for conservation significant fauna | Habitat value | Conservation significant fauna that utilise this habitat | Area with MDE (ha) | Area proposed to be clear (maximum) (ha) | % habitat remaining |
|---|---|---|---|---|---|
| BIF Ridgeline | Moderate to high | Long-tailed dunnart<br>Gilled slender bluetongue<br>Western spiny tailed skink | 1,041.09 | 311.98 | 70.03 |
| Chenopod plain | High | Gilled slender bluetongue | 215.22 | 3.79 | 98.24% |
| Riparian creek lines | High | Gilled slender bluetongue | 252.18 | 13.89 | 94.49% |
| Flood plain | Moderate | None | 391.26 | 0.0 | 100% |
| Granitic formations | High | Long-tailed dunnart<br>Gilled slender bluetongue<br>Western spiny tailed skink | 825.48 | 198.93 | 75.90 |
| Mixed acacia plain | Moderate | Gilled slender bluetongue | 5,470.71 | 984.91 | 82.22 |
| **Total** | | | 8,229.51 | 1,514.00 | 81.60 |

Table 9-11 shows that the fauna habitat that is most affected by the Proposal is the BIF ridgeline, which is expected given that it is where the resource exists, with almost 30% of BIF within the development envelope disturbed as part of the proposal. While this habitat represents habitat for multiple species of conservation significance (i.e. the Long-tailed Dunnart, Gilled Slender Bluetongue, and Western Spiny-tailed Skink), none of the species identified rely solely on this habitat to persist in this region, as indicated in Table 9-4 and Table 9-11.

The versatility of the Gilled Slender Bluetongue to utilise a variety of suitable habitats and the ability to create or modify its environment to fulfil its microhabitat requirements indicates that the removal of BIF ridgeline will not be significant, although it is recognised that this species is not well characterised.

The Long-tailed Dunnart relies solely on rocky habitats, however it does not have specific micro-habitat requirements within rocky environments. The dunnart is able to create its own refuge habitats from exfoliating granite, accumulated rock piles and vegetation debris within this area.

Micro-habitat availability for the Western Spiny-tailed Skink is known to be sporadic within wider suitable fauna habitat types such as the BIF Ridgeline and Granitic Formations, with the species requiring specific features to facilitate its use of the area. This includes having sufficient hide structures such as smaller enclosed areas formed by rock piles and crevices. The sporadic nature of these micro-habitats demonstrates their occurrence is highly valuable to the species,

with the removal of such micro-habitats likely to have a significant impact. The majority of the observances of the Western Spiny-tailed Skink occurred in the north-east of the site, on the outer areas of the MDE. As indicated in Figure 9-2, an 'avoidance area' will be established around the area where the majority of the Western Spiny-tailed Skinks occurred. In addition, during the Phase 2 Lelvel 2 survey (January 2020) potentially suitable relocation sites were identified (refer to Table 9-6), should any of the Western Spiny-tailed Skins require to be relocated. Proposed relocation procedures for the Western Spiny-tailed Skink are provided in Appendix D of the EMP. In recognition of the value of this habitat, where possible, the mine layout will be modified to minimise impacts to these fauna habitats and appropriate mitigation measures will be employed prior to clearing to reduce direct impacts to conservation significant fauna species, as outlined in the EMP (GHD 2020d, Appendix C).

No other fauna habitat types will be substantially cleared within the MDE, with the proposed clearing anticipated to be no more than 20%. 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, Gilled Slender Bluetongue, and Western Spiny-tailed 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.

Such impacts will be mitigated through the implementation of appropriate management measures, as outlined in Section 9.7.

Loss of habitat by habitat type for terrestrial SRE invertebrate fauna is outlined in Table 9-12.

Table 9-12 SRE invertebrate fauna habitat loss due to clearing

| Habitat suitable for conservation significant fauna | Potential SRE habitat | SRE Species Identified | Area with MDE (ha) | Area proposed to be clear (maximum) (ha) | % habitat remaining |
|---|---|---|---|---|---|
| BIF Ridgeline | High | Five possible SREs and one likely SRE species | 1249.57 | 357.48 | 71.39 |
| Mixed acacia plain | High | Nine possible SRE species | 4991.22 | 887.60 | 82.22 |
| Chenopod | Medium | Two possible SREs species | 253.24 | 0.00 | 100.00 |
| Granite | High | Three possible SREs species | 1027.03 | 201.45 | 80.39 |
| Riparian creek lines | Medium | Four possible SREs species | 421.03 | 71.98 | 82.90 |
| Flood plain | Low | No SRE species identified | 288.00 | 4.32 | 98.50 |

The location of the proposed mine pit is likely to impact the habitat of five potential and one likely SRE invertebrate fauna species, with two of these species only identified within the BIF ridgeline.

While the Mixed Acacia Plain represents habitat for nine potential SRE species, less than 20% of this habitat within the MDE is proposed to be disturbed as part of this proposal. This particular vegetation type, which closely aligns with the Beard vegetation association no. 18, is also widely dispersed throughout the Tallering IBRA sub-region, with 99.90% of pre-European extent remaining (as discussed in Section 5.3). Further, these nine SRE invertebrate species were also identified in multiple habitat types and widespread across and outside of the MDE, indicating that they are not restricted solely to the mixed acacia plain or that geographical location.

The remainder of the SRE species identified occur in multiple habitat types, indicating they are not confined to one habitat requirement. As such, the impacts to SRE specie are not considered significant.

#### *9.6.1.2 Pipeline development envelope*

Table 9-13 quantifies the loss of habitat by habitat type for terrestrial vertebrate fauna. A total of 199 ha of habitat within the 76,800 ha PDE will be cleared.

The following conservative assumptions have been made when determining the extent of habitat loss:

- Only the eastern portion of the PDE has been used to calculate percentage of habitat removed. The western portion is not assumed to contain identifiable fauna habitat
- A 10 m buffer either side of the proposed pipeline through the eastern portion has been used to determine estimates of habitat loss.

Table 9-13 Terrestrial vertebrate fauna habitat loss due to clearing

| Habitat suitable for conservation significant fauna | Area with PDE (ha) | Area proposed to be clear (maximum) (ha) | % habitat removed |
|---|---|---|---|
| Low granite outcrops | 131.67 | 6.95 | 5.28 |
| Riparian creek line | 189.25 | 8.84 | 4.67 |
| Mallee over mixed shrubland on sandplain | 277.35 | 12.14 | 4.38 |
| Open acacia woodland/shrublands on clayey soils | 3140.32 | 137.48 | 4.38 |
| Mixed Shrubland on Sandplain | 385.79 | 17.28 | 4.48 |
| Chenopod Claypan | 1.36 | 0.0 | 0.00 |
| Stony Plain | 178.11 | 7.59 | 4.26 |
| Acacia shrubland over shallow soils over granite | 34.28 | 1.3 | 3.79 |
| **Total (eastern PDE)** | **4,338.13** | **199.39** | **4.60** |

Table 9-13 shows that the most significantly affected fauna habitat is low granite outcrops, however, based on the estimates above the area cleared is less than 6%. The remaining fauna habitat types will not have more than 5% of their extent removed, with the total removal of fauna habitat equating to the 4.60% within the PDE. This is significantly less than the clearing proposed within the MDE. The pipeline is not proposing to remove a significant portion of any of the habitats identified within the PDE, however it does represent other barriers to fauna such as

habitat fragmentation, altered fire regime and introduction of weeds and feral animals (discussed below).

The absence of breeding and roosting habitat within the MDE for the Peregrine Falcon as well as the ability of this species to forage in a variety of habitats indicates the site development is not likely to result in a significant impact to this species.

With regards to the Malleefowl, while suitable habitat was identified within the PDE, it only represents a small portion of the area (14.2%). No individuals or Malleefowl mounds were sighted during the site reconnaissance, there is the potential that they may be present in the area. Every effort will be made to avoid having direct impacts on this species, and these will be addressed in the EMP (GHD 2020d, Appendix C).

The habitat versatility of this species and the widespread nature of its population indicates that the limited removal of suitable habitat within the PDE is not likely to result in a significant impact to this species.

Effort will be made to reduce impacts to this species by having appropriate management measures in place.

The Western Spiny Tailed Skink is known to inhabit localised features of suitable habitat, even though that particular habitat spans a larger area.

The only suitable habitat type identified included the low granite outcrops and this has a limited extent within the PDE (2.8%).

Impacts to this species are not likely to be significant with regard to the pipeline development.

### 9.6.2 Displacement and death of fauna

The development of the Yogi mine is likely to create opportunities for terrestrial vertebrate fauna to become entrapped in site infrastructure, such as the tailings facility, or in trenches and other excavations that are required as part of the installation of infrastructure. Fauna trapped in excavations and trenches may also be buried following completion of the infrastructure installation.

There is some risk that animals may collide with the fence lines (current and proposed), where they may injure themselves, potentially leading to a fatality, or they may become trapped in the fence, and unable to escape, they will eventually succumb to dehydration and starvation. However, the majority of the fauna detected on site are relatively small, and are not likely to be impacted by fence lines, and significant additional fencing (such as wire fencing which the most likely to lead to collisions or entrapment) above what is already existing is not proposed. As such, the risk relating to fences is considered minimal.

Impacts to SRE invertebrate fauna is expected to be minimal as they will be restricted to their immediate habitat and surroundings and any excavations are expected to only impact those directly in that location.

The current MDE spans several pastoral stations, and fences and dirt tracks were noted during the field surveys across the MDE. The presence of unsealed roads and fences suggests that fauna may be accustomed to some degree to impacts from roads and fences.

The operation of heavy machinery and vehicles on the haul road and access tracks within the Development Envelope will increase the likelihood for impact with native fauna. Small reptiles may be injured or killed on roads whilst basking during the day and mammals may be impacted particularly at dawn and dusk. Injured or dead animals attract scavenging species, which then are more likely to be struck themselves. Given that short range species are largely restricted to the immediate vicinity of their habitat, impact due to vehicle strike is likely to be minimal.

SRE invertebrate fauna are largely restricted to the immediate vicinity of their habitat, therefore impact due to vehicle or machinery strike is likely to be minimal.

Fauna may be temporarily displaced by light emissions associated with mining and haulage operations. Light emissions may be advantageous to some species, for example those that feed on insects around lights. Noise and vibration emissions may be disruptive to others whose communication may be disrupted by artificial background noise (e.g. the echolocation process of bats may be disrupted).

Regardless of the Proposal phase, noise and vibration may cause some vertebrate fauna species to move away from the area, alter their behaviours or change community structure. Information on the potential effects of noise, vibration and light emissions on SRE species limited and without further research, it is not possible to predict and quantify the potential impacts on SRE species (Invertebrate Solutions 2019).

With respect to vertebrate fauna, over time it is expected that most species will either become accustomed to light, noise and vibration associated with mining operations or move to a suitable distance away from the source so that they are no longer disturbed. SRE species are unable to move significant distances to avoid disturbances such as light, noise and vibration. Most SRE invertebrate fauna in the eastern Mid-west are active during the hours of darkness and it is possible that artificial light may influence feeding and breeding behaviours. Whilst the Proposal will be operating on a 24 hour basis, lighting will be limited to illumination of operational areas for safety requirements, primarily being the pit floor (which will move to below ground surface) and ROM pad, and vehicle lights.

Noise, vibration and light emissions are likely to dissipate rapidly with distance from the source and are not considered to be of significant risk to SRE species at either a local, or regional, scale.

Noise and vibration from the Proposal will be associated with blasting, heavy vehicles and machinery associated with the mining operation, which will vary in intensity and duration according to the different phases of the Proposal.

As described in Section 11, dust emissions may result in localised impacts on vegetation to the extent that faunal assemblages are affected through a reduction in both food and habitat resources. Localised dust emissions will be generated during all phases of the Proposal, with the greatest impact likely during construction when clearing of vegetation and topsoil occurs. The dust modelling, has indicated that due to the prevailing winds being easterly during summer and autumn, south-westerly during spring and evenly distributed during winter, the greatest deposition rates are expected to occur around the proposed mine pit and on the eastern side of the BIF range.

However, dust deposition rates can be maintained within acceptable levels for vegetation maintenance via the use of water-based suppression on the haul road and within the pit (GHD 2020d). Habitats with potential to be influenced by the higher concentrations of dust mostly comprises the BIF and Floodplain. Areas of the following habitats also occur within the areas with potential to be affected by dust include areas of the Mixed Acacia Plain and Chenopods.

### 9.6.3 Habitat fragmentation

The MDE forms part of a large continuous and variable tract of habitat which retains high connectivity to the habitats directly adjacent. The mine footprint is proposed to intersect areas of large uniform habitat, and through discrete sections of different habitats that coincide with landforms, such as water courses, and the impact that fragmentation of habitat has on fauna varies accordingly. Habitat fragmentation may result in individuals no longer being able to

access nesting or denning habitat or alternatively may lose access to areas where they may forage.

The mine footprint is anticipated to occupy or fragment linear and discrete formations of fauna habitat, including granitic formations, flood plains and riparian creek lines. While the flood plains are generally only noted as foraging habitat for conservation significant species such as the Peregrine Falcon, the granitic formations represent important habitat for the Western Spiny-tailed Skink, Long-tailed Dunnart, and Gilled Slender Bluetongue. The riparian creek line is assessed as habitat for the Gilled Slender Bluetongue, however this habitat is well connected with other suitable habitat including the adjacent mixed acacia plain and chenopod plain, and as such, this species is unlikely to be adversely affected by the removal of this habitat.

The proposed access road and pipeline corridor from the Geraldton-Mount Magnet Road to the site as well as the proposed pipeline corridor from Yogi mine to Geraldton present as a divider approximately 40 m wide through the landscape. Within the MDE, the most affected habitat is the mixed acacia plain that occurs throughout the southern 'tail' of the MDE, resulting in fragmentation of this habitat and impeding movement of fauna in an east-west direction.

The proposed clearing through the PDE will intersect multiple fauna habitats, and habitat fragmentation is the most substantial impact for this aspect of the proposal. The pipeline corridor will represent an approximately 20-40 m wide corridor in conjunction with the adjacent road and will disconnect habitat on the south and north sides, and impede fauna movement in that direction. It is notable that the pipeline corridor will cause fragmentation in the northern region of the ex Barnong pastoral lease, which is registered as a land of interest with the DBCA (Figure 2-8).

### 9.6.4 Degradation from introduction of weeds

Increased human activity and disturbance such as clearing for development and increased movement of vehicles, including earth moving machinery may result in the establishment of new populations of weed species, changes to species composition, fire frequency and abundance of native communities.

Increased numbers of weeds can significantly increase the risk of fire, which can impact on fauna habitat value (as discussed in Section 9.6.5). 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. Weeds can significantly alter the vegetation of a fauna habitat where infestations occur, resulting in significant declines in species richness or diversity of local fauna.

### 9.6.5 Altered fire regimes

Increased fires interrupt the natural ecological processes that Western Australia's fauna have adapted to. Fire opens up habitats and recurring fires prevent understory from re-establishing, allowing weedy species to dominate (EPA 2018). Increased human activity is correlated with increased fire risk and/or altered fire regimes. Construction and operation might increase chances of fire ignition by introducing more ignition sources into the area/environment, and clearing of vegetation might affect the transmission of fire by creating fire breaks.

Fire can be caused by:

- Sparks from grinding or welding
- Inappropriate disposal of cigarette butts
- Ignition of flammable vegetation through sparks and radiated heat from vehicle exhausts.

Fire can lead to temporary destruction of fauna habitat or more lasting degradation due to increased intensity and/or frequency, reduced food sources and increase in predation. SRE invertebrate habitats such as rocky outcrops are often fire refuges (EPA 2016f). The MDE contains granite outcrops and BIF, which are likely to provide a fire refuge.

### 9.6.6 Introduction and spread of feral animals

The proposal may result in the introduction and/or spread of feral fauna, which has the potential to affect native fauna assemblage. The introduction/and/or spread of feral fauna has the potential to result in increased predation, competition for food and shelter, habitat destruction and the spread of diseases. Putrescible waste and artificial water points around camps, offices and crib rooms could attract both native and introduced animals.

Implementation of feral animal and weed control measures will be required to ensure that introduced species do not significantly affect local terrestrial fauna.

### 9.6.7 Cumulative impacts

The review of the impacts to terrestrial fauna on other developments within the region indicates that on that is publicly available of the other developments within proximity to the site (as listed in Section 2.4.7) was completed and a summary of their impacts have been provided in Table 9-14. Note that fauna species which have been removed from the threatened species list since publication of the respective reports have been excluded from the table.

Implementation of the Proposal will have negligible impact to terrestrial fauna at a regional level. Impacts upon the majority of the conservation significant species are expected to be insignificant because their habitat is not restricted or they are not solely residents within the mining disturbance footprints.

The distribution of Malleefowl (*Leipoa ocellata*) within Western Australia appears to be widespread however, it is important to note that its range has been highly fragmented by land clearance for agriculture. Suitable habitat for the Malleefowl was not identified within the MDE, however it was identified within the PDE. Similarly, Malleefowl mounds were recorded within the survey areas of the other four mines in the region. Cleared fauna habitat will be replaced after mining, via progressive rehabilitation. Whilst rehabilitation will result in similar habitat types as pre-mining, it may not be identical and there may be areas of rehabilitation which require maintenance work to achieve the desired outcome. As such it can be concluded that there is likely to be some residual impacts from fauna habitat clearing and direct fauna mortality, even after rehabilitation. Those these impacts are not likely to manifest cumulatively across the region.

The Western spiny tailed skink (*Egernia stokesii badia)* has been recorded at three of the mine sites including the Yogi Mine site. Development of the mine and mining of the resource will result in the removal of approximately 30% of BIF Ridgeline and 20% of Granitic Formations, which are identified as critical fauna habitat for this species. At the Mount Gibson Iron Ore Mine and the Mummaloo Project the extent of clearing within known Western spiny tailed skink habitat is limited, representing only a small proportion of the potential habitat available across the Mt Gibson Ranges (0.1%) and (0.5%) respectively. It is acknowledged the implementation of this Proposal does have a cumulative impact on this species (through displacement and habitat loss).

Loss of habitat creates additional pressure on fauna to compete for food, shelter, breeding habitat and other resources Habitat fragmentation between mines has been limited due to the implication of effective management measures which all aim to reduce the local and regional effects of habitat clearing.

Due to the separation distance between Yogi Mine and the other developments identified in Table 9-14, secondary impacts due to light, noise, vibration and dust are not expected to have a cumulative impact on the surrounding area or the local air shed.

Changed fire regimes have the ability to modify a landscape significantly, and while the other developments are assessed to be sufficiently far away, it must be acknowledged that the implementation of the Proposal presents as an additional ignition source to the region and the viability of some faunal habitats. However, it is unlikely that any will impact the same area as the closest site is at least 20 km away from the Yogi mine and separated by large expanses of sparse vegetation and linear infrastructure.

Table 9-14 Comparison of terrestrial fauna impacts between other mining project s in the vicinity of the Yogi mine

| Project | Karara Iron Ore Mine | Mount Gibson Iron Ore Mine | Shine Iron Ore Project | Mummaloo Project |
|---|---|---|---|---|
| Variable Company | Karara Mining Ltd | Mount Gibson Mining Limited | Gindalbie Metals Ltd | Top Iron Pty Ltd. |
| Type | Magnetite Iron Ore | Iron Ore | Iron ore | Iron Ore |
| Location | Shire of Perenjori<br>215 east south east of Geraldton | Mount Gibson Range<br>270 km east south east of Geraldton | Shire of Yalgoo<br>68 km south of Yalgoo<br>290 km south east of Geraldton | Shire of Yalgoo<br>Approx. 300 km south east of Geraldton. |
| Habitats | BIF Ridgeline and its lower slopes comprises at least 1,165 ha of the development envelope. | BIF Ridgeline makes up the biggest portion of disturbed habitat | 500 Malleefowl mounds<br>BIF Ridge area | BIF Ridgeline – the main disturbance area |
| Priority fauna | Malleefowl (*Leipoa ocellata*) **VU**<br>Major Mitchell's Cockatoo (*Cacatua leadbeater*)<br>Gilled Slender Blue-tongue (*Cyclodomorphus branchialis*) ***VU***<br>Mulga Dragon (*Caimanops amphiboluroides)* | Western spiny-tailed skink ***VU (WA) EN (EPBC)***<br>Major Mitchell's Cockatoo<br>Peregrine Falcon (*Falco peregrinus*) ***OS***<br>Rainbow Bee-eater (*Merops ornatus)*<br>Tree stem Trapdoor Spider *(Aganippe castellum )*<br>Malleefowl ***VU*** | Malleefowl **VU** | Malleefowl ***VU***<br>Western spiny-tailed skink **VU (WA) EN (EPBC)** |
| SRE Fauna | Shield-backed Trapdoor Spider (*Idiosoma nigrum*) ***VU (WA) EN (EPBC)*** | | Shield-backed Trapdoor Spider ***VU (WA) EN (EPBC)*** | Shield-backed Trapdoor Spider ***VU (WA) EN (EPBC)*** |

## 9.7 Mitigation

The mitigation hierarchy (avoid, minimise, rehabilitate) has been applied to this proposal in relation to terrestrial and SRE fauna.

The inherent impacts that must be managed include:

- Clearing of native vegetation resulting in loss of suitable habitat and habitat fragmentation, altered fire regimes, and introduced weed and feral animal populations.
- Light, noise and dust impacts relating to the contraction and operation of Yogi Mine, and the construction of the pipeline.
- Fauna death due to vehicle and machinery collisions, and entrapment in earthworks, infrastructure and fencing.

Management and monitoring measures for the above impacts are well practiced and understood in the industry, and are considered to be effective. FIJV will continue to offset habitat loss through progressive rehabilitation of areas disturbed by mining activities.

Proposed mitigation measures to address the above potential impacts to terrestrial fauna are outlined in Table 9-15.

### Table 9-15 Mitigation measures for management of impacts to Terrestrial Fauna

| Impact | Mitigation measures |
|---|---|
| Habitat loss | **Avoid**<br>• Section of haul road traversing granitic formations and BIF Ridgeline will be deviated and narrowed to avoid and reduce impact to these habitats.<br>• Prior to clearing, areas of the granitic formation and BIF Ridgeline (all suitable habitat) will be targeted searched for Western Spiny-tailed Skink colonies. These areas will be demarcated and logged on the project's GIS database. The proposed site layout will be revised to avoid these areas. Where colonies of Western Spiny-tailed Skinks are present, and avoidance is not appropriate, these animals will be relocated to new sites. This will be discussed further in greater detail in the EMP (GHD 2020d, Appendix C).<br>• Pre-clearance surveys for Malleefowl mounds, with the aim to avoid all active mounds, within areas of potential Malleefowl habitat for pipeline development envelope.<br>• Disturbance footprint designed to reduce disturbance to fauna habitats.<br>• Vegetation clearing to be limited to 1,530 ha, with no clearing or mining activities to occur on the BIF ridgeline in excess of the required minimum area.<br>• Conduct a risk assessment to identify high risk areas, including areas where conservation significant fauna species and habitat have been identified and potential impacts to guide site design.<br>• Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat. |

| Impact | Mitigation measures |
|---|---|
| | **Minimise**<br>• Ensure staff and contractors are provided with appropriate training to ensure conservation significant fauna and associated habitat are protected.<br>• 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.<br>• Record conservation significant fauna and habitat identified during a targeted fauna survey in a centralised database to ensure that these area can be easily identified during mine planning and proposed works.<br>• Internal ground disturbance procedures and permitting system will be implemented.<br>• Develop and establish an internal clearing permit procedure for any required clearing works, which is discussed in the EMP (GHD 2020d, Appendix C).<br>**Rehabilitate**<br>• Waste dumps and general disturbance areas to be rehabilitated in accordance with the MCP (Appendix D).<br>• The rehabilitation of cleared areas where mining activities are complete to provide more habitat for fauna. |
| Habitat fragmentation | **Avoid**<br>• Minimise clearing and vegetation disturbance to ensure conservation significant fauna and associated habitat is minimally affected.<br>**Minimise**<br>• Conduct clearing in accordance with the permit and clearing procedure (to be developed).<br>• Fencing or tape to be in place around areas of fauna habitat outside the approved clearance area.<br>**Rehabilitate**<br>• Conduct progressive rehabilitation of disturbed areas, particularly those areas with known conservation significant fauna and associated habitat, in accordance with the Yogi MCP (included as Appendix D). |
| Displacement and death of fauna | **Avoid**<br>• Ensure that excavation and trenches are only open as long as necessary to facilitate the construction purpose.<br>• Vehicles and mining equipment access limited to designated roads/access tracks and cleared areas.<br>• During initial clearing, machinery will be sat idle for at least half an hour to allow fauna to migrate away from the disturbance area. A fauna spotter will also be employed to watch for fauna to ensure that they can be moved to a safe location. |

| Impact | Mitigation measures |
|---|---|
| | • Lighting designed to illuminate designated operations areas rather than the surrounding landscape.<br>**Minimise**<br>• Dust suppression, including use of water carts on access roads, to be implemented during all Proposal phases. Daily inspections of the waste storage facility to determine if fauna are entrapped within.<br>• Removal of dead fauna away from edges of roads.<br>• Implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off-road driving.<br>• Where possible, clearing should be undertaken on one front only, to provide an opportunity for the fauna to move out of the proposal area.<br>• Develop and implement a ground disturbance permit system and procedure to ensure management requirements as per the EMP are met (GHD 2020d, Appendix C). |
| Altered fire regimes | **Avoid**<br>• Proposal site induction to include information on prevention and management of fires.<br>• All machinery and vehicles undertaking clearing activities will be fitted with firefighting equipment.<br>• A Hot Work Permit system will be implemented.<br>**Minimise**<br>• Firefighting equipment will be located on site and emergency personnel will be trained in fire response. |
| Introduction of feral animals | **Avoid**<br>• No feeding of native or feral animals.<br>**Minimise**<br>• Putrescible wastes associated with site offices to be stored in bins with lids and prior to disposal.<br>• Develop and implement a Feral Animal Program to effectively manage and control feral animals within FIJV controlled sites to minimise impacts on conservation significant fauna.<br>• Fauna access to artificial on-site water sources will be prevented. |

## 9.8 Predicted outcome

### 9.8.1 Residual impacts

A summary of residual impacts after the implementation of the proposal and the application of the mitigation measures outlined in Table 9-15 above is provided in Table 9-16.

Table 9-16 Residual impacts to Terrestrial Fauna

| Impact | Residual impact |
|---|---|
| Habitat loss | Clearing of 1,530 ha of fauna habitat and 18.49% fauna habitat within the MDE. Removed fauna habitats will be re-established as part of |

| Impact | Residual impact |
|---|---|
| | rehabilitation during operations and closure in disturbed areas and new permanent landforms. There may be some permanent loss of habitat such as the loss of 311.98 ha of BIF Ridgeline and up to 198.93 ha of granitic formations.<br>Fauna habitat will be rehabilitated following completion of works within that area, indicating that the habitat loss period will vary according to completion of works, and success rehabilitation.<br>Adjacent vegetation within the buffer of the Mine and PDE should remain intact with little or no disturbance allowing ecosystem processes to continue both at local and regional scale.<br>While the vegetation of the MDE plays a role in providing fauna habitat, none of the vegetation types that are affected in development of the Proposal are known to provide habitat critical to the maintenance of fauna species. The proposed development has been designed to minimise impacts to the granitic formations and BIF ridgeline, which are considered to be the most significant of habitats from a SRE fauna utilisation and refuge perspective. The impact on the riparian vegetation is restricted to creek crossings, with remaining riparian vegetation undisturbed. The residual impact to riparian vegetation is considered to be minor. |
| Habitat fragmentation | The mine footprint is proposed to intersect areas of large uniform habitat, and through discrete sections of different habitats that coincide with landforms Rehabilitation will establish habitat for fauna species post-disturbance to restore ecological linkage for some species.<br>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. |
| Displacement and death of fauna | Implementation of the proposed management measures will reduce direct impacts to fauna to as low as possible. |
| Dust, noise and light emission impacts | Impacts to fauna due to light, dust and noise are anticipated to be limited to the short term, and not expected to impact on the ability of terrestrial fauna to persist long term. As such, the residual impacts are considered negligible. |
| Altered fire regimes | Weed management, construction of firebreaks and hot work permits will reduce the risk of fires caused by the proposal. |
| Introduction of 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. |
| Introduction of weeds | Impacts to fauna due to introduction of weeds are not assessed to be significant as the management measures are anticipated to adequately manage this issue, and not expected to impact on the ability of terrestrial |

| Impact | Residual impact |
|---|---|
| | fauna to persist long term. As such, the residual impacts are considered negligible. |

### 9.8.2 Assessment against the EPA objective

Following completion of the assessment and the residual impact outlined in Table 5-18, it is considered that the clearing required for the implementation of the proposal will not have significant residual impacts. As such, it meets the objective for this factor such that the biological diversity and ecological integrity of Terrestrial Fauna are maintained.

### 9.8.3 Offsets

Based on the results of the targeted survey for Western Spiny-tailed Skink, significant residual impact to the species will be determined and, if required, appropriate offsets, in accordance with the EPBC Act Environmental Offset Policy and WA Environmental Offsets Guidelines will be considered and discussed with the DAWE, DBCA and EPA.

Table 9-17 presents a summary of the mitigation measures to be undertaken to minimise impacts to the Western Spiny-tailed Skink and the potential suitable offsets options, based on current knowledge, if significant residual impact is determined and offsets are required.

Table 9-17 Potential environmental offsets for the Western Spiny-tailed Skink

| Existing Environment/Impact | Mitigation | | | Potential Significant Residual Impact | Potential Offset | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Avoid/Minimise | Rehabilitation Type | Likely Rehabilitation Success | | Type | Risk | Likely Potential Offset Success | Time Lag | Potential Offset Quantification |
| Clearing of up to 558 ha of suitable habitat (BIF Ridgeline and granitic formations) for the Western Spiny-tailed Skink | **Avoid**<br>• Section of haul road traversing granitic formations and BIF Ridgeline will be deviated and narrowed to avoid and reduce impact to these habitats.<br>• Prior to clearing, areas of the granitic formation and BIF Ridgeline (all suitable habitat) will be targeted searched for Western Spiny-tailed Skink colonies. These areas will be demarcated and logged on the project's GIS database. The proposed site layout will be revised to avoid these areas. Where colonies of Western Spiny-tailed Skinks are present, and avoidance is not appropriate, these animals will be relocated to new sites.<br>• A targeted survey for this species was undertaken (January 2020) to assess current use and presence within the known habitats, as well as, to identify suitable sites for potential relocation (refer to Table 9-6). In recognition of the value of this habitat, is possible, the mine layout will be modified to minimise impacts to these fauna habitats and appropriate mitigation measures will be employed prior to clearing to reduce direct impacts to the species.<br>• Conduct a risk assessment to identify high risk areas for the skink, including areas where the species and habitat have been identified and potential impacts to guide site design.<br>• Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on the skink and associated habitat. | Rehabilitation of the MDE will be undertaken in accordance with the Mine Closure Plan (GHD 2019c, Appendix D).<br>• Waste dumps and general disturbance areas to be rehabilitated.<br>• The rehabilitation of cleared areas where mining activities are complete to provide more habitat for fauna.<br>• Conduct progressive rehabilitation of disturbed areas, particularly those areas with known conservation significant fauna and associated habitat.<br>In addition, during operations, it will be investigated through studies and trials, how rehabilitation can be undertaken to re-establish habitat for the Western Spiny-tailed Skink. Activities, such as earthmoving of rocks to establish rock piles for habitat, will be investigated. | **Can the environmental values be rehabilitated?**<br>There is precedent in the region that rehabilitation back to pastoral lease land is viable (Mine Closure Plan, GHD 2019c).<br>Precedent projects in the region will be reviewed and assessed to further refine rehabilitation designs of landforms. | **Extent:**<br>558 ha of suitable habitat (BIF Ridgeline and granitic formations) for the Western Spiny-tailed Skink<br>**Quality:**<br>Moderate to high value for the Western Spiny-tailed skink (Fauna Assessment, GHD 2020b), but will be confirmed through a further targeted survey to be undertaken.<br>**Conservation significance:**<br>Species is listed as an endangered species under the EPBC Act 1999 and Vulnerable under the WA *Biodiversity Conservation Act 2016.*<br>**Land Tenure:**<br>Mining Tenements.<br>**Time Scale:**<br>21 years.<br>The residual impact to the Western Spiny-tailed Skink may be considered to be significant; however, the results of the targeted survey are required to confirm the residual impact. | Based on the results of the targeted survey for Western Spiny-tailed Skink, significant residual impact to the species will be determined and, if required, appropriate offsets, in accordance with the EPBC Act Environmental Offset Policy and WA Environmental Offsets Guidelines will be considered and discussed with the DAWE, DBCA and EPA.<br>A variety of offset options will be considered and investigated at that time. However, based on current knowledge, the following options may be suitable offset options:<br>• Establish a research trust to study the species present at the mine site since little is known about this species as compared to species types located in other regions of the country.<br>• Land acquisition in the Wheatbelt region of WA where the species is most vulnerable (discussed in *Western Spiny-tailed Skink (Egernia stokesii) National Recovery Plan (2012)* by David Pearson. | Low.<br>FIJV is committed to providing funding for the agreed upon offset option, if offsets are determined to be required. | High.<br>The establishment of a research trust has been previously implemented by other mining projects (e.g. Tropicana mine and in Pilbara region). Land acquisition and management in the Wheatbelt region is well understood and has been previously implemented by DBCA as an offset for other proposals. | N/A | If offsets are determined to be required, the quantity of offsets will be determined at that time in consultation with DAWE, DBCA and EPA. |

| Existing Environment/Impact | Mitigation | | | Potential Significant Residual Impact | Potential Offset | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Avoid/Minimise | Rehabilitation Type | Likely Rehabilitation Success | | Type | Risk | Likely Potential Offset Success | Time Lag | Potential Offset Quantification |
| | • Develop and establish an internal clearing permit procedure for any required clearing works.<br>• During initial clearing, machinery will be sat idle for at least half an hour to allow skinks to migrate away from the disturbance area. A fauna spotter will also be employed to watch for skinks to ensure that they can be moved to a safe location.<br><br>**Minimise**<br>• Conduct clearing in accordance with the permit and clearing procedure.<br>• Ensure staff and contractors are provided with appropriate training to ensure skinks and associated habitat are protected.<br>• Prior to conducting ground disturbance activities, ensure known locations of skinks and their habitat to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging. | | | | | | | | |

# 10. Inland Waters

## 10.1 EPA objective

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

For the purposes of an EIA, the EPA defines the factor 'Inland Waters' as the occurrence, distribution, connectivity, movement, and quantity (hydrological regimes) of inland water including its chemical, physical, biological and aesthetic characteristics (quality). Inland waters include groundwater (including superficial and confined aquifers), surface water (waterways, wetlands and estuaries).

## 10.2 Policy and guidance

### EPA Policy and Guidance

- *Statement of Environmental Principles, Factors and Objectives* (EPA 2018b)
- *Instructions on how to prepare an Environmental Review Document* (EPA 2018a)
- *Environmental Factor Guideline Inland Waters* (EPA 2018c).

### Other policy and guidance

- *Guidelines for Preparing Mine Closure Plans* (DMP and EPA 2015)
- *Australian groundwater modelling guidelines* (Waterlines Report Series No. 82) (Barnett B *et al*. 2012)
- *State Water Quality Management Strategy* (GoWA 2003)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018)
- *Western Australia water in mining guideline* (Water licensing delivery report series: Report *No. 12) (Department of Water [DoW] 2013a)*
- *A Directory of Important Wetlands in Australia* (Environment Australia 2001)
- *Guidelines for groundwater quality protection in Australia* (Australian Government 2013)
- *Preventing Acid and Metalliferous Drainage* (Australian Government 2016)
- M*ining and Mineral Processing* - Mine dewatering: Water Quality Protection Guidelines No. 11 (WRC, DME & DEP 2000)
- *Global Acid Rock Drainage* (GARD) Guide (International Network for Acid Prevention 2009).

## 10.3 Required work

The required work for the inland waters factor as stipulated in the approved ESD and its location within this ERD is documented in Table 10-1.

Table 10-1 Required work for Inland Waters

| Task No | Required work | Section |
|---|---|---|
| **Mine Development Envelope** | | |
| 66 | The key hydrogeological features relevant to the Development Envelope will be characterised including: aquifer system, aquifer recharge, discharge, flow direction, hydraulic parameters, hydrochemistry, from regional and site specific perspectives | Section 10.4.2 and 10.4.3 |
| 67 | Hydrogeological field investigation will be conducted including groundwater monitoring and aquifer testing | Section 10.4.1 |
| 68 | An initial conceptual and numerical groundwater flow model and water balance will be developed for predictive purposes (dewatering rates and impact assessment). | Section 10.4.4 |
| 69 | Potential impacts of the Proposal will be identified (for the borefield and mine dewatering) including changes to groundwater levels, flows and quality, including: | Section 10.6.2 |
| 69a | Assessing potential impacts to creeks, springs/soaks, salt lake ecology, water flats, groundwater dependant ecosystems (GDEs), subterranean fauna and other users. | Section 10.6.6 |
| 69b | Identifying appropriate management measures to mitigate the impacts of the Proposal | Section 10.7 |
| 69c | This will include noting whether these impacts are unknown, unpredictable or irreversible, or combination or contrary to that thereof | Section 10.1.1 |
| 70 | The potential for the formation of mine pit lakes after mine closure will be assessed. The pit lake risk assessment will determine the potential impact to hydrological regimes and water quality | Section 10.4.4 |
| 71 | A preliminary surface water assessment will be prepared for the construction and operation of the mine including: | Section 10.4.2 |
| 71a | Identifying and delineating catchments and drainage lines / waterways intersected by the proposed mine plan. | Section 10.4.2 |
| 71b | Assessing the potential risk of flooding associated with the construction of the mine and progression of mining | Section 10.4.2 |
| 71c | Assessing the potential impacts that the anticipated changes in flow regimes and/or surface water quality may have on sensitive receptors and endpoints and recommend mitigation measures | Section 10.6.1 |
| 72 | Waste characterisation will be undertaken for the waste material to assess potential for AMD, including leachate assessment | Section 10.4.5 |

| Task No | Required work | Section |
|---|---|---|
| 73 | The residual impacts on inland water quality for direct, indirect and cumulative impacts will be predicted, after considering avoidance and minimisation measures. This will include an assessment of all potential pathways and the risk of impact to receptors for worst case scenarios | Section 10.6.7 |
| 73d | The extent and significance of any significant residual impacts will be determined on the identified environmental values by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (GoWA 2014). Spatial data will be provided defining the area of significant residual impacts. | Section 10.7 |
| 74 | An environmental management plan will be prepared that describes the proposed management, and monitoring methods to be implemented to mitigate potential impacts to inland waters and the surrounding environment. | GHD 2020d, Appendix C |
| 75 | Where significant residual impacts remain, an appropriate offsets package will be provided, consistent with the WA Environmental Offsets Policy and Guidelines and where residual impacts relate to EPBC Act-listed threatened species and Communities the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Spatial data will be provided defining the area of significant residual impacts. | Section 10.1.1 |
| 76 | A mine closure plan will be prepared consistent with the DMIRS and EPA Guidelines | GHD 2019c, Appendix D |
| 77 | The ERD will demonstrate and document how the EPA's objective for this factor can be met. | Section 10.1.2 |
| **Pipeline Development Envelope** | | |
| 78 | A preliminary surface water assessment for the construction of the pipeline(s) will be provided. | Section 10.4.7 |
| 79 | A detailed description will be provided of the design and location of the water crossings and any other Proposal elements with the potential to impact surface water or groundwater. This will include noting whether these impacts are unknown, unpredictable or irreversible, or combination or contrary to that thereof | Section 10.4.7 |
| 80 | A detailed description will be provided of appropriate management measures to be implemented at water crossings | Section 10.7 |
| 81 | An environmental management plan will be provided that describes the proposed management, and monitoring methods to be implemented to mitigate potential impacts | GHD 2020e (Appendix C) |

| Task No | Required work | Section |
|---|---|---|
| | to hydrological processes and the surrounding environment, including those related to pipeline failures. | |
| 82 | The residual impacts on hydrological processes will be predicted for direct, indirect and cumulative impacts, after considering avoidance and minimisation measures. | Section 10.7 |
| 83 | A preliminary erosion and sediment control plan will be prepared for construction of the pipelines. | Appendix C |
| 84 | The ERD will demonstrate and document how the EPA's objective for this factor can be met | Section 10.1.2 |

## 10.4 Receiving Environment

This section has been prepared in alignment with the requirements of *Environmental Factor Guideline: Inland Waters* (EPA 2018c).

### 10.4.1 Supporting inland waters technical studies

The following supporting inland water technical studies have been completed as part of the investigation and planning for the proposed Yogi Mine (Table 10-2).

GHD completed both a surface water assessment (GHD 2019e) and a groundwater assessment GHD 2019f. Both studies are included in Appendix B.

Table 10-2 Supporting inland waters technical studies

| *Report Title*<br>Author (Month Year) | Focus | Date | Summary | Relevance to project |
|---|---|---|---|---|
| *Surface water assessment*<br>GHD 2019e (Appendix B) | Surface water | April 2019 | Preliminary surface water assessment<br>Desktop assessment including delineation of catchments and drainage lines, determination of flow regimes, and the interaction between groundwater and surface water.<br>Detailed surface water quality and flow assessment | The study area of this technical assessment is congruent with the MDE. |
| *Groundwater assessment*<br>GHD 2019f (Appendix B) | Groundwater | May 2019 | Groundwater investigation including installation of new groundwater wells, groundwater sampling, and groundwater level gauging.<br>Modelling of groundwater behaviour across the Site. | The study area of this technical assessment is congruent with the MDE |

### 10.4.2 Hydrology

#### *Catchment*

At a regional-scale, the majority of the proposed Yogi Mine deposits are located within the Yarra Yarra Basin, which forms part of what is referred to as the Moore-Monger or Yarra-Monger Drainage Basin System. The Yarra Yarra basin is characterised by flat to gradual slopes, ephemeral streams with intermittent flow and salt pans or salt playas along the flow lines. The basin has been created over time by the action of tectonics, fault lines, folds and erosion. Figure 10-1 illustrates the proposed mine site in the context of these regional catchments. Land use in these sub-catchments consists primarily of current and former pastoral leases and old gold mining excavation zones.

The proposed mine site lies within the catchment of the Salt River, which originates in salt flats south of the mining town of Mt Magnet, about 120 km east of the proposed mine site. The river flows west and becomes braided as it passes south of the mine site, connecting into playas. The river bends south after Yalgoo towards the Yarra Yarra Lakes. The intermittent outlet from Yarra Yarra Lakes continues south along the Darling Fault as Coonderoo River and connects with the Moore River North Branch. Upon joining with the Moore River East Branch further south, the combined river makes its way westwards to the intermittent ocean discharge at the Moore River Estuary. Numerous significant streams intersect the watercourse along its journey to the estuary (GHD 2019e).

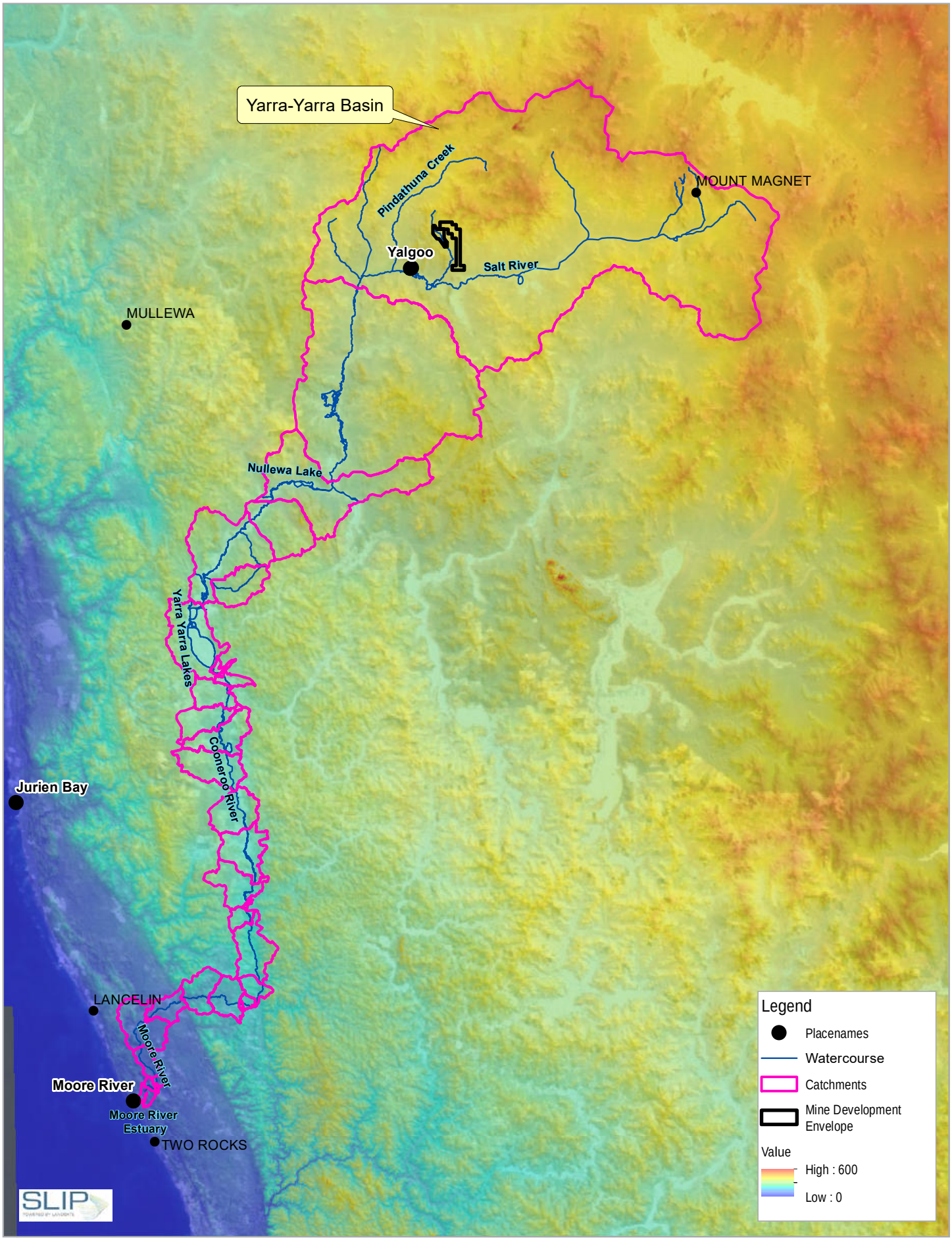
#### *Onsite hydrological features*

The proposed mine site is intersected by two non-perennial significant streams that intersect the MDE. These streams are the Western Primary Watercourse (WPW) which traverses the western side of the envelope, and the Eastern Primary Watercourse (EPW) along the eastern side of the envelope. These watercourses divide the mine site into two distinct catchment areas.

The WPW forms the most significant stream intersecting the mine site, and is shown in Figure 10-2. The WPW flows south through the mine site between the proposed Mine Pit and WRD. At the headwaters of the WPW, north-west of the mine tenement, the WPW channel is generally undefined and is likely to exhibit sheetflow when flowing. This profile continues up until the southern end of the proposed Mine Pit, where the channel becomes well defined. The defined WPW channel runs between the BIF to the west and the Moore Monger Paleovalley. The watercourse becomes braided again near the intersection with the Geraldton-Mount Magnet Road and continues this profile until it reaches the Salt River.

The EPW flows in a southerly direction along the eastern side of the development envelope and is predominantly ill defined, with flow likely to be made up of sections of sheet flow and short braided channels given the very flat nature of this area. The watercourse is likely to be distributed over a significant area, and given the low-lying and flat nature of this area, it is possible that water will pool in some areas over long periods, with sheet flow occurring once saturated. The EPW is therefore likely to provide significant groundwater recharge within this area. The strong groundwater connectivity is reinforced by the abundance of vegetation observed along the EPW channel's bed and banks. Headwaters of minor streams that lead into the WPW from the eastern side of the mine site make up a third, albeit less significant catchment area of the site.

The total catchment area of the site is 25,396 ha, with the WPW making up 16,122 ha (64%), the EPW 8,264 ha (33%), with the remaining headwaters only 1,010 ha (4%). All watercourses from the site, when flowing, discharge into Salt River to the south of the site. Appendix B (GHD, 2019h) contains further details of the Eastern and Western Primary Watercourses.




1:2,000,000 at A4

0 20 40 60 80

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

FI Joint Venture Pty Ltd
Environmental Review Document

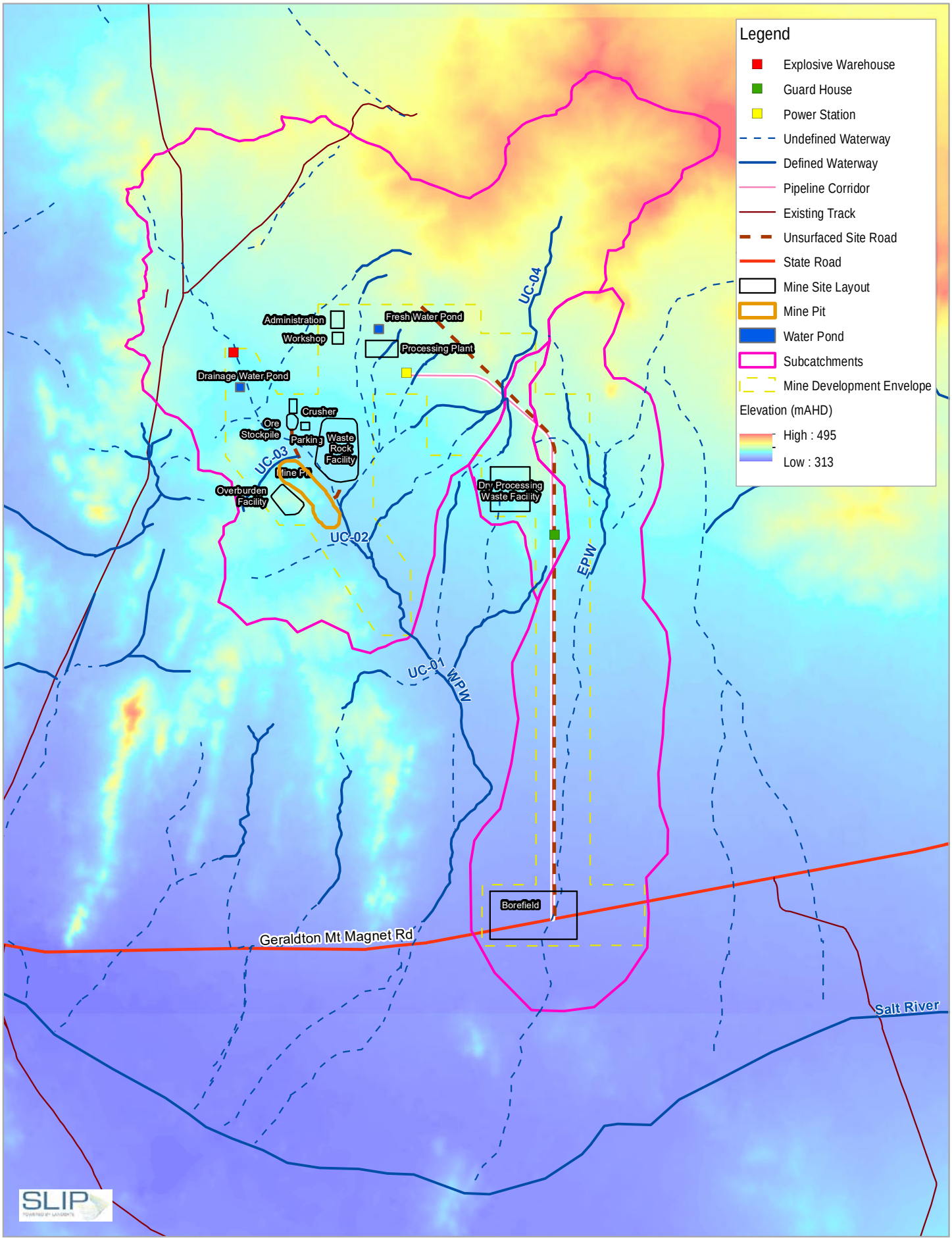
Project No. 61-37117
Revision No. 0
Date 12 Jul 2019

# Hydrological Catchments - Regional Context

FIGURE 10-1

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_010-1_HydroCatchmentsRegional_rev0.mxd
Print date: 12 Jul 2019 - 15:04

Data source: GHD: Regional Catchments - 20190206; FIJV: Mine Tenements - 20171025; Landgate: Placenames - 20190206, Imagery - October 2015 - January 2018; GA: Elevation - 2008..
Created by: cgverzosa




1:150,000 at A4

0 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

Catchments and Drainage Lines

Project No. 61-37117
Revision No. 0
Date 26 Feb 2020

FIGURE 10-2

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_010-2_CatchmentsDrainage Lines_rev0.mxd
Print date: 26 Feb 2020 - 16:05

Data source: MRWA: State Roads - 20171024; FIJV: Mine Tenements, Mine Site Layout, Development Envelope, Pipeline Development Envelope - 20171025; DoW: Waterways - 20130902; Landgate: Roads - 20171211; Imagery. Created by: cgverzosa

### *Groundwater and surface water interaction*

There is potential for significant surface water – groundwater interactions within the vicinity of the proposed mine site due to its location within an alluvial floodplain and the presence of ephemeral surface water drainage systems with flood-out zones, and paleo-drainage channels. The site creeks are all ephemeral and will drain to groundwater. The primary watercourses will contribute significant recharge to aquifers when flood-outs are activated. During rainfall events the alluvial aquifers predominantly in the south-eastern part of the development envelope will be recharged, followed by sheet-flow once the soil is saturated (GHD 2019d).

### *Baseline surface water quality*

The baseline surface water quality of the site was determined through sampling of water courses, and comparison of samples with the Australian and New Zealand Environment and Conservation Council (ANZG 2018) guidelines and the Agricultural and Resource Management Council of Australia and New Zealand (ANZG 2018) guidelines.

The baseline sampling results indicated that the water is fresh, with a total dissolved solids of 420 to 630 mg/L, which equates to an electrical conductivity (EC) of 764 to 1,145 µS/cm. These EC values exceed the default guideline, however are considered to represent the high evaporation of standing water (SW01) and initial flush conditions following an infrequent rain event (SW03).

Both water samples exceeded default guideline values for total nitrogen, ammonia (as N) and total phosphorus for tropical Australia upland rivers (ANZG 2018). Ammonia concentrations did not exceed the default ANZG 2018 95% guideline value. Heavy metals were observed in the surface water samples including chromium, copper, lead, zinc, nickel, manganese which exceeded the assessment criteria either one or both samples collected (GHD 2019e).

The elevated total metal and metalloid concentrations in surface water samples may be related to naturally elevated background concentrations due to mineralisation of ore bodies (DEC 2014). The exceedance of filtered chromium and copper in water samples above guideline values indicates that bioavailable forms are present in water at levels which are of concern to some freshwater species. Further characterisation of surface water samples is required to assess background filtered metal concentrations. Further details of the background surface water quality are detailed in the *Surface Water Assessment* in Appendix B (GHD 2019e).

### *Baseline sediment quality*

The exchangeable sodium percentage (ESP) ranged between 0.05 and 0.34, and combined with the predominantly sandy nature of the sediments this was deemed to be a low risk of dispersion of channel sediments. The sediment pH was found to be neutral, ranging from 6.3 to 7.4. The EC was low at all sites, ranging from less than < 10 uS/cm to 19 uS/cm. The preliminary sediment sampling targeted depositional zones of fluvial channels, and therefore the ambient surface and subsurface sediment properties are unknown (GHD 2019e).

Sediment and water samples were assessed against existing guideline trigger values where available, using the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018), specifically the Metals and metalloids Interim Sediment Quality Guidelines (ISQG) which include two concentrations:

- ISQG Low – which indicates concentrations below which there is a low risk of unacceptable effects occurring
- ISQG- High, which is intended to represent a concentration above which adverse biological effects may occur more frequently.

Sediment samples collected from the watercourses onsite detected the presence of several metals and metalloids including chromium, nickel, cobalt, copper, zinc, lead and manganese. The majority were lower than their respective guideline value, where guidelines are available, with the exception of chromium and nickel.

Chromium levels exceeded guideline values in 54% of samples taken, with one exceeding the ISQG-Low level and five exceeding the ISQG-High level. Nickel levels exceeded the guideline values in 27% of samples, with one sample exceeding the ISQG-Low level and two samples exceeding the ISQG-High level. The location of the samples indicates that both total chromium and total nickel are typically higher in the western portion of the study area and total nickel was also elevated at downstream sampling locations (GHD 2019e). These exceedances may be indicative of the elevated background sediment concentrations, which may be related to local geology. High levels of metals and metalloids can be associated with naturally elevated background concentrations due to mineralisation of ore bodies (DWER 2014). Chromium and nickel have previously been reported to be elevated in sediments of Western Australian salt lakes (GHD 2019e).

Further details of the background sediment quality are detailed in the *Surface Water Assessment* in Appendix B (GHD 2019e).

### *Flood Risk*

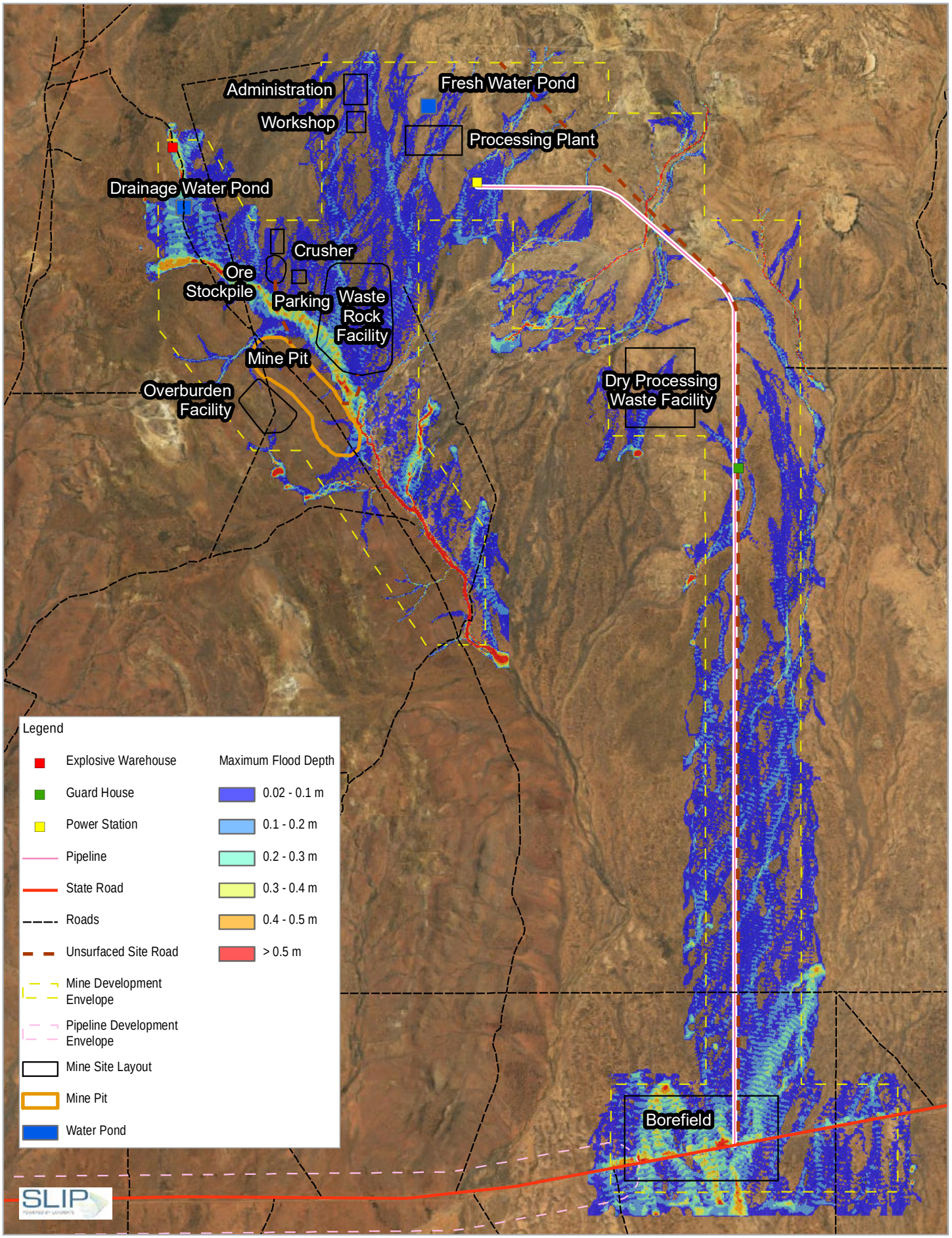
Flood modelling was undertaken for the 1% and 2% Annual Exceedance probability (AEP) storm events. A design flood of these magnitudes is considered sufficient for operational purposes, assuming a mine life of 20-30 years. The predicted flood depths and extents at 1% and 2% are shown in Figure 10-4 and Figure 10-4, respectively.

The Department of Water and Environmental Regulation's (DWER) Water Information Reporting indicates a lack of stream gauging records in the vicinity of the mine site. The nearest streamflow gauging site is located approximately 100 km south west at the Morawa Drain, where only three years of gauging data (from December 2004 to January 2007) were available. This limited availability of records meant that a meaningful flood frequency analysis could not be conducted in that the model could not be calibrated to real flow gauging data.

The results from the flood modelling showed there was negligible difference between the 1% and 2% AEP flood depths; however, there were a few key areas of the MDE which may be affected by such flood events. These were:

- **WRD:** Flood depths of 0.2 m to 0.5 m for both the 1% and 2% AEP events are estimated within the WPW at the south-western corner of the WRF. Flood levels are otherwise 0.02 m to 0.3 m within the majority of the WRF
- **Mine Pit:** Flood depths of 0.02 m and 0.5 m for both the 1% and 2% AEP events are the south-eastern corner adjacent to the WPW, and up to 0.2 m for both events at its northern end
- **Drainage Water Pond:** Flood depths of up to 0.3 m are estimated for both the 1% and 2% AEP within the drainage water pond area. This area is noted to be within the portion of the WPW that is ill defined
- **Explosives Warehouse**: Flood depths of up to 0.3 m are estimated for both the 1% and 2% AEP within the proposed Explosives Warehouse area. This area is noted to be within the portion of the WPW that is ill defined
- **Access Road and Pipeline**: Flood depths of up to 0.2 m for both the 1% and 2% SEP events are estimated to occur at various sections along the pipeline route and access road within the mine site, with a large portion of the south-eastern portion of the mine site situated to be inundated by shallow sheet flows

- Flood depths within the remaining areas of the mine site (Power Station, Guard House, Crusher, Parking, Ore Stockpile, Processing Plant, Fresh Water Pond, Administration, Workshop, DPWF) are estimated to be within 0.2 m for both the 1% and 2% AEP events
- Flood depths of up to 0.5 m are also estimated to occur within UC-04, which traverses the Borefield, however, infrastructure in this area is unlikely to be situated within the watercourse itself.




1:85,000 at A4

0 1 2 3 4 Kilometers

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

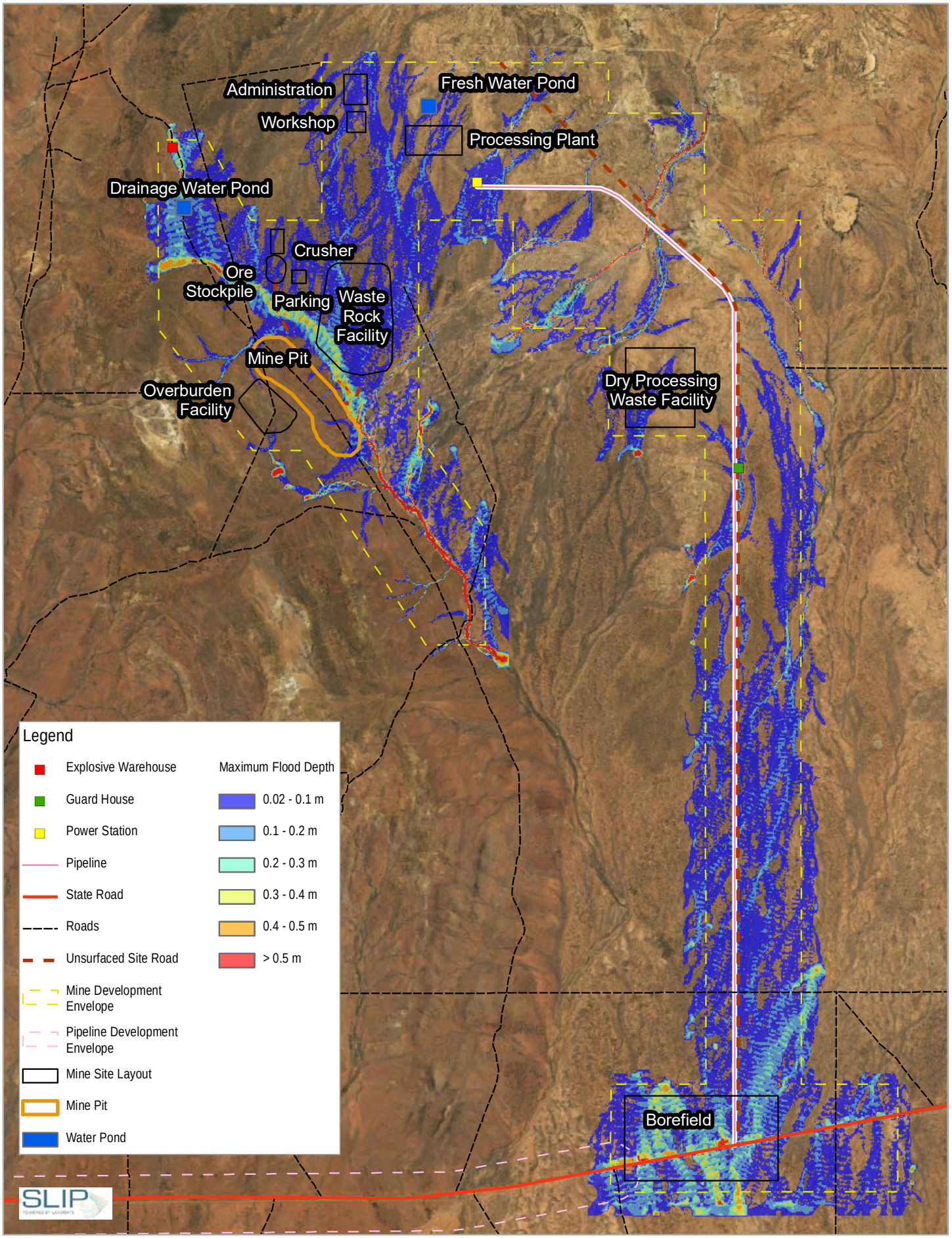
1% AEP Flood Depths and Extents

Project No. 61-37117
Revision No. 0
Date 26 Feb 2020

FIGURE 10-3

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_010-3_FloodDepthsExtents_1%_rev0.mxd
Print date: 26 Feb 2020 - 16:09

Data source: GHD: Flood depths - 20190225; MRWA: State Roads - 20171024; FIJV: Mine Tenements, Mine Site Layout, Development Envelope, Pipeline Development Envelope - 20171025; Landgate: Roads - 20180420; Imagery. Created by: cgverzosa




1:85,000 at A4

0 1 2 3 4 Kilometers

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

2% AEP Flood Depths and Extents

Project No. 61-37117
Revision No. 0
Date 26 Feb 2020

FIGURE 10-4

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_010-4_HydroCatchmentsRegional_rev0.mxd
Print date: 26 Feb 2020 - 16:12

Data source: GHD: Flood depths - 20190225; MRWA: State Roads - 20171024; FIJV: Mine Tenements, Mine Site Layout, Development Envelope, Pipeline Development Envelope - 20171025; Landgate: Roads - 20180420; Imagery. Created by: cgverzosa

### 10.4.3 Hydrogeology

#### *Local geology*

Banded iron formations (BIF) are located along the western sides of the proposed mine site, and form part of the north-south trending ridges and hills in the southern part of tenement E59/642 which rise ~100 m above the adjacent plains. The south eastern section of the proposed mine site lies in a region that forms part of the Moore Monger Paleovalley. The geology and landform within the paleovalley features flat land with deep alluvial soils that have undergone significant weathering over time. The north-eastern part of the mine site constitutes solid rock and alluvial areas which form part of the Woonjedie Hill geological formation.

Geological mapping (Geological Survey of WA, GHD 2018b) indicates that the MDE is characterised by the following lithology types:

- Sand (alluvial and eolian, unit *Qa* and *Qss*). Quaternary in age and mapped over the majority of the tenement excluding the north eastern higher ground, and the exposed BIF (mineral zone) in the far west).
- Granite (fine to medium, even grained, unit *Agif* and *Age*). Archaean in age and mapped in the far north eastern corner (in the location of the proposed borefield).
- Banded Iron Formation (*Norie Group*) Archaean in age and mapped in the far west (in the location of the orebody and proposed pit).

The majority of the MDE comprises alluvial and colluvial sediment (5,936.38 ha and 404.15 ha respectively). The remainder of the MDE is represented by sedimentary and igneous rock, silicate minerals and weather rock, with represents a fractured rock aquifer. These geologies are typically tight formations and although there may be some weathering and fractures throughout, they are not anticipated to represent optimal habitat for stygofauna.

#### *Local hydrogeology*

In the mine pit the groundwater levels were generally found to be around 20 m bgl, occurring at a reported elevation of approximately 355-365 m Australian Height Datum (GHD 2019f). Groundwater was inferred to occur within a fractured rock aquifer situated near and immediately below the base of weathering, typically 10 to 30 m bgl (GHD 2019f). Falling head tests completed on two open holes indicated an inferred hydraulic conductivity of 1.4 to 1.8 x $10^{-7}$ m/s (0.01-0.02 m/d) (GHD 2019f).

The figure indicated that groundwater levels are broadly consistent with topography, and indicate a dominating groundwater high point coincident with the topographic high located approximately 40 km north east of the Pit area. Data for the Project area indicates that groundwater is generally flowing in the southern direction, discharging to the low ground present along the current drainage line of the Salt River. There is a groundwater divide, consistent with the catchment divide, located along the higher ground present to the immediate west of the mine pit area.

There are two main aquifers identified within the MDE, this includes the palaeovalley aquifer, which is largely an alluvial aquifer present within existing and paleo-drainage areas. Drilling completed for the Proposal identified that this aquifer was typically silt/fine grained sand dominated, and present up to a maximum depth of around 70 m in the far south of the MDE. Under the BIF landform, and further west, a fractured rock aquifer has been identified, with the majority of groundwater flow occurring in the upper zone of weathering (up to a nominal depth of around 60 m) (GHD 2019f).

### *Groundwater quality*

Groundwater quality between the palaeovalley (southern area of the MDE) and the pit area (northwest area of the MDE) were noted to have a significant difference in quality (GHD 2019f). Salinity was notably higher in the paleovalley area, with an average TDS of 10,000 mg/L, compared to just over 800 mg/L recorded in the pit area (GHD 2019f). Groundwater with a salinity greater than 5000 mg/L is considered unsuitable for stock watering. The relatively fresh groundwater (low salinity) found at the pit bores is indicative of those bores being close to a groundwater recharge area.

Nutrient concentrations are generally quite low for throughout the MDE; however, the mine pit area was noted to have a higher concentrations of nitrogen, predominately as nitrate. This may be related to naturally occurring sources and/or surface water runoff (resulting in recharge) in areas that are occupied by cattle. Metal concentrations were generally quite low for all test bores with no exceedance of any assessment criteria.

### *Wetlands and Groundwater Dependent Ecosystems*

The botanical assessment in Section 5.4.2 did not identify any wetlands or Groundwater Dependent Ecosystems within or in proximity to the MDE.

## 10.4.4 Groundwater modelling

Groundwater dewatering will be required in order to safely access the mine pit. At this stage the groundwater requirements are approximately expected to match the groundwater drawdown. However, it is expected that the borefield will also be used at some stages to supplement groundwater supply.

A groundwater model was developed to assess the availability of groundwater from the mine pit and borefield. In assessing the availability of water the extent of groundwater drawdown was also determined.

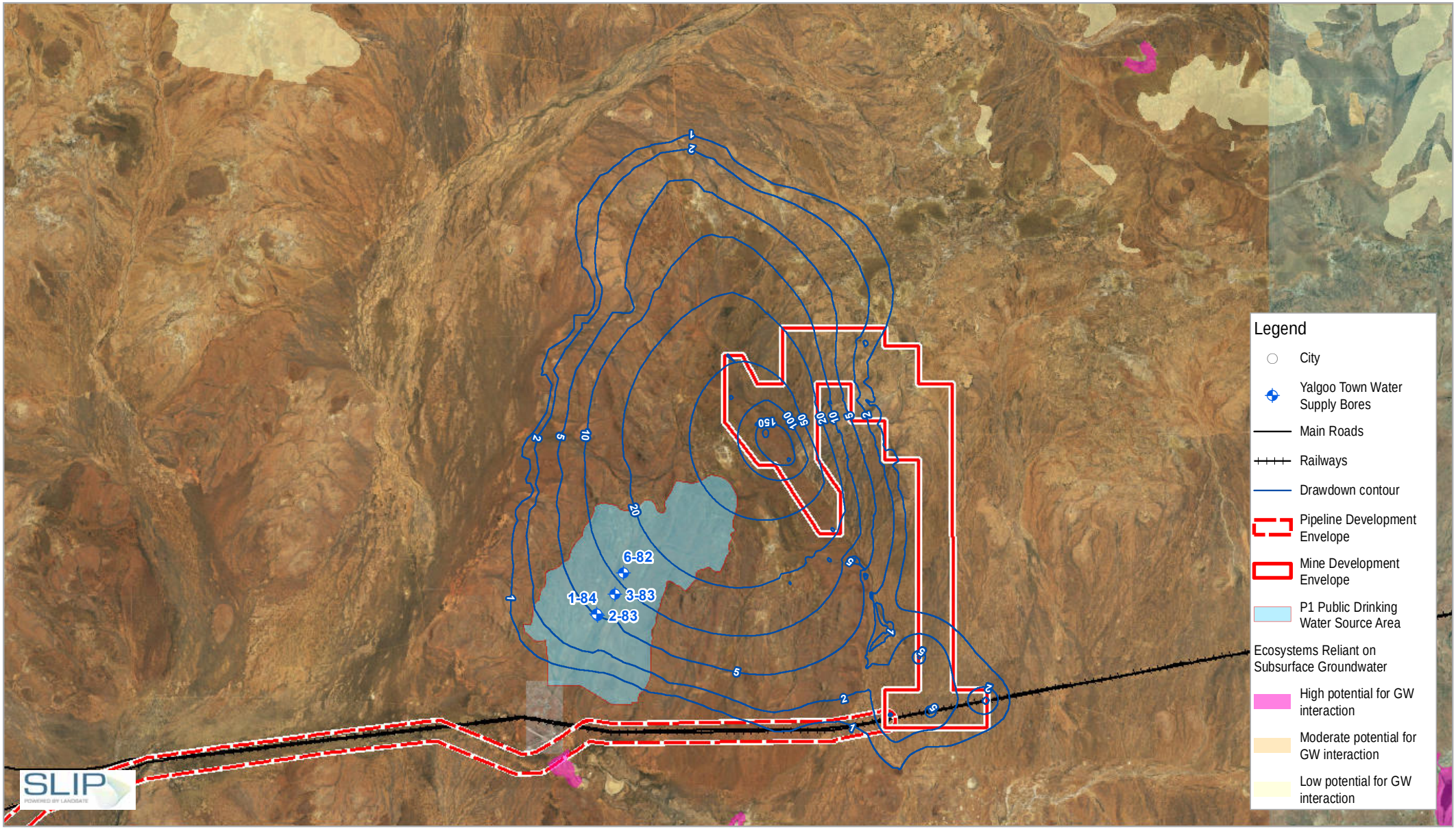
Based on the modelling results, a total of up to 5.0 GLpa is expected to be possible from the mine site. The bores in the borefield are expected to produce <1.0 GLpa to supplement the 4.0 GLpa balance from the mine pit dewatering. Due to the separation requirements between the bores in the borefield only four bores could be used within the current tenure held by FIJV.

Figure 10-5 presents the extent of the groundwater drawdown at the end of mine life (21 years). The one (1) metre contour representing the extent of impact detectable in relation to natural water level variability is expected to extend up to 16 km from the mining pit at its furthest. Figure 10-6 presents the estimated drawdown at different stages of the mining process, including at the completion of mining (after 21 years), which will reach a maximum depth at 125 m AHD, i.e. approximately 225 m below the pre-mining water level.

The potential for the formation of a mine pit lake after closure was assessed as part of the modelling component of the Hydrogeological Investigation (GHD 2019f). The pit lake is predicted to be groundwater sink (terminal lake) and its cone of depression will reach equilibrium after about 150 years following the cessation of mining. The cone of depression will be wide, but shallow.

At 100 years, the extent of the 1 m drawdown is seen at a maximum distance of 16 km to the north and south west of the Pit. There is only a marginal difference between the 100 year and 500 year drawdown, with drawdown extending to the south west for the 500 year results, to a maximum distance of 17 km from the pit.

The model also predicts a relatively linear increase in salinity in the lake. The predicted salinity (as TDS) for 10, 20, 50, 100 and 500 years after cessation of dewatering are 1,035 mg/L, 1170 mg/L, 1600 mg/L, 2355 mg/L and 8800 mg/L respectively.




Paper Size ISO A4

0 2 4 6 8 10

Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

FI Joint Venture Pty Ltd
Environmental Review Document

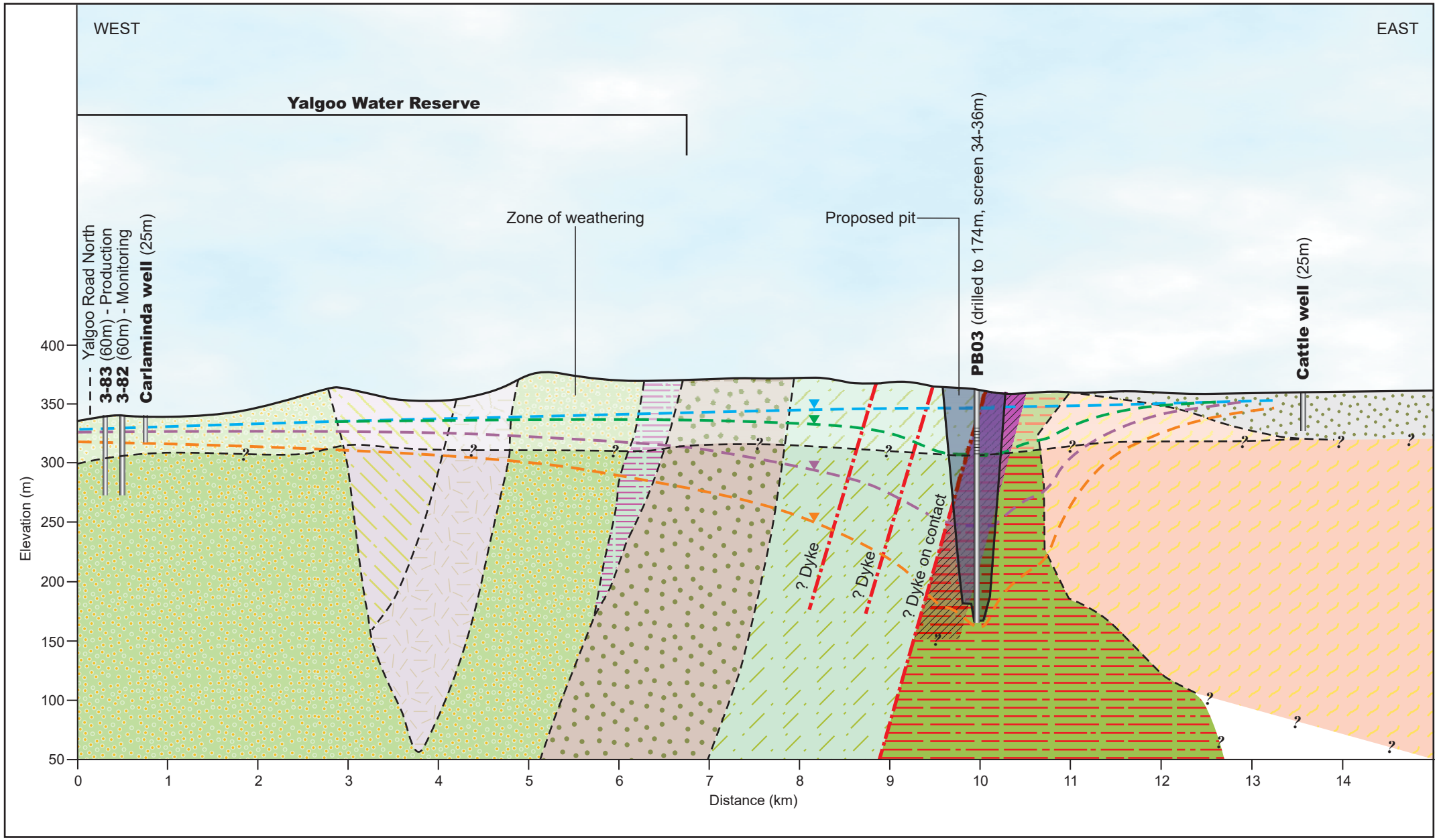
Extent of Groundwater Drawdown at End of Mine (Year 21)

Project No. 61-37117
Revision No. 0
Date 26 Feb 2020

FIGURE 10-5

G:\61\37117\GIS\Maps\Working\Environmental Review Document\6137117_010-5_ExtentofGWDrawdown_rev0.mxd
Print date: 26 Feb 2020 - 16:39

Data source: GHD: Pipeline Corridor and Pipeline Development Envelope - 20190124, Drawdown contours - 20191002; DSEWPaC: IBRA Regions - 20130118; Landgate: Roads - 20190128, Railway - 20190304, Imagery. Created by: cgverzosa




LEGEND

- Mugs Luck Basalt Member
- Carlaminda Komatite Member
- Warriedar Suite
- Wadgingarra Gabbro
- Mougooderra Formation
- Olive Queen Gabro
- Norrie Group
- Big Bell Suite
- Alluvials
- Zone of BIF mineralisation
- Existing water table pre-mining
- Drawdown - 5 years of mining
- Drawdown - 10 years of mining
- Drawdown - end of mine

FIJV
Yogi Magnetite Project

Yogi Regional Hydrogeological Cross Section

| | |
|---|---|
| Job Number | 12-521047 |
| Revision | A |
| Date | 13 Feb 2020 |

Figure 10-6

AU\Launceston\Projects\12\5210477\12521047_LTN_01.cdr



999 Hay Street Perth WA 6000 Australia **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com **W** www.ghd.com

### 10.4.5 Ore and waste characterisation

Potentially acid forming (PAF) material when exposed to oxygen and water can result in the leaching of sulfuric acid. PAF materials contain sulfidic compounds (such as pyrite) that are exposed during the mining process. The production of sulfidic acid during the oxidation process has the potential to mobilise heavy metals and metalloids into the environment. Downstream vegetative and aquatic ecosystems are at risk of being affected through both acidification and heavy metal contamination. A materials characterisation assessment (GHD 2019d) was undertaken to understand the leaching potential, particularly acid and metalliferous drainage (AMD), of the Project's ore and waste materials.

#### *Assessment of acid potential*

The ore body and waste material exhibit relatively low concentrations of sulfur, assumed as sulfide (0.11% S), as shown in Table 10-3, which presents the sulfur statistics data. Net Acid Production Potential (NAPP) was calculated to be 3.36 kg $H_2SO_4$/ tonne for both the waste-rock and the ore. According to the Department of Industry, Tourism and Resources (DITR) (2007) guidelines on AMD, the ore and waste material are "Potentially Acid Forming – Low Capacity". The risk that strong acidic conditions could develop on site is probably unlikely. However, further data/information is required to quantify the buffering capacity, and provide confidence that acidic conditions will not prevail at concentrations that will cause concern. Further material characterisation investigations are accounted for in the MCP (GHD 2019c) and completion is to occur in the short to medium-term.

Table 10-3 Summary of sulfur (%) occurrence based on rock type (GHD 2019d)

| Rock ID | Count | Minimum | Maximum | Average |
|---|---|---|---|---|
| **Waste rock:** | | | | |
| Felsic | 431 | 0.001 | 5.46 | 0.15 |
| Mafic | 224 | 0.001 | 0.49 | 0.08 |
| Misc | 25 | 0.001 | 0.52 | 0.06 |
| Pyroxenite | 3 | 0.002 | 0.02 | 0.01 |
| Regolith | 40 | 0.001 | 0.41 | 0.03 |
| Sedimentary | 32 | 0.001 | 0.04 | 0.01 |
| Talc-chlorite | 72 | 0.001 | 0.61 | 0.04 |
| BIF (<20% Fe) | 1747 | 0.001 | 5.32 | 0.11 |
| **Ore:** | | | | |
| BIF (>20% Fe) | 3950 | 0.001 | 5.01 | 0.11 |

#### *Assessment of metal leaching potential*

The available metals data from the mineralogical database shows that a total of 12 metals and elements have been assayed within the ore and the waste rock. The 12 metals and elemental average concentrations have been compared to the reference concentration (global abundance) to assess the relative enrichment, with the following results:

- Iron, silicon and aluminium and lead are relatively enriched in all waste rock types and ore material, at two to three times the reference concentrations.
- Chromium and nickel indicate relative enrichment in a few of the waste rock types associated with mafic composition (pyroxenite, talc-chlorite schist and BIF (< 22% Fe), and felsic units).
- Titanium enrichment is restricted to the regolith rock type, presumably as a consequence of deflationary style weathering.

- Zinc, copper and cobalt are not relatively enriched in all waste rock types and ore material.

Given the assessment of “Potentially Acid Forming – Low Capacity” conditions at the site, high concentrations of dissolved metals in groundwater are not anticipated. However, dissolved metals can occur at concentrations that may be of concern to the human health and the environment under mild acid conditions, which until testing confirms, cannot be excluded from developing in the waste rock and processed waste material (GHD 2020b).

#### *Assessment of saline drainage potential*

Although the detailed mineralogy of the waste rock is not available, the dominant iron and silicic mineralogy of the BIF and the volcanic nature of the footwall and hanging wall lithologies may preclude the presence of readily dissolvable minerals (e.g. halite, gypsum, carbonate, sulfur). Confirmatory testing is considered necessary to demonstrate that the risk of adverse saline impacts, derived from leaching from the waste rock and processed waste material is considered low (GHD 2019d).

Further details on the materials characterisation are presented in Appendix B.

### 10.4.6 Onsite water use

Near-mine bores will supply water for early works, construction, initial operations phases, and potable purposes. In-pit sump/pumps and return water from Geraldton Port will ultimately supply water for later operations stages. Dewatering water will also be used for processing.

Water is also proposed to be supplied from a proposed borefield on site, which has been assessed as part of this environmental review. Water requirements for the Yogi project are expected to be up to 5 GLpa, which would be supplied from the borefield.

The preferential use of surplus dewatering water to meet operational water demand at the proposed Yogi operations will reduce reliance on abstraction from the borefield for water supply.

Groundwater abstraction will be managed under a Groundwater Licence issued by DWER, and associated Groundwater Operating Strategy.

### 10.4.7 Pipeline water crossings

An analysis of pipeline route (Table 10-4) identified that 19 watercourse crossing will be required over the ~250 km pipeline route. While the exact pipeline route is subject to further optimisation based on stakeholder feedback, the number of water crossing required is not expected to changes as the majority encountered flow north-south.

All watercourses identified are non-perennial (i.e. ephemeral). On this basis open trenching is considered the most appropriate construction methodology.

A Bed and Banks Permit under the RIWI Act will be required to construct the pipeline through these watercourses. Following finalisation of the pipeline route applications will be submitted. Relevant approvals under the AH Act will also be obtained where the watercourses are also Registered Sites/ The ongoing stakeholder consultation program is being undertaken to determine the most appropriate location for these watercourse crossings.

Table 10-4 Watercourse crossing requirements

| Pipeline Water Crossing ID | Watercourse Name | Approximate Crossing Width | Duration of Flow | Water Course Profile | Indicative Crossing Strategy |
|---|---|---|---|---|---|
| 1 | Unnamed | ~60 m | Minor non perennial | Defined | Open trench |
| 2 | Chapman River East | ~50 m | Minor River Non Perennial | Defined | Open trench |
| 3 | Unnamed | ~40 m | Minor non perennial | Defined | Open trench |
| 4 | Unnamed | ~30 m | Minor non perennial | Braided | Open trench |
| 5 | Greenough River | ~150 m | Major River Non Perennial | Defined | Open trench |
| 6 | Kockatea Gully | ~230 m | Major River Non Perennial | Braided | Open trench |
| 7 | Wooderarrung River | ~60 m | Minor non perennial River | Defined | Open trench |
| 8 | Winmilla Creek | ~30 m | Major tributary non perennial | Defined | Open trench |
| 9 | Irwin River North | ~150 to 650 m | Minor River Non Perennial | Braided | Open trench |
| 10 | Irwin River North | ~200 to 350 m | Minor River Non Perennial | Defined | Open trench |
| 11 | Unnamed | ~60 m | Minor non perennial | Defined | Open trench |
| 12 | Unnamed | ~30 m | Minor non perennial | Defined | Open trench |
| 13 | Unnamed | ~150 to 250 m | Minor non perennial | Braided | Open trench |
| 14 | Unnamed | ~20 m | Minor non perennial | Defined | Open trench |
| 15 | Unnamed | ~90 m | Minor non perennial | Defined | Open trench |
| 16 | Unnamed | ~50 to 75 m | Major non perennial | Defined | Open trench |
| 17 | Salt River | ~200 to 580 m | Minor River non perennial | Braided | Open trench |
| 18 | Salt River | ~1,000 to 3,000 m | Minor non perennial | Braided / Ponded | Open trench |
| 19 | Unnamed | ~30 m | Minor non perennial | Defined | Open trench |

## 10.5 Potential impacts

The following potential impacts and risks associated with changes to surface water and groundwater quality as a result of the implementation of the proposed Yogi operations were identified:

Direct Impacts

- Alteration to surface water flows as a result of mining and infrastructure construction and operations, including potentially altering natural erosion and deposition patterns which could increase the surface water turbidity (Section 10.6.1)
- Alteration of the hydrology of the area from groundwater abstraction (Section 10.6.2)
- Impacts to inland wetland communities or groundwater dependent ecosystems as a result of groundwater drawdown (Section 10.6.3)
- Indirect Impacts
- Contamination of surface water associated with Acid and Metalliferous Drainage (Section 10.6.4)
- Groundwater contamination from Acid and Metalliferous Drainage (Section 10.6.5)
- Impacts to inland wetland communities or groundwater dependent ecosystems as a result of groundwater drawdown and changes to groundwater quality (Section 10.6.6).

## 10.6 Assessment of impacts

### 10.6.1 Alteration to surface water flows

#### Mine site

Some alteration of the surface water flows may occur due to mitigation measures to prevent flooding of areas nominated to be developed as part of the Proposal. The mine pit is currently proposed to be located in an area adjacent to the WPW, and is at a potential risk of flooding without diversion of this watercourse, particularly along its south-eastern end. The WRD is also located within a zone that is characterised by flat low-lying topography, and may require water diversion structures. Diversion of flows west of the overburden facility and north of the Mine Pit is also expected to be required to minimise erosion of the overburden and Mine Pit walls, and to minimise ingress of water into the Mine Pit.

Typical of the area, the watercourses in the area are ephemeral and only flow in response to substantial rainfall events. Based on these flow conditions any flows are expected to be highly turbid. On this basis any minor changes in flow velocities, associated with the construction of flood protection, are not expected to result in any measurable change in sediment load of the watercourses.

Rainfall and surface water runoff from mining areas has the potential to increase sediment-laden water and the mobilisation of fine-grained ore, which can discharge into natural drainage systems and surface waters. The site is an active pastoral station and there was evidence of erosion found across the proposed mine site. Rill erosion was found in sheetflow prone areas on the low-lying alluvial plains, bank erosion within some water courses, and live-stock traffic induced erosion within the primary unnamed watercourse located on the western side of the site adjacent to the proposed mine pit.

Further, the Drainage Water Pond, Explosives Warehouse, Crusher, Ore Stockpile, and WRF are located in areas of potential sheetflow occurrence, and as such drainage controls would be required in these to minimise structural impacts.

### Pipeline corridor

The construction of the pipeline corridor has the potential to alter surface water flows due to the presence of linear infrastructure. There are 19 non-perennial (i.e. ephemeral) watercourses which have been determined to intersect the pipeline corridor. The majority of these watercourses are minor, with only four watercourse being major rivers/tributaries.

Significant impacts to surface water flows are expected to be avoided by burying the pipelines under water crossings so not to affect natural surface water flows. Following finalisation of the location of the water crossings detailed construction strategies will be required.

### 10.6.2 Alteration of hydrology from groundwater abstraction

The extent of drawdown from groundwater abstraction will not extend to any major watercourse or permanent waterway. The drawdown will extend within the area of the WSW, which is in the immediate vicinity of the mine pit. As flow within the WSW only occurs in response to substantial rainfall in the local area, the groundwater abstraction is not expected to affect the hydrology of the WSW or any other surface water feature.

Overall the groundwater flow is approximately to the south. The abstraction of water will affect the groundwater hydrology of the local area. No environmental uses of the water (i.e. wetlands or GDEs) have been identified; however, the drawdown will intersect the Public Drinking Water Source Area for Yalgoo. Yalgoo currently only has a population of 120 people. The drawdown in the Public Drinking Water Source area is not expected to affect the supply of water to the town. FIJV will undertake any additional drilling required to ensure continuation of water supplies to the town.

FIJV are undertaking ongoing consultation with the Water Corporation regarding proposed mitigation strategies which would be implemented in the event drawdown effects the Yalgoo Town Water Supply (TWS). These mitigation measures are outlined in Table 10-6.

As groundwater modelling has shown, the development of a pit lake would lead to a maximum of 1 m drawdown at its furthest, 17 km, from the pit lake at 500 years post closure, which is only 1 km larger than the extent at end of mine (21 years). Due to the shallow drawdown predicted, the presence of a pit lake it is not expected for the regional hydrology to be altered.

### 10.6.3 Impacts to inland wetland communities or groundwater dependent ecosystems as a result of groundwater drawdown

As shown in Figure 10-5, the identified GDEs will not be affected by the drawdown. The GDEs are more than 1 km from the extent of drawdown.

### 10.6.4 Contamination of surface water due to AMD

The quality of surface water may be reduced through contamination from AMD as a result of mine construction and operations. The potential negative impacts to surface water quality from AMD generated during the mining process are considered to be low. The materials characterisation (GHD 2019d) concluded that risks relating to AMD appear to be low based on a waste rock/ore classification of “Potentially Acid Forming – Low Capacity” (Section 10.4.5). Although additional materials data is necessary to further characterise the risk, it is not expected that there is a likelihood of significant adverse impacts to surface water quality from AMD.

### 10.6.5 Groundwater contamination from AMD

The quality of groundwater may be reduced through contamination from AMD as a result of mine construction and operations. The potential for groundwater contamination from AMD is low as the materials characterisation (GHD 2020b) concluded that risks relating to AMD appear to

be low based on a waste rock/ore classification of “Potentially Acid Forming – Low Capacity” (Section 10.4.5). Also, according to the CSIRO’s Australian Soil Resource Information System (accessed 5 May 2019), the MDE lies within a region mapped as low acid sulfate soil probability. Although further materials data is necessary to further characterise the risk, it is not expected that there is a likelihood of significant groundwater contamination from AMD.

### 10.6.6 Impacts to inland wetland communities or groundwater dependent ecosystems from changes to groundwater quality

As identified in Section 10.6.3, no GDEs have been identified within or in proximity to the MDE. Sections 10.6.4 and 10.6.5 identified that contamination of surface water or groundwater would be unlikely. On this basis it is unlikely that there would be any impact to wetland or GDEs as a result of changes to groundwater quality.

### 10.6.7 Cumulative impacts

A review of the environmental approval documentation that is publicly available of other developments within proximity to the site was completed, and a summary of their impacts have been provided in Table 10-5. The following assessment of cumulative impacts have been made.

- Due to the distance between Yogi mine and other developments, there are no anticipated cumulative impacts relating to groundwater. None of the Projects abstract groundwater from the same aquifer, and the cone of depression from drawdown is not anticipated to overlap
- The distance between Yogi mine and other developments indicates that there are no cumulative impacts relating to surface water. None of the Projects intercept or impact on the same river system, which indicates that there will be no cumulative impacts to environmental or surface flows, downstream sedimentations or to riparian vegetation and wetland communities.

Table 10-5 Cumulative impacts: mining operations

| Variable<br>Company | Karara Mining Ltd | Mount Gibson Mining Limited | Gindalbie Metals Ltd | Top Iron Pty Ltd. |
|---|---|---|---|---|
| Type | Magnetite Iron Ore | Iron Ore | Iron ore | Iron Ore |
| Groundwater constraints | Construction: Bores at the mine site and pit dewatering from Silverstone Mine Up to 2.3 GL over 18 months.<br>Water supply: Borefield near Mingenew and bores at the mine site<br>Required: Approximately 6.6 GLpa of process water to produce 12 Mtpa of concentrate, and supply all potable water (accommodation village, offices and workshops). | Mining is proposed above the groundwater level, so dewatering is not required.<br>The proposal requires abstraction of groundwater for dust suppression. | Dewatering flow rates are indicated to peak at 3,900 kL/d but will generally be less than 2,000 kL/d.<br>Localised drawdowns during dewatering are expected to extend up to 700 m east and west of the pit, and 800 to 1,000 m to the north and south. | Dewatering is not required (the pit is 5 - 10 m deep, whereas the groundwater table is at approximately 40 m).<br>Dry processing is being utilised – therefore a borefield is not required to supply a wet processing plant. All other water needs will be trucked or piped from a separately approved off site source. |

| Variable Company | Karara Mining Ltd | Mount Gibson Mining Limited | Gindalbie Metals Ltd | Top Iron Pty Ltd. |
|---|---|---|---|---|
| Surface water constraints | There exists three drainage depressions, two claypans and several drainage lines. These collect water following heavy rainfall, however the average annual rainfall is less than 360 mm.<br>Impacts to surface water flows should be localised, temporary and of no overall detriment to the environment. | No information available | Minor drainage lines only exist within the development envelope.<br>The impact from the project to stormwater flows is considered insignificant. | Ephemeral surface water drainage: There is no permanent running water but an ephemeral creek occurs in the centre of the tenement and there are numerous small gullies indicating seasonal surface drainage. |

## 10.7 Mitigation

The mitigation hierarchy (avoid, minimise, rehabilitate) has been applied to this proposal in relation to inland waters.

The inherent impacts that must be managed include:

- Alteration of the surface water hydrology as a result of mining and infrastructure construction and operations
- Potential contamination of surface water and groundwater, leading to biological impacts on flora and fauna.

Management and monitoring measures for the above impacts are well practiced and understood in the industry, and are considered to be effective.

Proposed mitigation measures to address the above potential impacts to inland waters are outlined in Table 10-6.

Table 10-6 Mitigation measures for impacts to inland waters

| Impacts | Mitigation Measures |
|---|---|
| Alteration to surface water flows | **Avoid**<br>• Where possible, mining infrastructure will be placed to avoid interaction with major surface water features such as the WPW, and minor surface water features.<br>• Pipelines in the PDE will be buried under water crossings to prevent the alteration of surface water flows.<br>**Minimise**<br>• Undertake design and construction of linear infrastructure corridors (access corridor, water pipeline) with the aim of minimising changes to the hydrology and geomorphology of the rivers and creek lines, and minimise the risk of exposure of dispersive soils.<br>• For the pipeline, this includes installing a control system which monitors pipeline flow and detects leaks, and inspections of the pipeline internally and from the ground, on an as needs basis (GHD 2020d, Appendix C).<br>• Install appropriate cross-drainage along linear infrastructure corridors (including access routes, haul roads and pipelines) to reduce the impact of the proposed infrastructure on the existing flow paths and sediment deposition during flood events.<br>• Install rock armour protection from scour and erosion along the edges of causeways.<br>• The explosives warehouse, drainage water pond, ore stockpile, processing plant, workshop, and administration at the mine site may need to be raised and/or armoured to avoid erosive or structural impacts to the waste rock.<br>**Rehabilitate**<br>• Areas affected by the mitigation measures put in place for the protection of the mine site from flooding risk will be rehabilitated in accordance with the MCP (GHD 2019c, Appendix D). |

| Impacts | Mitigation Measures |
|---|---|
| Alteration of hydrology from groundwater drawdown | **Avoid**<br>• Hazardous materials and waste will be subject to appropriate handling, storage and disposal procedures to avoid any impact on the environment.<br><br>**Minimise**<br>• Efficient water use onsite, including use of dry-stack tailings, to minimise groundwater requirements.<br>• The project drawdown cone will be monitored and shall not exceed 5 GLpa.<br>In consultation with the Water Corporation, FIJV have proposed the following mitigation strategies in the event dewatering at the mine adversely effects the Yalgoo TWS:<br>• Lowering the level of pumps in Yalgoo TWS bores<br>• Installation of additional production bores at a greater depth than the existing Yalgoo TWS bores<br>• Development of a new bore field location<br>• Providing water from the Project, either via water truck (short-term) or installation of pipeline (long-term). |
| Impacts to inland wetland communities or groundwater dependent ecosystems as a result of groundwater drawdown | No wetlands or GDEs in (or in proximity to) MDE will be affected by the drawdown, therefore no impacts expected. |
| Contamination of surface water associated with AMD<br>Groundwater contamination from AMD | **Avoid**<br>• Hazardous materials and waste will be subject to appropriate handling, storage and disposal procedures to avoid any impact on the environment.<br>**Minimise**<br>• If PAF material exists within the waste rock, it should be appropriately disposed of in a dedicated facility which is constructed in a way which will prevent acid generation.<br>• All critical infrastructure will need to have the necessary flood protection measures and stormwater will be separated into clean and dirty water diversion channels. This will reduce the likelihood of contamination of downstream waters.<br>• Any water discharged from the mine should be tested to confirm the suitability of discharge and/or treated to render the water suitable for discharge.<br>• Monitoring of the surface water and groundwater will be undertaken throughout mine construction, operations and closure to assess for potential contamination. |

| Impacts | Mitigation Measures |
|---|---|
| | **Rehabilitate**<br>• If surface water or groundwater is contaminated due to the Proposal, it will be remediated, as discussed in the MCP (Appendix D). |
| Impacts to inland wetland communities or groundwater dependent ecosystems as a result of changes to groundwater quality | No wetlands or GDEs in (or in proximity to) MDE will be affected by the drawdown, therefore no impacts expected. |

## 10.1 Predicted outcome

### 10.1.1 Residual impact

A summary of residual impacts after the implementation of the proposal and the application of the mitigation measures outlined in Table 10-6 above is provided in Table 10-7.

It is anticipated that the potential impacts on the surface water quality will be able to be adequately managed such that the environmental objective will be met.

Table 10-7 Residual impacts to Inland Water

| Impacts | Residual Impacts |
|---|---|
| Alteration to surface water flows | • Alteration of surface hydrology may be permanent in areas where significant changes have been made to the surface landforms.<br>• Minimal impacts to surface water quality are expected from sedimentation resulting from clearing and construction of mine infrastructure.<br>• With the proper implementation of the proposed mitigation measures, the residual impacts of the Proposal on surface water flows are not anticipated to be significant. |
| Alteration of hydrogeology from groundwater drawdown | • No changes to surface water hydrology<br>• Abstraction of water will affect the groundwater hydrology of the local area.<br>• While drawdown will intersect the Public Drinking Water Source Area for Yalgoo. Yalgoo currently only has a population of 120 people. The drawdown in the Public Drinking Water Source area is not expected to affect the supply of water to the town. FIJV will undertake any additional drilling required to ensure continuation of water supplies to the town. |
| Impacts to inland wetland communities or groundwater dependent ecosystems as a | • No wetlands or GDEs in (or in proximity to) MDE will be affected by the drawdown, therefore no impacts expected. |

| | |
|---|---|
| result of groundwater drawdown | |
| Contamination of surface water associated with AMD<br>Groundwater contamination from AMD | • Groundwater or surface water contamination from AMD has the potential to occur. However, this is unlikely due to the low risk associated with the waste materials.<br>• With the proper implementation of the proposed mitigation measures, the residual impacts of surface water and groundwater contamination from the Proposal are not anticipated to be significant. |
| Impacts to inland wetland communities or groundwater dependent ecosystems as a result of changes to groundwater quality | • No wetlands or GDEs in (or in proximity to) MDE will be affected by the drawdown, therefore no impacts expected. |

### 10.1.2 Assessment against the EPA objective

Following completion of the assessment and the residual impact outlined in Table 10-7, it is considered that the implementation of the proposal will not have significant residual impacts. As such, it meets the objective for this factor such that the hydrological regimes and quality of groundwater and surface water are maintained.

### 10.1.3 Offsets

This Proposal meets the EPA's objective for the inland waters environmental quality factor, with residual impacts not considered significant, and thus no offsets are proposed for this environmental factor.