Environmental Review Document

Mulga Downs Iron Ore Mine

Environmental Protection Act 1986
Assessment Number 2326

Hancock Prospecting Pty Ltd

ABN 69 008 676 417

29 August 2025

Revision Register

REV	DATE	AUTHOR	REVIEWER	APPROVED FOR ISSUE	DESCRIPTION OF CHANGES
0	15/06/2023	JBS&G	L. Taylor V. Campagna	S. Blake	FIRST DRAFT
1	28/03/2024	JBS&G	V. Campagna S. Goldsworthy	K. Frehill	Updated assessment report following s43A and agency RFI from first draft ERD
2	20/12/2024	JBS&G	B. McGuire	J. Huang	Updated in response to EPA RFI dated 4 July 2024 and s43A approval dated 4 October 2024
3	2/04/2025	JBS&G	B. McGuire		Updated in response to EPA RFI dated 20 March 2025
4	10/04/2025	JBS&G	B. McGuire	J. Huang	Finalised for publication.
5	29/08/2025	HanRoy / JBS&G	B. McGuire	B. McGuire	Document updated to address EPAS comments and public submissions.

Invitation to make a submission

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

Hancock Prospecting Pty Ltd proposes to develop the Mulga Downs Iron Ore Mine located 210 km south of Port Hedland and 180 km north west of Newman in the Pilbara Region of Western Australia. This Environmental Review Document (ERD) has been prepared in accordance with the EPA's ***Procedures Manual.*** The ERD is the report by the proponent on their environmental review which describes this Proposal and its likely effects on the environment.

The ERD is available for a public review period of **6** weeks from **17 April 2025**, closing on **3 June 2025**.

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

Why write a submission?

The EPA seeks information that will inform its consideration of the likely effect of the Proposal, if implemented, on the environment. This may include relevant new information that is not in the ERD, such as alternative courses of action or approaches.

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

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

Why not join a group?

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

Developing a submission

You may agree or disagree with, or comment on information in the ERD.

When making comments on specific elements in the ERD:

- clearly state your point of view and give reasons for your conclusions
- reference the source of your information, where applicable
- suggest alternatives to improve environmental outcomes.

What to include in your submission

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

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

The closing date for public submissions is: **3 June 2025.**

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

Alternatively, submissions can be:

posted to: Chairman, Environmental Protection Authority, Locked Bag 10, Joondalup DC WA 6919, or

delivered to: Environmental Protection Authority, Prime House, 8 Davidson Terrace, Joondalup 6027.

If you have any questions on how to make a submission, please contact EPA Services at the Department of Water and Environmental Regulation on 6364 7000.

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Executive Summary

Hancock Prospecting Pty Ltd (HPPL, the Proponent) is proposing to develop the Mulga Downs Iron Ore Mine (MDIOM, the Proposal), located approximately 210 kilometres (km) south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia. The Proposal will produce up to 12 million tonnes per annum (Mtpa) of iron ore and have an operational life of approximately 18 years. The Proposal is a new asset that will contribute to maintaining the supply of iron ore product for HPPL customers through port facilities located at Port Hedland.

The Proposal is being assessed under Part IV of the *Environmental Protection Act 1986* (EP Act). The Proposal has also been separately referred for assessment under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) (EPBC 2021/09255). The assessment process by the Commonwealth is not an accredited assessment. This ERD has been prepared for assessment under Part IV of the EP Act and provides an assessment of key environmental factors which fall under the EP Act. MNES are being assessed separately by the Commonwealth under the EPBC Act.

A Development Envelope approach has been proposed for this Proposal, which allows for flexibility in respect to the Proposal footprint. The Proposal footprint is considered indicative and is referred to as the Indicative Footprint for the purpose of the impact assessment. As the planning and design of the mine progresses and studies that inform the assessment are completed, changes may occur to the Indicative Footprint to apply the mitigation hierarchy and further reduce and prevent potential environmental impacts.

The Proposal extent is a Development Envelope of 16,848.53 hectares (ha) within which up to 4,339.16 ha of vegetation will be cleared.

The Proposal description and Proposal Content Elements are outlined below in **Table ES 1** and **Table ES 2.**

Table ES 1: General Proposal Description

Proposal title	Mulga Downs Iron Ore Mine (Proposal)
Proponent name	Hancock Prospecting Pty Ltd (HPPL)
Short description	The Proposal is for the development of the MDIOM located approximately 210 km south of Port Hedland and 180 km north west of Newman in the Pilbara Region of Western Australia (refer to **Figure 2-1**). The Proposal includes and is not limited to the following: • The development of a series of above and below water table mine pits; • Dry ore crushing and screening plant(s); • Groundwater abstraction for water supply (for the mine and all associated infrastructure) and for the dewatering to facilitate the recovery of ore below water table in the mine pits; • Surplus water management via managed aquifer recharge (MAR) and/or in pit infiltration; • Waste rock dumps (WRD); • Infrastructure to manage surface water (diversion of creeks and surface water flows); • Linear infrastructure (haul roads, powerlines, pipelines and conveyor corridors); • Mine associated infrastructure and support facilities (including, but not limited to accommodation camp, energy supply infrastructure, airstrip; wastewater treatment plant; landfill, offices, workshops, laydown areas, etc.); and • Transport of the ore via the Great Northern Highway to Port Hedland or via road to a siding along the existing Roy Hill railway and then via that railway to Port Hedland for export. Future transport options (e.g. rail) will be subject to a separate referral. • The Proposal is located within a 16,848.53 ha Development Envelope and will require the clearing of up to 4,339.16 ha of native vegetation.

Table ES 2: Proposal Content Elements

Proposal Element	Location / Description	Maximum Extent, Capacity or Range
Physical Elements		
Mine elements, including: • Series of open pits (above and below water table); • WRDs; • Topsoil stockpiles; and • Dewatering.	Within the Development Envelope	Clearing of up to 4,339.16 ha of native vegetation within the 16,848.53 ha Development Envelope.
Processing elements, including: • Ore stockpiles; • Crushing and screening plant(s); • Dry crushing and screening plant; • Transfer water dams/ponds.		
Infrastructure elements, including: • Accommodation camp; • Energy supply infrastructure; • Road haulage of ore from the mine to Port or Rail Siding; • Conveyors for the transportation of ore; • Bore fields/water reinjection infrastructure; • Mine workshops & infrastructure; • Pipelines; • Haul and light vehicle roads; • Ancillary buildings (e.g. workshops, telecommunications, offices); • WWTPs; • Landfill; • Hydrocarbon storage; • Explosive mixing and storage facility; • Laydown areas; • Evaporative ponds; • Water diversion channels and catchment ponds; and • Above ground water storage dams to manage supply or disposal of clean or mine water.		
Operational elements		
Groundwater abstraction for water supply and mine dewatering	Within the Development Envelope	Over the life of the mine, it is anticipated that the water extraction requirements may reach up to 12 gigalitres per annum (GL/a),

Proposal Element	Location / Description	Maximum Extent, Capacity or Range
		due to mine dewatering and water supply requirements. Consideration may be given to the use of a water treatment facility (i.e., reverse osmosis desalination) should it be required to provide the necessary water quality.
Management of surplus water	Within the Development Envelope	Up to 11 GL/a to be disposed of through MAR and/or infiltration within the Development Envelope. Temporary water storage may be required to assist in the management of water quality for supply or prior to discharge.
Evaporation ponds	Within the Development Envelope	May be required to assist in the management of surplus water and discharge. These will preferentially be located in disturbed areas such as pit voids, however some ex-pit structures may be required within the WRDs.
Crushing and screening plant(s)	Within the Development Envelope	Dry processing of ore to produce up to 12 Mtpa of iron ore product.
WRD	Within the Development Envelope	Approximately 160 Mt of waste rock will be mined throughout the life of the Proposal. WRDs will be designed to integrate into the surrounding landforms where possible, with a maximum height defined by waste rock characterisation studies.
Proposal elements with greenhouse gas emissions		
Construction elements- Annual average		
Scope 1	62,393 t CO_2-e based on 2 year construction period	
Scope 2	0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).	
Construction elements- Over period of construction		
Scope 1	124,786 t CO_2-e over ~2 years	
Scope 2	0 t CO_2-e (operational electricity demand met by on-site generation and included in Scope 1 emissions)	
Operation elements- Annual average		
Scope 1 unmitigated	250,079 t CO2-e	
Scope 1 mitigated	100,000 t CO2-e	
Scope 2	0 t CO_2-e (operational electricity demand met by on-site generation and included in Scope 1 emissions)	
Commissioning		
Commissioning of the processing facility will be undertaken subject to the operational limits above.		

Proposal Element	Location / Description	Maximum Extent, Capacity or Range
Rehabilitation		
Where practicable, progressive rehabilitation will be undertaken over the LoM. Areas disturbed through the implementation of the Proposal will be designed to be safe and non-polluting and will be constructed so the final shape, size, stability, are comparable with the natural landforms in the area.		
Other elements which affect extent of effects on the environment		
Proposal duration	Maximum Proposal life	18 years

The EPA identified the preliminary key environmental factors for the Proposal as:

- Inland waters (**Section 7**);
- Subterranean fauna (**Section 8**);
- Flora and vegetation (**Section 8**);
- Terrestrial fauna (**Section 10**);
- Terrestrial environmental quality (**Section 11**);
- Greenhouse gas emissions **(Section 12**);
- Air Quality (**Section 13**), and
- Social surroundings (including Aboriginal heritage) (**Section 14**).

A summary of the potential impacts identified for each key environmental factor are summarised in **Table ES-3**, along with details of the proposed mitigation and management measures.

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

Inland Waters	
EPA Objective	"To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected"
Potential Impacts	**Direct Impacts: Surface Water** The identification of potential impacts from the Proposal on the hydrological environment was completed by comparing the proposed infrastructure layout to the existing catchments and baseline floor modelling results. Direct impacts to the hydrological environment fall into the following categories (AQ2 2024b) • Modification of the existing hydrological regime, by increasing or reducing water availability within the downstream environment. This can have impacts both immediately downstream of the disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Project are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools. • Modification of the physical water quality (i.e. suspended sediments) in the downstream environment, which may be due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste rock dumps (among others). The environmental impacts from this would be increased sediment loads to the Fortescue Valley (including claypans and pools). • Modification of the chemical water quality (for example hydrocarbon pollution) resulting in contamination of local waterways and the Fortescue Valley. **Direct Impacts: Surface Water** Potential indirect impacts to surface water include changes to physical and chemical water quality through: • Leaks and spills from mine operations including vehicles, stored fuels, chemicals and hydrocarbons; • Acid mine drainage (AMD) leachate seepage from the WRD and to a lesser extent the run of the mine (RoM); and • Saline water runoff (dust suppression), saline pipeline leaks/failure. Modification of the chemical water quality (for example hydrocarbon pollution, seepage from WRDs) may result in contamination of local waterways and the Fortescue Valley. Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur. Use of saline water for the suppression of dust during construction and operations of the mine can result in increased surface water salinity entering onto the receiving environment (creeklines, claypans, pools and floodplains). There is also the potential for pipeline failure resulting in release of saline water into the receiving environment, including vegetation. **Direct Impacts** • Changes in groundwater levels (groundwater drawdown and groundwater mounding). • Changes to groundwater salinity. **Indirect Impacts: Groundwater** Potential indirect impacts to groundwater include: • Contamination through: o Spills and accidental discharged of stores materials (oils, fuels etc); o Leaching contaminants or acid mine drainage from WRDs or RoM and/or onsite landfill. • Impacts on other groundwater users through reduction in quantity or quality of groundwater available. **Cumulative Impacts:**

<table>
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- The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:
  - Changes in surface hydrological regimes.
  - Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR).

</td></tr>
<tr><td>Mitigation Hierarchy</td><td>

Avoid

- Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal
- Diver surface water flows away from mining areas to avoid the potential for contamination.

Minimise

- The Water Management Plan will be implemented.
- The surface water management during construction, mining and closure will be designed to minimise adverse impacts on the natural function and environmental value of watercourses water quality and sheet flow downstream of the mine area
- Adherence to permit requirements under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

Rehabilitate/ Monitor

- Implement the monitoring as outlined in the Water Management Plan.
- Implement the approved Mine Closure Plan (MCP).
- Temporary infrastructure will be removed and natural flow paths, and catchments, reestablished in these areas.

</td></tr>
<tr><td>Significant Residual Impact</td><td>The residual impacts of the Proposal to Inland Waters are not considered significant. HPPL therefore considers the Proposal can be managed to meet the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.</td></tr>
<tr><td rowspan="3">Proposed Environmental Outcomes</td><td colspan="2">Direct Impacts</td></tr>
<tr><td>Modifications to hydrological processes</td><td>

- Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. Water depth reductions of up to 0.2 m are predicted in some areas of valley floor ponding.
- No significant impacts to key environmental assets (including the claypans) are predicted.
- No impacts to terrestrial groundwater dependent ecosystems.
- Groundwater drawdown and catchment area modifications are not predicted to materially impact on the key ecohydrological receptors.
- The potential indirect impacts on claypans within the vicinity of the Development Envelope are not considered significant.

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<tr><td>Changes to surface water quality</td><td>

- The residual risks to the physical quality of surface water have been rated Low.
- Potential changes to surface water quality will be managed in accordance with the Water Management Plan.

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	Change to groundwater levels	• Potential changes to groundwater levels will be managed to ensure that mounding is maintained beneath root zones of vegetation. • Managed in accordance with the Water Management Plan.
	Changes to groundwater salinity	• Changes (and extent of changes) to groundwater salinity resulting from dewatering and MAR are predicted to be minor with respect to beneficial use and stygofauna habitat
	Indirect Impacts	
	Contamination of Surface Water	• Potential contamination of surface water will be managed in accordance with the MCP and Water Management Plan.
	Contamination of groundwater	• Potential contamination of groundwater will be managed in accordance with the MCP and Water Management Plan.
Assessment of Offsets (if relevant)	Not applicable.	
Subterranean Fauna		
EPA Objective	"To protect subterranean fauna so that biological diversity and ecological integrity are maintained" (EPA 2016a).	
Potential Impacts	**Direct Impacts: Troglofauna** The direct impacts to troglofauna from implementation of the Proposal are from the excavation of the mine pits (including some proposed borrow pit areas) and MAR leading to mounding. These impacts have the potential to result in: • Loss of troglofauna habitat; and • Loss of troglofauna species. **Indirect Impacts: Troglofauna** Indirect impacts to troglofauna have been identified as: • Clearing of vegetation and construction of infrastructure (i.e., WRD, RoM pads) – resulting in the loss of energy transfer to the subterranean environment); • Contamination of subterranean environment from mine activities – such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste dumps, and use of saline mine water for dust suppression in mine area; and • Changes to groundwater affecting humidity in vadose zone. **Direct Impacts: Stygofauna** The indirect impact which has the potential to effect stygofauna as a result of the Proposal is the contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste rock. There is the potential for contaminants to seep into the subterranean environment and be transported across the aquifer. There is the risk of contamination from hydrocarbon spills and leaching from the waste rock. The use of saline water within the mine area to suppress dust has the potential to increase salinity levels of surface water which move through into subterranean fauna habitat. These potential impacts may reduce the suitability of subterranean habitat. **Cumulative Impacts**	

	The proposal and other projects in the region may have a cumulative impact on subterranean fauna at a regional scale through: • Changes in surface hydrological regimes. • Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR). • Clearing, construction and operation of the Proposal.
Mitigation Hierarchy	**Avoid** • Complete avoidance is not possible for this Proposal; however, the Proposal has been designed so that excavation is contained to seven designate mine pits as per mining schedule. • Excavation of troglofaunal habitat is contained in seven mine pits. • The number of pits has been reduced and mining output has been reduced from20 Mtpa to 12 Mtpa avoiding troglofaunal habitat. **Minimise** • Excavate no more than 66,731.74 m^3 of Tertiary/Detritals identified as likely troglofauna habitat. • Limit the reduction of habitat to 274,648,900 m^3 of troglofauna habitat primarily in the CID/Pisolite. • Undertake pit construction in stages to manage dewatering and MAR requirements – optimise the West to East mining scenario as outlined in Water Management Plan. • Maintain the current beneficial use of groundwater as per the Water Management Plan, to limit the extent of groundwater extraction (and associated drawdown and MAR). • Maintain groundwater levels such that there is no surface expression of groundwater (as a result of MAR) limiting troglofauna habitat. • Implement management actions as defined in the Water Management Plan. • Apply the developed habitat assessment model to updated species list. • Loss of no more than 370,648,900 m3 of stygofauna habitat from extraction of mine pits for LoM • Implement mine schedule of staged pit excavation (optimise West to East mining scenario as per Water Management Plan). • Limit dewatering profile to that which is necessary for mining. • Limit MAR profile to that which is necessary for mining. • Backfilling of pits to reduce ex-pit WRDs. • Minimise the clearing of vegetation required where possible. • Design of potential contaminating facilities (landfill, WRD, TSF) to prevent seepage to surface water and/or groundwater. • Adhere to works approval and licence conditions under Part V of the EP Act. • Storage of contaminating materials in Australian Standard compliant locations with bunding, spill controls and leak prevention. • Saline water (> 5000 mg/L TDS) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation. • WRD to be designed in accordance with the MCP. • Design and construction of WRD with appropriate seepage and leachate control structures. • Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained.

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- Manage any spills including any contaminated material, in accordance with the internal procedures; and investigate and report incidents in accordance with internal procedures, to prevent the recurrence of incidents of the same or similar nature.
- Limit mounding to that which is necessary for mining.

Rehabilitate/ Monitor

- Develop and implement a MCP as approved by DEMIRS (as per the requirements of the Mining Act and DEMIRS Guidelines for Preparing Mine Closure Plan, March 2020).
- Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act..
- Implement monitoring as detailed in the Water Management Plan and SFMP.
- Backfilling of pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process.
- Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures.
- Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards.
- Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine in accordance with the Water Management Plan.

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<tr><td>Significant Residual Impact</td><td>

The significant residual impact of the Proposal to Subterranean Fauna, after the application of the mitigation hierarchy, is:

- The loss of up to 96,048,900 m^3 of troglofauna habitat from the excavation of pits.
- A reduction of up to 274,648,900 m^3 of troglofauna habitat as a result of changes to the groundwater levels from MAR reinjection.
- Loss of up to 370,648,900 m^3 of stygofauna habitat from dewatering of mine pits for LoM.
- The loss of stygofauna habitat as a result of changes to groundwater salinity from MAR and dewatering drawdown.
- There is potential to impact up to two troglofauna taxa which have not been found outside the mine pit and mounding areas.
- No stygofauna taxa will be lost. The data shows dispersal is possible from areas of impact to areas outside any impact from the Proposal. Up to 12 have been found to be limited to areas of impact, however there is no evidence of isolated or fragmentated habitat where these taxa were found.

Surveys for both stygofauna and troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for stygofauna and troglofaunal has been assessed and found to be extensive and continuous, dispersal has been displayed by the subterranean fauna at MDIOM. Further studies have investigated the likely occurrence of stygofauna based on inferred baseline groundwater salinities from 0 m to 30 m.

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<tr><td>Proposed Environmental Outcomes</td><td>

Potential Impact	Environmental Outcome
Direct Impacts	
Loss of subterranean fauna habitat	• Loss of no more than 66,731,740 m^3 of likely troglofauna habitat (mostly Mineralised Marra Mamba). • A reduction of up to 128,396,700 m^3 of troglofauna habitat altered as a result of changes in groundwater levels (mounding) from MAR during the LoM

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		• A reduction of no greater than 16% Upper Calcrete stygofauna habitat from dewatering; • A reduction of no greater than 4% Channel Iron Deposits (CID)/Pisolite habitat which can support stygofauna. • A reduction of no more than 6% of undifferentiated tertiary habitat which can support stygofauna. • Loss of stygofauna habitat from changes in groundwater salinity as a result of MAR of up to 4,200 mg/L TDS (6562 µS/cm)
	Impact on species	• Impact on up to two troglofaunal taxa from excavation of mine pits • No impact to stygofauna from changes in groundwater levels or salinity.
	Indirect Impacts	
	Contamination of GW/subsurface habitat from mining activities	Not considered significant as will be controlled under EP Act Part V and the Mining Act approvals
	Reduction in energy input (removal of vegetation)	Not considered significant because of limit transfer of energy across epigean (surface) to hypogean (below surface) environments
	Reduction in humidity in vadose zone (altered hydrology)	Not considered significant
Assessment of Offsets (if relevant)	Not applicable	
Flora and Vegetation		
EPA Objective	"To protect flora and vegetation so that biological diversity and ecological integrity are maintained" (EPA 2016a; EPA 2021d).	
Potential Impacts	**Direct Impacts** The direct impact to flora and vegetation from the Proposal will be from clearing. The impacts include: • Loss of native vegetation; • Loss of conservation significant vegetation communities, and • Loss of conservation significant flora. **Indirect Impacts** Indirect impacts which will result in the decline of vegetation health are: • Altered fire regimes and increased risk of fire; • Dust deposition and management with saline or decant water; • Introduction and spread of weed species; • Altered hydrological regimes, and • Fragmentation and/or isolation of populations/occurrences. **Cumulative Impacts** The Proposal and other projects in the region including the Mulga Downs Hub and Rail Spur and Murray's Hill, will have a cumulative impact on flora and vegetation at a regional scale through:	

	• The loss and fragmentation of native vegetation from clearing; and • The loss of conservation significant species and communities as a result of clearing.
Mitigation Hierarchy	**Avoid** • Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of native vegetation and a FHEZ corridor which avoids impacts within an additional 991.45 ha area, both of which includes drainage lines to avoid fragmentation in that area of the Development Envelope. • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 Priority Ecological Community (PEC) are avoided. **Minimise** • The Development Envelope and Indicative Footprint has been revised and reduced through iterative mine planning to reduce the extent of clearing required where possible resulting in a 5,288.84 ha reduction in impacts to native vegetation. • Utilise areas of existing disturbance before clearing of new ground where possible. • Proposal elements have been located to minimise impacts on environmental factors. • Phase the works to enable progressive clearing and where possible progressive rehabilitation. • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • Ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal Ground Disturbance Permit (GDP). • Located Proposal elements to minimise impacts to Priority flora species and locally significant vegetation communities. • Implement induction and education of the workforce with respect to flora and vegetation protection and management. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal GDP. • An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire. • Ensure compliance with the *Bushfire Act 1954*. • Compliance with internal Hot Works Procedures. • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks. • An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment. • Dust management measures will be utilised to minimise dust emissions and subsequent deposition on retained native vegetation in proximity to disturbance. • Dust control measures will be implemented throughout the life of the Proposal and may include: • Saline water (> 5000 mg/L Total Dissolved Solids [TDS]) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation; • Dust suppression techniques (e.g. water trucks) shall be used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; • Vehicle speeds on haul roads, work and camp sites shall be reduced where necessary to minimise dust emissions; • Vegetation clearing and earthworks during high winds (>50 km/hr) shall be avoided; and

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- Zones for saline water use will be in place. This includes, for instance, using saline water on heavy vehicle roads that do not cross a drainage line or creek crossing, whilst not allowing saline water to be used on roads that cross drainage lines without an appropriately sized windrow, not using saline water on topsoil stockpiles etc

Rehabilitate/ Monitor

- Construction areas no longer required for operations will be rehabilitated upon completion of construction.
- Progressive rehabilitation of operational areas no longer required, throughout life of mine (LoM).
- Decommissioning and rehabilitation of disturbed areas at the end of LoM.
- Topsoil will be collected in windrows and stored for rehabilitation of temporary construction areas.
- Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation.
- Topsoil will be progressively re-spread over temporary construction areas or utilised for future rehabilitation.
- Rehabilitation will occur with vegetation comprised of native species of local provenance in accordance with a DEMIRS approved MCP.
- Consultation with Banjima to determine which species are ideal for seed collection.
- Decommissioning and rehabilitating of Development Envelope at end of LoM. Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation.
- Consultation with Banjima to determine which species are ideal for seed collection.
- Progressive rehabilitation will be undertaken as areas become available.
- Ongoing monitoring and management of weeds within the Development Envelope.
- The MCP will detail specific weed management measures in rehabilitation areas.
- Impacts to vegetation as a result of altered hydrological regimes will be managed through the implementation of the Water Management Plan.
- Conduct rehabilitation in accordance with the MCP.
- Weed monitoring.

</td></tr>
<tr><td>Significant Residual Impact</td><td>

The significant residual impact of the Proposal to Flora and Vegetation, after the application of the mitigation hierarchy, is:

- Clearing of up to 4,296.93 ha of native vegetation in Good to Excellent condition;
- Loss of up to 2,973.51 ha of sheet flow dependent vegetation;
- Loss of 4.31 ha of riparian vegetation, and
- Loss of 70.31 ha of ‘Four Plant Assemblages of the Wona Land System’ P1 PEC.

</td></tr>
<tr><td>Proposed Environmental Outcomes</td><td>

<table>
<tr><th>Potential Impact</th><th>Environmental Outcome</th></tr>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Loss of native vegetation</td><td>

- Loss of no more than 4,296.93 ha of native vegetation in Good to Excellent condition of which:
  - 243.12 ha occurs within the Chichester Interim Biogeographic Regionalisation for Australia (IBRA) subregion.
  - 4,053.80 ha occurs within the Fortescue IBRA subregion.

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		• Loss of native vegetation across 15 vegetation types, including five locally significant vegetation types.
	Loss of Conservation Significant Vegetation	• Loss of up to 2,973.51 ha of potential sheet flow dependent vegetation. • Loss of up to 70.31 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC. • Loss of up to 4.31 ha of Riparian vegetation
	Loss of Conservation Significant Flora	• No impact to Threatened Flora listed under the *Biodiversity Conservation Act 2016* (BC Act). • Clearing of three Department of Biodiversity Conservation and Attractions (DBCA) listed Priority flora species (based on the Indicative Footprint): o Up to 622 known *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) (Priority 1 [P1]) individuals of the 4,226 known individuals recorded from within and outside of the Development Envelope. This represents the direct loss of 14.7% of all recorded individuals. o Up to 574 known Triodia veniciae (P1) individuals, of the 1,278 recorded in the Development Envelope. 3,994 individuals were recorded during the survey effort for the Proposal and the adjacent Hub and Rail Proposal. o Up to 2 known Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3 [P3]) individuals of the 29 recorded in the Development Envelope. 180,220 individuals were recorded in total during the local survey effort.
	Indirect Impacts	
	Altered fire regimes and increased fire risk	No significant damage to vegetation and flora as a result of fires caused by the Proposal
	Dust and use of saline water for dust suppression	No significant decline in vegetation and flora health as a result of dust deposition and the use of saline water for dust suppression required for the Proposal.
	Introduced weeds	No introduction of new environmental weed species within the Development Envelope as a result of Proposal activities.
	Altered hydrological regime	No significant decline in health of potential sheet flow dependant vegetation or Freshwater claypans of the Fortescue Valley P1 Priority Ecological Community (Fortescue claypans) PEC as a result of altered hydrological regimes resulting from Proposal activities as determined through monitoring and adaptive management in accordance with the Water Management Plan.
Assessment of Offsets (if relevant)	Environmental offsets are proposed to mitigate the significant residual impacts of the Proposal.	
Terrestrial Fauna		
EPA Objective	"To protect terrestrial fauna so that biological diversity and ecological integrity are maintained" (EPA 2016b).	
Potential Impacts	**Direct Impacts** Potential direct impacts as a result of the Proposal include:	

	• Loss of fauna individuals (collision and entrapment) resulting from ground disturbance, vehicle strike (including heavy haulage vehicles), machinery, infrastructure and mining operations. • Loss of fauna habitat resulting from clearing for ore extraction, construction and operation (mining infrastructure) – this includes clearing of vegetation and removal of landforms (caves, ridges). **Indirect Impacts** Potential indirect impacts to terrestrial fauna as a result of the Proposal may include: • A decline or change in health/composition of fauna habitat arising from: o Deposition of dust during construction and operation of the mine and use of saline water for dust suppression. o Altered hydrological and hydrogeological regimes. o Impacts (i.e. cave collapse) from blasting/vibrations; o Introduction and spread of weeds. o Altered fire regimes. • Disruption of natural foraging and breeding patterns of terrestrial fauna due to: o Fragmentation; o Noise, light, vibration and vehicle movements; and o Increased feral animals. **Cumulative Impacts** The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, will have a cumulative impact on terrestrial fauna at a regional scale through: • The loss and fragmentation of terrestrial fauna habitats, including that of SREs, from clearing; and • The fauna individuals as a result of the clearing activities.
Mitigation Hierarchy	**Avoid** • Establishment of a FHEZ which avoids impact to 1,320.82 ha of habitat (including native vegetation). • Establishment of FHEZ Corridor which both avoids and minimises impact within 991.45 ha of habitat (including native vegetation). • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided which provide important habitat for migratory species. • Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor. • Freshwater Claypans of the Fortescue Valley P1 PEC is outside the Development Envelope. This is habitat for Migratory species when inundated and foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat, Northern Quolls and potentially the Night Parrot. • Establishment of the FHEZ and FHEZ Corridor protecting breeding and foraging for conservation significant fauna and allowing dispersal across high value Rocky Hills Habitat. **Minimise** • Implementation of the Conservation Significant Fauna Management Plan (CSFMP). • Utilise areas of existing disturbance before clearing of new ground where possible. • Where possible Proposal elements have been located to avoid and minimise impacts on environmental factors.

	• Removal of Mulga West Borefield from the Development Envelope which reduces the extent of clearing and associated impacts. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with a GDP). • No more than 4,339.16 ha of clearing within a Development Envelope of 16,848.53 ha. • Phase the works to enable progressive clearing and rehabilitation. • Manage construction and operational works through an Environmental Management System (EMS). • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • No permanent mining activities will be undertaken within the FHEZ corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal. • Implement the Water Management Plan. • Appropriate permits will be obtained under the RiWI Act. • Blasting requirements will be designed to meet vibration thresholds of susceptible caves. • All machinery and vehicles shall be cleaned down of all soil and vegetation material prior to arriving or entering on site. Any soil and vegetation removed from machinery or vehicles during clean down upon arrival, but prior to entry on site shall be collected and disposed of offsite. • All vehicles and machinery mobilised to site shall be inspected prior to entry to site and issued with a Weed & Soil Hygiene Certificates. • Imported fill or other potential weed mediums to be certified by the supplier as being free from weed free sources prior to arrival on site. • Areas of known weed-infestation will be identified and managed separately to weed free areas. • Where areas of weed-infestation are to be disturbed or cleared, material will be stockpiled/placed in windrows separately from weed-free material. • Targeted control of infestations. • An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire. • Ensure compliance with the *Bushfire Act 1954*. • Compliance with internal Hot Works Procedures. • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks. • An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment. **Rehabilitate / Monitor** • Implementation of the CSFMP. • Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout LoM. • Decommissioning and rehabilitation of disturbed areas at the end of LoM. • Consultation with Banjima to determine which species are ideal for seed collection, as informed by the ethnobotanical surveys. • Implement the Water Management Plan.

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- Rehabilitation of areas of land utilised for construction purposes will occur upon completion of construction.
- Progressive rehabilitation of temporary disturbance areas will be undertaken (such as borrow pits and temporary construction areas).

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<tr><td>Significant Residual Impact</td><td colspan="2">

The significant residual impact of the Proposal to Terrestrial Fauna, after the application of the mitigation hierarchy, is:

- Loss of up to 1,406.03 ha of high value habitat for conservation significant fauna species, comprising Rocky Hills; Stony Spinifex Plains and Slopes; and Drainage Lines / Floodplain.

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<tr><td rowspan="4">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Loss of conservation significant fauna</td><td>Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.</td></tr>
<tr><td>Loss of fauna habitat</td><td>

- Clearing of up to 4,339.16 ha of fauna habitat within two Pilbara IBRA bio-subregions and across nine fauna habitat types, including:
  - Clearing of up to 4,095.65 ha of Fortescue Valley subregion;
  - Clearing of up to 243.51 ha of Chichester subregions;
- Loss of up to:
  - 520.80 ha of Rocky Hills habitat;
  - Loss of up to 2,824.74 ha of Mulga Woodland habitat;
  - Loss of up to 813.97 ha of Stony Spinifex Plains and Hillslopes habitat;
  - Loss of up to 71.26 ha of Drainage Line/Floodplain habitat;
  - Loss of up to 15.27 ha of Chenopod/Cracking Clay Floodplain habitat;
  - Loss of up to 56.69 ha of Gibber Cracking Clay habitat
  - Loss of up to 28.10 ha of Cracking Clay habitat; and
  - Loss of up to 8.04 ha of Snakewood habitat.
  - Loss of up to 520.80 ha of Rocky Hills habitat which is the habitat where four possible SREs taxa were only recorded.

Potential impacts to the conservation significant fauna recorded from within the Development Envelope include the loss of up to:

- 1,462.72 ha of Ghost Bat (*Macroderma gigas*) (Vulnerable BC Act) foraging habitat;
- 1,406.03 ha of Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (Vulnerable BC Act) foraging habitat;

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		• 1,406.03 ha of Northern Quoll (*Dasyurus hallucatus*) (Endangered BC Act) habitat of which 520.80 ha is potential denning habitat; • 1,406.03 ha of Pilbara Olive Python (*Liasis olivaceus*) (Vulnerable BC Act) foraging habitat; • 813.97 ha of Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4, DBCA) foraging and breeding habitat. • 2,896.00 ha Gane's Blind Snake (*Anilios ganei*) (Priority 1, DBCA) habitat; • 921.37 ha of Grey Falcon (*Falco hypoleaucos*) (Vulnerable, BC Act) habitat; • 648.75 ha of Peregrine Falcon (*Falco peregrinus*) (OS, specially protected BC Act); • 900.95 ha of potential habitat for Night Parrot (*Pezoporus occidentalis);* • 2,911.72 ha of potential habitat for Greater Bilby *(Macrotis lagotis);* • There will be no loss of Category 1, 2 or 3 roosts for Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) or Ghost Bat (Macroderma gigas). Up to 8 Category 4 roosts will be removed. • Up to 31 possible SREs and one confirmed SRE (*Buddelundia* 56) were recorded within various habitats in the Development Envelope, primarily Rocky Hills, Drainage Line/Floodplain, and Stony Spinifex Plains and Hillslopes habitats.
	Indirect Impacts	
	A decline or change in health/composition of fauna habitat	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.
	Disruption of natural foraging and breeding patterns of terrestrial fauna	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.
Assessment of Offsets (if relevant)	Environmental offsets are proposed for the clearing of high value fauna habitat.	
Terrestrial Environmental Quality		
EPA Objective	"To maintain the quality of land and soils so that environmental values are protected" For the purposes of EIA, the EPA defines terrestrial environmental quality as "*the chemical, physical, biological and aesthetic characteristics of soils*"	
Potential Impacts	**Direct Impacts:** • Not applicable **Indirect Impacts:** The potential indirect impacts to Terrestrial Environmental Quality from implementation of the Proposal, prior to mitigation, include: • Contamination of soils, surface water and groundwater.	

	• Redistribution of Asbestos Containing Material (ACM) that is present from historical anthropogenic activities. • Contamination of Soils, Surface Water and Groundwater. **Cumulative Impacts:** The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, may have a cumulative impact on Terrestrial Environmental Quality through: • Contamination of soils, surface water and groundwater. • Redistribution of asbestos containing material (ACM) that is present from historical anthropogenic activities.
Mitigation Hierarchy	**Avoid** • As a result of the Acid Mine Drainage (AMD) risk posed by elevated sulfur material at depth, HPPL purposely designed the pits to exclude basal Nammuldi Member subunits and Jeerinah Formation (Roy Hill Shale). • The Development Envelope avoids the Wittenoom Asbestos Management Area (WAMA). • The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access. **Minimise** • The Proposal has been designed to avoid direct impacts to areas prone to Acid Sulfate Soils (ASS), such as wetlands. • Surface water diversions have been designed to ensure surface water flows avoid contact with WRDs. • Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Appropriate siting of landfill facilities to avoid interaction with surface drainage. • If Potential Acid Forming (PAF) material is encountered during mining, PAF material will be managed according to the Waste Management Plan to ensure final landform is non-acid forming. • Ongoing waste characterisation studies. • Waste rock material will be used as pit backfill to minimise the need for surface waste rock landforms. • Low stability or material the Uncertain or PAF classification waste rock material will not be placed on waste rock landform surfaces. • Competent waste rock material will be used to armour waste rock dump surfaces. • WRD design, including heights, slope lengths, batter angles and surface water control structures account for physical and chemical properties of waste rock. • Design landforms and infrastructure to contain sedimentation where possible. Toe bunds and sediment basins will direct and contain sediment runoff to prevent excessive scour and increased sediment volumes to the downstream environment. • Adherence to Dangerous Goods licence conditions and Australian Standards • Adherence to EP Act Part V licence conditions with respect to bulk chemical storage and landfill management. • Disposal of waste to landfill will be a last resort. Materials will be repurposed or recycled where practicable. • Adherence to the Asbestos Management Plan.

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- The Proposal has been designed to avoid impacts to areas where ACM has been confirmed or is suspected, where practicable.

Rehabilitate / Monitor

- If unexpected Potential ASS (PASS) is encountered, disturbed soils or low pH waters will be neutralised prior to discharge.
- Excavation or dewatering will cease until suitable management measures are employed.
- If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria.
- Monitoring of surface and groundwater quality in accordance with a Water Management Plan to detect any adverse changes in water quality between the mine and sensitive receptors, with 'early response' criteria, 'trigger' criteria and 'threshold' criteria.
- Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act.
- Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures.
- Pipelines, water storage dams and landfills will be appropriately decommissioned and disturbed areas rehabilitated, unless there is a specific agreement in place with a third party to take ownership and responsibility of the infrastructure post mining. The requirements will be regulated as per a MCP to be assessed and approved by DEMIRS, in accordance with the Mining Act.
- All chemical and hydrocarbon storage areas will be appropriately decommissioned and closed as per DEMIRS requirements of the MCP, in accordance with the Mining Act.
- ACM-contaminated areas will be rehabilitated where appropriate, and asbestos management will be subject to monitoring through the Asbestos Management Plan (AMP).

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<tr><td>Significant Residual Impact</td><td>The residual impacts of the Proposal to Terrestrial Environmental Quality are not considered significant. Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with Terrestrial Environmental Quality meet the EPA's objective for this factor.</td></tr>
<tr><td>Proposed Environmental Outcomes</td><td>
<table>
<tr><th>Potential Impact</th><th>Environmental Outcome</th></tr>
<tr><td colspan="2">Indirect Impacts</td></tr>
<tr><td>Contamination of soils, surface water and groundwater</td><td>

- The risk of contamination of soils, surface water and groundwater from AMD is significantly reduced from HPPL's strategy of purposely designing pits not to intersect basal Nammuldi and Roy Hill Shale/ Member of the Jerrinah Formation stratigraphic units, as these have been shown to have the highest sulfur levels and are most likely to lead to generation of AMD.
- SRK (2024) confirms that the AMD potential is, in general, low.
- The potential for leaching is expected to be limited given the neutral pH conditions expected for the majority of waste rock.
- Other regulatory processes such as DEMIRS' Mining Proposal and MCP will ensure waste structures such as waste rock dumps are designed, operated, decommissioned and closed to meet the EPA's objectives for Terrestrial Environmental Quality.
- Any contamination of soils, surface water and/or groundwater arising from failure, leaks or seepage from

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<tr><td></td><td></td><td>saline water pipelines, or water storage dams is likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts.
• Similarly, impacts associated with spillage of chemicals and hydrocarbons and landfill leachate or also are likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts.</td></tr>
<tr><td></td><td>Redistribution of asbestos containing material (ACM) that is present from historical anthropogenic activities</td><td>• It is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM.
• The implementation of, and adherence to, an AMP, including procedures for the safe decommissioning and removal of ACM structures and an unexpected finds procedure can adequately manage ACM risks to Terrestrial Environmental Quality to ensure the EPA's objective for this environmental factor can be met.</td></tr>
<tr><td>Assessment of Offsets (if relevant)</td><td colspan="2">Not applicable.</td></tr>
<tr><td colspan="3">Greenhouse Gas Emissions</td></tr>
<tr><td>EPA Objective</td><td colspan="2">"To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable."</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">Scope 1 emissions associated with the Proposal construction phase will occur from/are associated with:
• Combustion of fuel during the construction phase; and
• Combustion of fuel during the operation phase.
Estimated emissions, following application of the mitigation hierarchy, are summarised below:
<table>
<tr><th>Construction phase</th><th>Estimated annual average emissions</th></tr>
<tr><td>Scope 1</td><td>62,393 t CO2-e based on 2 year construction period</td></tr>
<tr><td>Scope 2</td><td>0 t CO2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).</td></tr>
<tr><td colspan="2">Operational phase – Annual average</td></tr>
<tr><td>Scope 1 unmitigated</td><td>250,079 t CO2-e</td></tr>
<tr><td>Scope 1 mitigated</td><td>100,000 t CO2-e</td></tr>
<tr><td>Scope 2</td><td>0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).</td></tr>
<tr><td>Scope 3</td><td>Estimated Scope 3 emissions of ~14.38 Mt CO_2-e per annum from transport, shipping and steel making.</td></tr>
</table></td></tr>
<tr><td>Mitigation Hierarchy</td><td colspan="2">Avoid – avoid emissions through best-practice design;
Reduce – reduce emissions over the project life; and
Offset – offset some or all residual emissions.</td></tr>
<tr><td>Significant Residual Impact</td><td colspan="2">After application of the mitigation hierarchy, HPPL considers that the Proposal can be managed to meet the EPA's objective.</td></tr>
<tr><td>Proposed Environmental Outcomes</td><td colspan="2">The peak annual Scope 1 emissions will contribute approximately 0.23% to the State's total emissions, 0.04% to national emissions, and 0.0004% to global emissions.</td></tr>
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Assessment of Offsets (if relevant)	• Carbon offsets will be considered as a last resort and will, as far as practicable, be limited to residual emissions that cannot be avoided or to account for emissions that exceed emission reduction commitments and targets. • Where carbon offsets are to be implemented, they will meet offset integrity principles and be based on clear, enforceable and accountable methods. • HPPL will report GHG emissions in accordance with the National Greenhouse and Energy Reporting (NGER) Scheme, in accordance with scoping definitions.
Air Quality	
EPA Objective	The EPA's objective for the environmental factor of Air Quality is "to maintain air quality and minimise emissions so that environmental values are protected" (EPA 2023a). For this assessment, air quality is defined as "the chemical, physical, biological and aesthetic characteristics of air" (EPA 2020d).
Potential Impacts	**Direct Impacts** • Volatile emissions and airborne particulates (dust). • Activities which may disturb asbestiform minerals and Asbestos Containing Material (ACM). **Indirect Impacts** • Changes in air quality due to dust emissions have the potential to indirectly impact flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings. **Cumulative Impacts** • Cumulative impacts to air quality may occur from projects in the immediate vicinity of the Proposal (Mulga Downs Hub and Rail Spur and Murray's Hill), as a result of dust emissions and potential asbestiform fibres.
Mitigation Hierarchy	**Avoid** • Complete avoidance of volatile emissions and dust is not possible. • Asbestos contaminated areas will be clearly demarcated and access restricted. • Known asbestos contaminated area (abandoned infrastructure area) has been excised from the Development Envelope, and access to site structure containing ACM will be restricted. **Minimise** • Standard dust management measures will be utilised to minimise dust emissions, including: o Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; o Vehicle speeds on haul roads, work and campsites shall be reduced where necessary to minimise dust emission; o No vegetation clearing and earthworks during wind speed greater than 50 km/hr; and o Clearing activities will be staged to minimise areas of exposed surfaces • Induction and education of the workforce and contractors with respect to dust minimisation. • Adherence to the AMP. **Rehabilitate/ monitor** • Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities. • Any dust complaints received will be reported to HPPL and entered into the incident management system. • If ACM is found onsite during construction and operation, it will be remediated as per AMP.

<table>
<tr><td></td><td colspan="2">• Asbestos management will be subject to monitoring through the AMP.</td></tr>
<tr><td>Significant Residual Impact</td><td colspan="2">Overall, the assessment of potential air emissions impacts indicates that the EPA's objective for Air Quality can be met and that there will be no significant residual adverse impacts from the Proposal. In addition, consideration of other statutory decision-making processes determined that Department of Water and Environmental Regulation (DWER) can manage the potential air quality impacts of the Proposal under Part V of the EP Act and the Contaminated Sites Act 2003 (CS Act) to ensure that the environmental outcomes are achieved.</td></tr>
<tr><td rowspan="4">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td>Dust (PM_{10} concentration or dust deposition)</td><td>No significant changes to ambient air quality (PM_{10} concentration or dust deposition) at sensitive receptor locations due to the implementation of the Proposal</td></tr>
<tr><td>Volatile emissions</td><td>Negligible</td></tr>
<tr><td>ACM and asbestiform minerals</td><td>Low risk of Proposal interaction causing disturbance to ACM and asbestiform minerals within the Development Envelope and from asbestos dust emissions</td></tr>
<tr><td>Assessment of Offsets (if relevant)</td><td colspan="2">Not applicable</td></tr>
<tr><td colspan="3">Social Surroundings</td></tr>
<tr><td>EPA Objective</td><td colspan="2">"To protect social surroundings from significant harm"
Social Surroundings is defined in the EP Act as:
'In the case of humans, the reference to social surroundings in the definition of environment in subsection (1), is a reference to aesthetic, cultural, economic and other social surroundings to the extent to which they directly affect or are affected by physical or biological surroundings'</td></tr>
<tr><td>Potential Impacts</td><td colspan="2">Direct
• The potential direct impacts of the Proposal to Social Surroundings within or surrounding the Development Envelope, have been identified as follows:
• Disturbance to sites and areas of social, cultural and heritage value;
• Restricting access to country and ability to care for country; and
• Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure that impacts ability to enjoy.
• The Development Envelope excludes the potential for direct impacts to national parks or other recreational or tourism features within the vicinity of the Proposal.
Indirect
• Potential indirect impacts arising from the current Indicative Footprint or activities within the Proposal may cause indirect impacts to Social Surroundings, including heritage sites, social, cultural and environmental values within and/or surrounding the Development Envelope. The potential indirect impacts have been identified as follows:
• Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including changes to groundwater depth, water, surface water flows and altered surface and groundwater quality;
• Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and/or vibration; and
• Disturbance to broader cultural associations as a result of environmental changes to country.
Cumulative
• The Proposal and other projects in the Pilbara will have a cumulative impact on social surroundings values in the region.</td></tr>
</table>

Mitigation Hierarchy	**Avoid** • Development Envelope excludes the lodged Mungurrdu site. • Heritage sites will be demarcated and identified as no-go areas for site personnel prior to ground disturbing works. • Aboriginal cultural heritage, or suspected Aboriginal cultural heritage, must not be removed from any heritage place under any circumstance, unless authorised under the Aboriginal Heritage Act 1914 (AH Act). • Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi Country. • Indicative Footprint amended to avoid key heritage sites with ongoing refinement of the Mine Plan to maximise site avoidance and avoid access restrictions. • Avoidance buffers of 25 m (individual sites may have additional buffers applied in consultation with Banjima traditional owners) will be established around retained heritage sites within the Development Envelope, in consultation with Traditional Owners. These avoidance buffers will be demarcated and managed in accordance with appropriate site procedures. This will be monitored via the GDP process. • HPPL will consult with the Banjima Traditional Owners regarding asbestos management. The Proposal is located outside of the WAMA. HPPL is not proposing to undertake any mining in proximity to Wittenoom and has no intention to reopen Wittenoom. • Direct impacts to claypans (including Koodjeepindarrnna and Ngarlganoona pools) and Fortescue valley are avoided through Proposal design. **Minimise** • Facilitate Banjima Traditional Owner involvement in monitoring activities where possible. • Minimise clearing areas as far as practicable. • Ongoing consultation with Traditional Owners during the Proposal. • Waste dumps will be designed to blend in with the surrounding landscape. • Noise, dust and vibration mitigation measures to be implemented. • Implement the Cultural Heritage Management Plan (CHMP). • Implement water management measures, including implementation of the Water Management Plan. • Engagement with Traditional Owners to identify sites of cultural significance and avoid impacts to these sites where possible. • Minimise, as far as practicable, interactions with significant water features and impacts to surface water flow, including changes to the hydrological regimes of culturally significant water sources. • Minimise clearing and access restrictions within areas used for cultural purposes or areas that have cultural significance (e.g. at watercourse crossings). • Ensure sediment controls are in place during construction at waterway crossings. • Implement a SCHMP that is co-developed with the Banjima Traditional Owner group. • Implement Waste Rock Management Plan. • The Proponent will implement standard dust management measures to minimise potential airborne dust emissions and associated impacts to amenity. This includes (but is not limited to) use of dust suppression on access roads and open areas, water sprays for ore processing, transport and stockpiles, limiting the number and height of stockpiles, controlling/reducing trip distance and ensuring vehicles are confined to designated routes with speed limits strictly enforced.

	• Operating noise, vibration and potential mitigation measures (e.g. sound absorption devices) must be considered when selecting equipment. • Equipment must be fitted with appropriate noise reduction devices (where necessary) to comply with Proposal Health, Safety and Environment (HSE) and regulatory requirements. • Blasting activities must be undertaken in accordance with Mines Safety Inspection Regulations 1995 and Noise Regulations. • Regularly inspect, maintain and replace mobile equipment so that noise levels are minimised during the equipment life. • Implement HPPL's Drill and Blast near Aboriginal Cultural Heritage (ACH) Procedure. **Rehabilitate / Monitor** • Personnel must not enter an Aboriginal Cultural Heritage site or a Heritage Restriction Zone (HRZ) without prior consent. • Ongoing engagement with Traditional Owners to understand key impacts and avoid where possible. • Appropriate education of the workforce will occur through the implementation of a Cultural Awareness Training program. • Adherence to internal GDP procedures. • Maintenance of Traditional Owner access to culturally significant places where safe and practical. • Implement a CHMP. • Implement HPPL's Heritage Management Framework; a suite of management procedures. • Maintenance of access to culturally significant places where safe and practical. • Impacts to specific sites of cultural and heritage significance, if unavoidable, will be discussed with Traditional Owners and Approvals sought under the AH Act. • Salvage of heritage material will be undertaken, where appropriate, in consultation with Traditional Owners, prior to direct impact. • Repatriation and restitution of salvaged Heritage material will be undertaken in consultation with Traditional Owners. • Post-closure access to sites of cultural significance will be maintained. • Post-closure access restrictions will be limited only to areas immediately adjacent to remaining open pits (due to safety reasons). • Monitoring for dust, noise and visual impacts will be ongoing. • Monitoring surface water quality in accordance with a Water Management Plan. • WRDs at closure will be rehabilitated to ensure they are stable and revegetated. • Closure landforms are designed to minimise long-term impacts to hydrological regimes associated with sites of cultural significance. • Groundwater recovery will be investigated and incorporated into the final MCP, to be submitted to support the Mining Proposal. • Monitor sites of cultural and heritage significance and the avoidance buffer zones. Report new or unauthorised disturbances to culturally sensitive sites and avoidance buffers. • Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners, including incorporation of bushtucker/ medicine species, and habitat for traditional hunting species and the objectives of the MCP, as required under the Mining Act 1914 (Mining Act). • Seed collection prior to/during construction and operations for use in rehabilitation with involvement of Traditional Owners.

<table>
<tr><td>Significant Residual Impact</td><td colspan="2">Overall, with the implementation of mitigation actions as formalised and detailed within management plans such as the SCHMP, impacts to Social Surroundings are considered manageable and that the EPA's objectives for this factor can be met. This will be managed via ongoing consultation with Banjima Traditional Owners and other stakeholders identified above.</td></tr>
<tr><td rowspan="9">Proposed Environmental Outcomes</td><td>Potential Impact</td><td>Environmental Outcome</td></tr>
<tr><td colspan="2">Direct Impacts</td></tr>
<tr><td>Disturbance to sites and areas of Social, Cultural and Heritage Value</td><td>• The entire Development Envelope will be surveyed for heritage significance, impacts to sites will be managed via the Aboriginal Heritage Act 1972 (AH Act).</td></tr>
<tr><td>Restricting access to Country and ability to Care for Country</td><td>• No disturbance to Aboriginal cultural heritage sites as identified in consultation with the Banjima Traditional Owners, unless consent is granted to disturb that site under the AH Act.</td></tr>
<tr><td>Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure</td><td>• Subject to reasonable health and safety requirements, no interruption of ongoing access to land utilised by the Banjima people</td></tr>
<tr><td colspan="2">Indirect Impacts</td></tr>
<tr><td>Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality</td><td>• Groundwater drawdown and catchment area modifications will not materially impact on the key ecohydrological receptors.
• Potential impacts on claypans (including Koodjeepindarrnna and Ngarlganoona pools) can be managed to ensure they are not significant.
• Water quality and hydrological/hydrogeological regimes will be maintained and monitored through implementation of the Water Management Plan.
• Water quality and hydrological/hydrogeological regimes can be managed to ensure no significant impact to heritage sites or areas of cultural significance.</td></tr>
<tr><td>Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust and noise and vibration</td><td>• No dust plumes originating from the Proposal received at sensitive receptors outside of the Development Envelope.
• Noise and vibration will be managed in accordance with relevant regulations.</td></tr>
<tr><td>Disturbance to broader cultural associations as a result of environmental changes to country</td><td>• No impacts to cultural associations outside of the Development Envelope.</td></tr>
<tr><td>Assessment of offsets (if relevant)</td><td colspan="2">Not applicable.</td></tr>
</table>

Other Factors

Landforms

Mining activity will result in a direct residual direct effect (loss) on a portion of the Chichester Range landform through the excavation of mine pits and construction of waste landforms, over a linear distance of approximately 40 km. In consideration of the broader local extent of such landforms (noting Chichester Ranges extend ~350 km) and the extent of similar landforms across the wider Pilbara region, the effect of the Proposal to the Chichester Ranges landform is not considered to be environmentally significant.

The Fortescue Valley is split by the Goodiadarrie Hills into the Fortescue Marsh to the east, and the Goodiadarrie Swamp to the west. The Proposal is fully contained within the Goodiadarrie Swamp catchment. The Goodiadarrie Swamp comprises a series of variably interconnected ephemeral swamps, claypans, and floodplains that form a wetland mosaic over a distance of 70 km. Collectively, the Goodiadarrie Swamp has an area of approximately 4,140 km^2. The Goodiadarrie Swamp catchment is bounded by the Chichester Range to the north and the Hamersley Range to the south (AQ2 2024a). Discharge of surface water into the Fortescue Valley is from the northern Chichester Ranges and the southern Hamersley Ranges.

The Proposal will be developed to ensure the flow of surface water from the northern Chichester Range to the Lower Fortescue River valley is maintained and sustained. Accordingly, the impact of the Proposal to the Fortescue River Valley landform is not anticipated to be significant.

HPPL propose to manage the potential effect of the Proposal to 'Landforms' through key management measures including:

- Avoidance of Claypan habitat features within the Fortescue River Valley landform;
- Surface water management structures designed to maintain natural patterns of surface water flow; and
- Progressive and post-mining rehabilitation of landforms to restore flora and vegetation values and fauna habitat values.

Based on the predicted impacts of the Proposal to the recorded landform values, subject to the implementation of the identified management measures (above), it is considered EPA objective for the environmental factor of 'Landforms' can be met.

Human Health

For the purposes of EIA, consideration of possible impacts to human health is largely confined to EIA of harmful emissions to air and harmful discharges to soil, inland waters and marine waters, that is through impacts to the physical environment. Because the consideration of the above health hazards are explicitly informed through other EPA guidelines, the assessment of impacts to human health provides the specific framework for considering the possible impacts to human health arising from the emission of radiation.

The Proposal has no potential to cause or emit radiation that could impact on human health.

1 Introduction

Hancock Prospecting Pty Ltd (HPPL, the Proponent) is proposing to develop the Mulga Downs Iron Ore Mine (MDIOM, the Proposal), located approximately 210 kilometres (km) south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia. The Proposal will produce up to 12 million tonnes per annum (Mtpa) of iron ore and have an operational life of approximately 18 years. The Proposal is a new asset that will contribute to maintaining the supply of iron ore product for HPPL customers through port facilities located at Port Hedland.

1.1 The Proponent

The nominated Proponent for the Proposal is Hancock Prospecting Pty Ltd (HPPL). HPPL is an independent, privately owned Australian company that has a long history within the Pilbara and iron ore sector.

HPPL holds exploration and miscellaneous tenements located across the HPPL owned Mulga Downs Pastoral Station and adjacent land in the Central Pilbara region of Western Australia. HPPL has been exploring the tenements held across the Mulga Downs and adjacent Mt Florance and Hooley Station Pastoral Leases since the late 2000's.

HPPL is currently in the process of applying to convert the exploration and miscellaneous leases to mining leases.

HPPL has identified approximately 360 million tonnes (Mt) of Measured, Indicated, and Inferred iron ore Resource on these leases with a cut-off grade of 55% iron (Fe). It is this iron ore resource that forms the Proposal.

The contact details for the Proponent are provided in **Table 1-1**.

Table 1-1: Proponent Details

Proponent	Hancock Prospecting Pty Ltd (ABN 69 008 676 417)
Contact Person	Brett McGuire, Manager Environment and Approvals Projects 28-42 Ventnor Avenue, West Perth, WA 6005 E-mail: brett.mcguire@hanroy.com.au

HPPL has not been subject to any convictions or proceedings under Commonwealth, State or Territory law that pertain to the protection of the environment or the conservation and sustainable use of natural resources.

The registered holder of the mining tenements that is the subject of this Proposal is (or will be shortly, as the transfers are in process) Mulga Downs Iron Ore Pty Ltd (ACN 080 659 150) (MDIO). MDIO is a wholly-owned subsidiary of Mulga Iron Holdings Pty Ltd (ACN 600 967 404) (MIH). Over 94% of the shares in MIH are held by a wholly-owned subsidiary of HPPL. Each of Marubeni Iron Ore Australia Pty Ltd (ACN 156 488 130) (1.71%), POSCO WA Pty Ltd (ACN 145 260 108) (1.43%) and CSC Steel Australia Holdings Pty Ltd (ACN 123 783 282) (0.29%) have small holdings in MIH. Mulga Downs Investments Pty Ltd (ACN 132 484 041) (MDI), which is not a company in the HPPL Group, will shortly hold 1.93% of MIH. While not a member of the HPPL Group, MDI's commitments to the Mulga Downs Project will be funded by HPPL.

HPPL has recently undertaken an internal restructure to consolidate its projects capability in an expert team to deliver project studies, construction and operations readiness - HanRoy Iron Ore Projects Pty Ltd (ACN 657 533

974) (HanRoy) was created as of 1 April 2023. HanRoy will lead the study, design and development of a globally significant pipeline of projects that will provide ongoing supply of critical minerals and energy essential for everyday life, including the Proposal. HanRoy, or its delegate, will manage the delivery of construction and operations of the Proposal, to which contractors will be appointed to fulfill various roles as required, on HanRoy's behalf.

HPPL holds a 70% majority share in Roy Hill Holdings Pty Ltd (Roy Hill). Roy Hill is one of Australia's largest single iron ore mines. Its class-leading operations include dedicated rail and port infrastructure that enables international export of 60 Mtpa, with approvals in place for an increase to 70 Mtpa.

HanRoy's environmental policy is provided **Appendix 2**. To implement this policy, HanRoy will develop an Environmental Management System (EMS) for the Proposal, aligned with that of Roy Hill and to the requirements of ISO 14001. The EMS provides a structured, strategic approach to environmental management, and ensures environmental risks and issues are identified and managed, and regulatory obligations are met in accordance with the HanRoy Environment Policy. Both HanRoy and HPPL are committed to minimising potential harm to the natural environment, local visual amenity and biodiversity, as well as preventing pollution whilst implementing its activities.

1.2 Purpose and Scope

The purpose of this Environmental Review Document (ERD) is to provide a detailed description of the Proposal and the potential effects on the environment resulting from its implementation. The information in this document will allow for the environmental impact assessment (EIA) of the Proposal by the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act).

The Proposal was referred to the EPA in December 2021. On 24 February 2022, the EPA determined the Proposal should be assessed at a Public Environmental Review (PER) level of assessment with a 6-week public review period. A Proponent prepared Environmental Scoping Document (ESD) was submitted and approved by the EPA on the 24 August 2022.

Since referral of the Proposal in 2021, HPPL has continued to refine and develop Proposal design and has undertaken additional environmental studies to support the impact assessment. This refinement has resulted in applications made under Section 43A (s43A) of the EP Act to amend aspects of the Proposal and reduce the overall environmental impact. These applications include:

- s43A application submitted on 15 March 2023 to reduce the overall extent of the Development Envelope and Indicative Footprint. This application was approved on 29 May 2023.
- s43A application submitted in December 2023 to remove the Mulga West Borefield. This application was approved on 23 February 2024.
- s43A application submitted on 12 September 2024, to reduce the scale of the Proposal from a 20 Mtpa mine to an up to 12 Mtpa Direct Shipping Ore (DSO) mine. This application was approved on 4 October 2024.

This ERD revision reflects all approved variation applications in relation to the Proposal that have occurred during the assessment process. Details of the s43A applications submitted are provided in **Section 2.3.3**.

The ERD provides detailed information, using relevant studies specific to the Proposal (provided as Appendices), on each of the key environmental factors which the Proposal may significantly impact, should it be implemented. Eight key environmental factors (**Section 6.1**) were identified by the EPA. The ERD considers all phases of Proposal implementation including construction, commissioning, operation and closure. Cumulative impacts with other projects (**Section 17**) and holistic impacts (**Section 18**) between the EPA key environmental factors are also addressed.

The Proposal has also been separately referred for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2021/09255). The Proposal differs slightly from the Proposed Action being assessed by the Commonwealth Department of Climate Change, Energy, Environment and Water (DCCEEW) under the EPBC Act in that the Proposal being assessed by the EPA does not include the Murray's Hill Project which forms part of the Proposal under assessment by DCCEEW. The ERD therefore does not assess the potential impacts of the Proposal to Matters of National Environmental Significance (MNES). This difference is explained in **Section 2.2.5**.

2 Proposal

2.1 Background

HPPL is proposing to develop a greenfield iron ore mine at Mulga Downs, located in the Fortescue River valley and on the flanks of the adjacent Chichester Range (MDIOM; the Proposal). The Proposal is located within the boundaries of the HPPL owned Mulga Downs Pastoral Station. The Proposal is approximately 210 km south of Port Hedland and 180 km north-west of Newman in the Pilbara Region of Western Australia (**Figure 2-1**).

For the purpose of EIA, the Development Envelope is the maximum area within which the physical Proposal elements will occur (EPA 2021a).

A Development Envelope approach has been proposed for this Proposal, which allows for flexibility in respect to the Proposal footprint. The Proposal footprint is considered indicative and is referred to as the Indicative Footprint in all assessment documents. As the planning and design of the mine progresses and studies that inform the assessment are completed, changes may occur to the Indicative Footprint to apply the mitigation hierarchy and further reduce and prevent potential environmental impacts.

The Proposal extent is a Development Envelope of 16,848.53 hectares (ha) (**Figure 2-2)** within which up to 4,339.16 ha of vegetation will be cleared. This equates to approximately 25.7% of the Development Envelope that will be disturbed to construct and operate the Proposal (**Figure 2-2**).

The Proposal includes above and below the water table mining of iron ore from multiple open cut pits (**Figure 2-3**). The production rate of the mine will be up to 12 Mtpa of ore over an expected Life of Mine (LoM) of 18 years.

The Proposal will be accessed from the existing Great Northern Highway. The maximum extent of the Proposal is detailed in the Proposal Content Document (PCD) (**Appendix 1**) and is further detailed in **Section 2.2.1.**

Subject to approval, construction of the Proposal is planned to commence FY 2026 with operations scheduled to occur from FY 2027 to approximately FY 2044.

2.2 Proposal Content

Key elements and associated activities of the Proposal are described in **Section 2.2.1** and **Section 2.2.2**. The PCD (**Appendix 1)** has been published on the EPA website (www.epa.wa.gov.au).

2.2.1 General Proposal Description

The general Proposal description is summarised in **Table 2-1**.

Table 2-1: General Proposal Description

Proposal title	Mulga Downs Iron Ore Mine
Proponent name	Hancock Prospecting Pty Ltd
Short description	The Proposal is for the development of the Mulga Downs Iron Ore Mine (MDIOM) located approximately 210 km south of Port Hedland and 180 km north west of Newman in the Pilbara Region of Western Australia. The Proposal includes and is not limited to the following: • The development of a series of above and below water table mine pits; • Dry ore crushing and screening plant(s); • Groundwater abstraction for water supply (for the mine and all associated infrastructure) and for the dewatering to facilitate the recovery of ore below water table in the mine pits; • Surplus water management via managed aquifer recharge (MAR) and/or in pit infiltration; • Waste rock dumps (WRD); • Infrastructure to manage surface water (diversion of creeks and surface water flows); • Linear infrastructure (haul roads, powerlines, pipelines and conveyor corridors); • Mine associated infrastructure and support facilities (including, but not limited to accommodation camp, energy supply infrastructure, airstrip; wastewater treatment plant; landfill, offices, workshops, laydown areas, etc.); and • Transport of the ore via the Great Northern Highway to Port Hedland or via road to a siding along the existing Roy Hill railway and then via that railway to Port Hedland for export. Future transport options (e.g. rail) will be subject to a separate referral. • The Proposal is located within a 16,848.53 ha Development Envelope and will require the clearing of up to 4,339.16 ha of native vegetation.

2.2.2 Proposal Elements

Key elements of the Proposal are summarised in **Table 2-2** and discussed below.

Table 2-2: Proposal Content Elements

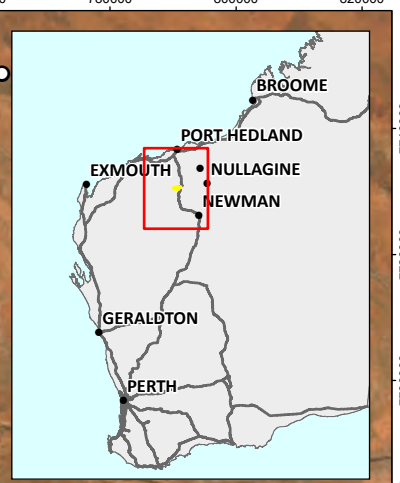
Proposal Element	Location	Maximum Extent or Capacity
Physical Elements		
Mine including: • Series of open pits (above and below water table); • WRD; • Topsoil elements, in stockpiles; and • Dewatering.	Within the Development Envelope (**Figure 2-2** and **Figure 2-3**)	Clearing of up to 4,339.16 ha of native vegetation within the 16,848.53 ha Development Envelope.
Processing elements, including: • Ore stockpiles; • Crushing and screening plant (s); • Dry crushing and screening plant; and • Transfer water dams/ponds.		
Infrastructure elements, including: • Accommodation camp; • Energy supply infrastructure; • Road haulage or ore from the mine to Port or Rail Siding; • Conveyors for the transportation of ore; • Bore fields/water reinjection infrastructure; • Mine workshops & infrastructure; • Pipelines; • Haul and light vehicle roads; • Ancillary buildings (e.g. workshops, telecommunications, offices); • WWTPs; • Landfill; • Hydrocarbon storage; • Explosive mixing and storage facility; • Laydown areas; • Evaporative ponds; • Water diversion channels and catchment ponds; and • Above ground water storage dams to manage supply or disposal of clean or mine water.		
Operational elements		

Proposal Element	Location	Maximum Extent or Capacity
Groundwater abstraction for water supply and mine dewatering	Within the Development Envelope (**Figure 2-2**)	Over the life of the mine it is anticipated the water abstraction requirements may reach up to 12 GL/a, due to mine dewatering and water supply requirements. Consideration may be given to the use of a water treatment facility (i.e. reverse osmosis desalination) should it be required to provide the necessary water quality.
Management of surplus water	Within the Development Envelope (**Figure 2-2**)	Up to 11 GL/a to be disposed of through MAR and/or pit infiltration within the Development Envelope. Temporary water storage may be required to assist in the management of water quality for supply or prior to discharge.
Evaporation ponds	Within the Development Envelope (**Figure 2-2**)	May be required to assist in the management of surplus water and discharge. These will preferentially be located in disturbed areas such as pit voids, however some ex-pit structures may be required within the WRD's
Crushing and screening plant(s)	Within the Development Envelope (**Figure 2-2**)	Dry processing of ore to produce up to 12 Million tonnes per annum (Mtpa) of iron ore product**.**
WRD	Within the Development Envelope (**Figure 2-2**)	Approximately 160 Mt of waste rock will be mined throughout the life of the Proposal. WRDs will be designed to integrate into the surrounding landforms where possible, with a maximum height defined by waste rock characterisation studies.
Proposal Elements with Greenhouse Gas Emissions		
Construction Elements - Annual Average		
Scope 1	62,393 t CO_2-e based on 2 year construction period	
Scope 2	0 t CO_2-e (construction electricity demand met by on-site generation and included in Scope 1 emissions).	
Construction Elements - Over period of construction		
Scope 1	124,786 t CO_2-e over ~2 years	
Scope 2	0 t CO_2-e (operational electricity demand met by on-site generation and included in Scope 1 emissions)	
Operation Elements - Annual Average		
Scope 1 unmitigated	250,079 t CO2-e	
Scope 1 mitigated	100,000 t CO2-e	
Scope 2	0 t CO_2-e (operational electricity demand met by on-site generation and included in Scope 1 emissions)	
Commissioning		
Commissioning of the processing facility will be undertaken subject to the operational limits above.		
Rehabilitation		
Where practicable, progressive rehabilitation will be undertaken over the LoM.		

Proposal Element	Location	Maximum Extent or Capacity
Areas disturbed through the implementation of the Proposal will be designed to be safe and non-polluting and will be constructed so the final shape, size, stability, are comparable with the natural landforms in the area.		
Other elements which affect extent of effects on the environment		
Proposal duration	Maximum Proposal life	18 years

The key components of the Proposal are described in more detail in the following sections.

FINUCANE
PORT HEDLAND
POINT SAMSON
COSSACK
BALLA BALLA
ROEBOURNE
MALLINA
GREAT NORTHERN HWY
MARBLE BAR
Millstream Chichester National Park
Mungaroona Range Nature Reserve
Yandeyarra Aboriginal Reserve
NULLAGINE
Wittenoom Asbestos Management Area (WAMA)
TOM PRICE
Karijini National Park
PARABURDOO
NEWMAN



Legend

- Development Envelope
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve
- Yandeyarra Aboriginal Reserve (LGATE-227)

Directory of important wetlands (DBCA-045)

- Lower Fortescue River
- Upper Fortescue River including the Fortescue Marsh
- Watercourses (LGATE-053)

Roads (LGATE-195)

- Highway
- Major road

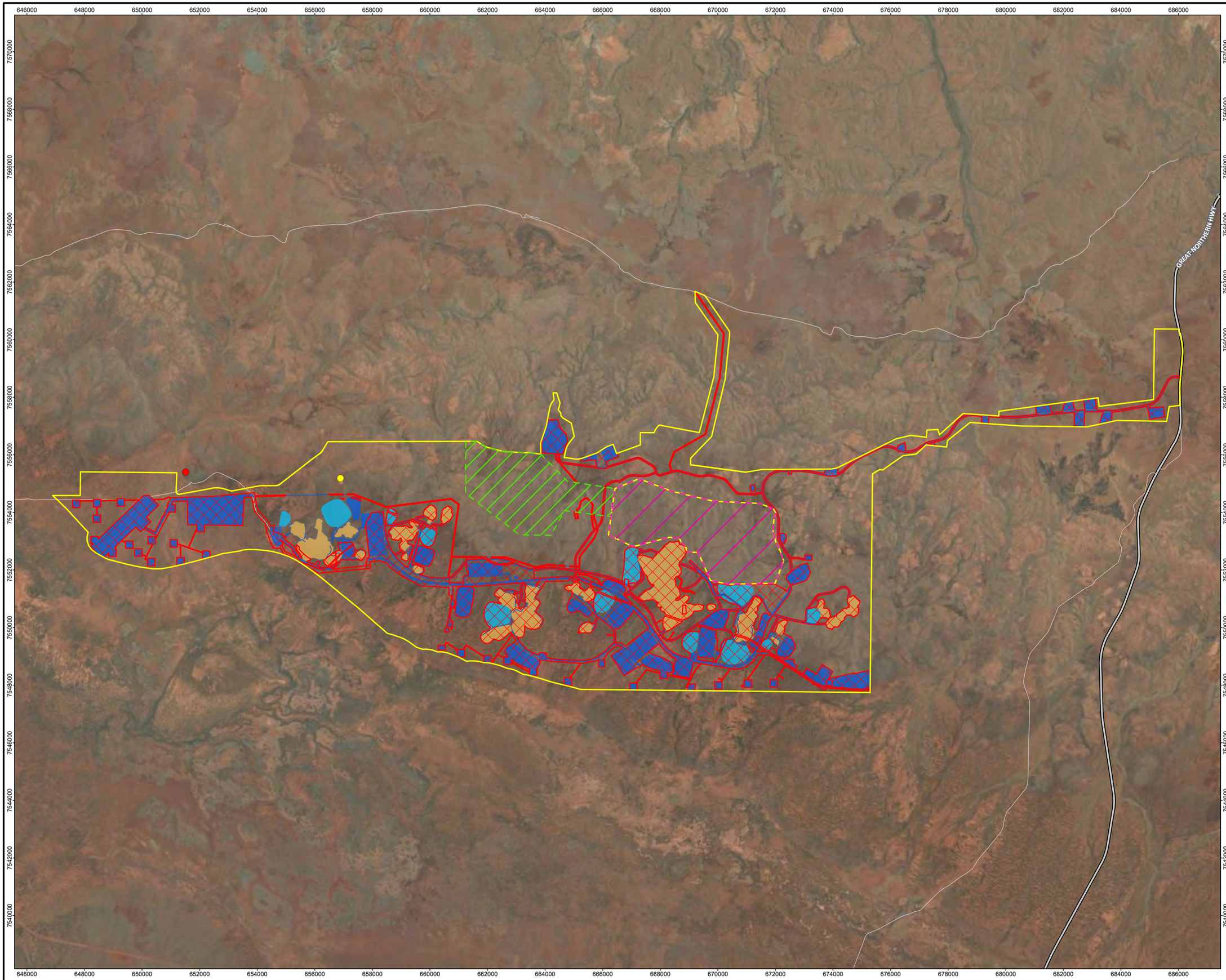
JBS&G

0 15 30
Kilometers

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

Job Number: 67751		Scale 1:1,200,000 at A3		**REGIONAL LOCATION OF THE PROPOSAL**
Client: Hancock Prospecting Pty Ltd		Coord. Sys. GDA2020 MGA Zone 50		
Drawn By: droberts	Checked By: VC	Version: Rev A	Date: 31-Oct-2024	**FIGURE: 2.1**

Document Path: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Mine Layout

- Supporting infrastructure
- Pit
- Waste Dump
- Mulga Downs Exploration Camp (LGATE-013)
- Mulga Downs Homestead (LGATE-013)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PROPOSAL LOCATION, DEVELOPMENT ENVELOPE AND INDICATIVE FOOTPRINT

FIGURE 2.2

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PROPOSED PITS WITHIN THE PROPOSAL

FIGURE 2.3

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

2.2.3 Detailed Description of Proposal Elements

2.2.3.1 Construction

Construction of the Proposal is anticipated to commence FY 2026 and is forecast to take approximately 24 months. Construction activities for the Proposal will involve the clearing of vegetation and development of associated infrastructure required to establish the Proposal. Associated infrastructure required as part of the Proposal includes:

- Facilities for dry crushing and screening of ore;
- Infrastructure to manage surface water (diversion of creeks and surface water flows);
- Linear infrastructure (haul roads, powerlines, pipelines and conveyor corridors); and
- Mine associated infrastructure and support facilities (including, but not limited to accommodation camp, energy supply infrastructure, airstrip, wastewater treatment plant, landfill, offices, workshops, laydown areas, etc.).

Pre-strip of the mine pits will commence in both the west at Murrays Hill and east at Fridge Hill, with pits developed over the LoM to allow for appropriate water management and grade control. Surplus water not required for the operation of the Proposal will be disposed of through Managed Aquifer Recharge (MAR) through reinjection and/or in-pit infiltration within the Development Envelope.

A construction water supply of approximately 1 GL per annum (GL/a) will be required over the duration of construction prior to mining. It is intended that the construction water supply will be sourced from mining / MAR areas, thereby providing advanced dewatering and / or increased MAR capacity.

The expected footprint of the Proposal is referred to as the Indicative Footprint. A Development Envelope approach for the Proposal has been proposed which allows for flexibility in placement of certain infrastructure elements. The Indicative Footprint is shown on all the maps and figures which will inform the impact assessment as per EPA guidance (EPA 2021d). The extent of impact of the Indicative Footprint is presented for each key environmental factor in this ERD. The exact location of the footprint may change within the Development Envelope as the design progresses and to reduce environmental impacts where possible.

Clearing of up to 4,339.16 ha of vegetation will be required within a Development Envelope of 16,848.53 ha. Where possible, topsoil and vegetation will be removed and stockpiled in adjacent well-drained areas.

2.2.3.2 Operation

The Proposal is expected to operate for up to 18 years and will involve mining within the Mulga East area, establishing WRDs, processing (dry) ore and operation of associated supporting infrastructure. Supporting infrastructure to the primary operation is detailed in **Section 2.2.3.7**. Ore from third-party iron ore mines may also be processed at the Proposal.

The Proposal will be undertaken in accordance with a Mining Proposal, which will require approval by the Department of Energy, Mines, Industry Regulation and Safety (DEMIRS) under the *Mining Act 1978* (Mining Act) prior to construction commencing. The key operational activities for the Proposal are detailed below.

2.2.3.3 Mining

The open pits are described by seven domains (refer to **Section 2.2.5.1**). These are: Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West, and Horseshoe Hill (**Figure 2-3**). Mining will be undertaken using conventional drill and blast, load, and haul methods. The maximum production capacity will be up to 12 Mtpa. It is expected the iron ore will be mined with an average strip ratio of 1:1.4. A portion of the ore is located below the water table and dewatering of groundwater will be required for dry-floor mining.

Groundwater abstraction for water supply and to dewater is projected to increase over the LoM, to a maximum of 12 GL/a. Dewatering rates are expected to decrease rapidly in the last year of mining. The operation of the mine is driven by the mine dewatering volumes.

Mining will be undertaken on a 24-hour basis, seven days a week.

Where possible, topsoil and vegetation will be removed in stages prior to construction. The topsoil will be stockpiled in adjacent, well-drained areas. Topsoil stockpiles will be managed so the material will be available for future rehabilitation operations.

Mined ore will be transported (loaded and hauled) from the open pits after blasting to the run of mine (RoM) pads. Three RoM pads at approximately 5 m height are anticipated to be constructed across the Development Envelope (two operational at a time) over the LoM to service the various open pits.

At the end of mining (but before closure), Managed Aquifer Recharge (MAR) via in-pit infiltration and groundwater recharge will result in temporary standing water within some of the pits. At closure, HPPL will backfill pits to above the water table after settlement to avoid formation of permanent pit lakes. This will be further informed by future infield study work as part of the closure planning process. A preliminary Mine Closure Plan is provided in **Appendix 3**.

2.2.3.4 Waste Rock Dumps

The indicative locations of the WRDs are shown in **Figure 2-2**. Approximately 160 Mt of waste rock will be mined throughout the life of the mine. Waste rock will initially be used to construct infrastructure (e.g. access roads and ramps, RoM and stockpile bases, drainage structures and safety bunds) with the remainder stored in above ground WRDs or used to backfill pits.

WRDs will be designed to minimise the area of disturbance, maintain the overall surface water flows feeding into the Fortescue Valley and integrate into the surrounding landforms, with a height that enables a stable landform and minimises visual impacts.

2.2.3.5 Processing

Ore from the Proposal will be transported to two crushing plants to produce combined up to 12 Mtpa (dry) iron ore -14 mm fines product. One crushing plant will be located at the West Crusher location and the other plant will be located at the East Crusher location. The West Crusher will operate in its location for the first 11 years before relocation to a Central Crusher location for the remainder of the LoM. The East Crusher will remain in its position for the entire LoM.

Each crushing plant consists of:

- RoM bin/feed hopper;
- Vibrating grizzly;
- 1 x primary jaw crusher;
- Rock breaker;
- Primary screening unit;
- Surge bins above secondary and tertiary crushers;
- 1 x secondary cone crusher;
- 1 x tertiary cone crusher;
- 2 x secondary screening units;
- Conveyors;
- Sampling station; and
- Radial stacker.

Each crushing plant will be fed ore by front end loaders into the RoM bin/feed hopper. The product will be stacked by a radial stacker at each of the crushing plants, prior to being loaded by front end loaders into road trains and transported out of the Development Envelope.

2.2.3.6 Non-process Infrastructure

Linear Infrastructure

Linear infrastructure associated with the Proposal includes:

- Pipelines and powerlines and associated corridors;
- Haul and light vehicle roads; and
- Conveyor corridors.

Northern Haul Road

The Northern Haul Road is the primary haulage route to transport ore from the RoM pads to the Great Northern Hwy and also acting as the mine's main access road. The design of the Northern Haul Road was in response to Community Consultation, where proximity of the previous access route was determined to be too close to the Wirrilimarra Community (see Section 14.4.1 for further information). At the current level of design, the Northern Haul Road is approximately 36 km. To avoid excessive dust generation from this primary haulage route, HPPL have committed to sealing the length of the road from Great Northern Hwy to the RoM pads.

Power Supply

HPPL is considering several energy solutions for the Proposal. These include a combination of gas and renewable energy or diesel and renewable energy for onsite power generation.

To reduce greenhouse gas emissions associated with the Proposal, HPPL plans to construct a 9-13 Megawatt (MW) solar farm including the installation of piles, photovoltaic panels, and related infrastructure. It is important

to note that the solar farm will be dedicated solely to meet the power needs of the Proposal and will not export electricity offsite.

Water Supply and Demand

HPPL estimates a raw water demand of between 1,750 kL/d and 2,250 kL/d throughout the mining period water demands will be preferentially met by dewatering volumes and, if required, water treatment will ensure that the water quality criteria are met. It is intended that construction water will be sourced from the mining area and, as such will either provide advance dewatering and / or increased aquifer capacity for the disposal of excess water, dependent on the source area.

Surplus Water Management

As dewatering exceeds the required water demand, excess water will be disposed of by MAR within the Development Envelope. MAR is proposed on the slopes of the valley (i.e., in, and along strike of, the proposed mining areas) and will be implemented via purpose-built injection bores, re-purposed dewatering bores and in-pit infiltration.

Temporary water storages may be required to assist in managing water quality, for supply or prior to discharge.

The mining sequence is being determined based on the dewatering required and excess water management.

2.2.3.7 Support Infrastructure

The supporting infrastructure for the Proposal will include an airstrip and aerodrome facility, accommodation camp, and ancillary buildings such as workshops, telecommunications, and offices. Wastewater treatment plants (WWTP) to manage waste from the accommodation camp and ancillary buildings and a landfill to dispose of wastes generated from the mine are proposed within the Development Envelope.

Haul and light vehicle roads will be built to access areas of the mine and to allow for ore to be hauled to Port Hedland or rail siding along the Roy Hill rail mainline for export. Areas to store hydrocarbons and explosives and a mixing facility will be required, along with laydown areas and conveyors for the transportation of ore.

Other infrastructure required includes energy supply infrastructure; water abstraction borefields and water reinjection infrastructure; and pipelines and above ground water dams to manage supply or disposal of mine water. Evaporative ponds and water diversion channels and catchment ponds are also proposed.

The elements of the Proposal are listed in the PCD (**Appendix 1**) as required for EIA (EPA, 2021a).

2.2.3.8 Closure

Site-specific closure objectives and plans will be prepared for the Proposal. A PMCP (**Appendix 3**) has been developed with regard to the *Statutory Guidelines for Mine Closure Plans* (DMIRS 2023) and describes the process by which site rehabilitation will meet the planned objectives.

HPPL's overall closure vision for the MDIOP is to:

Establish a safe, stable and non-polluting environment with a self-sustaining and resilient vegetative cover, similar in species richness and density to the surrounding landscape, which supports the re-establishment of the pre-mining or other agreed land use and is compliant with all conditions and commitments.

The closure outcomes are necessary to provide the basis for developing completion criteria (DEMIRS, 2020a). The HPPL closure outcomes have been split into a number of environmental aspects impacted by the operation as detailed below:

Compliance

- Comply with all legally binding conditions and commitments relevant to rehabilitation and closure as summarised in a Legal Obligations Register (to be developed).

Landform

- Confirm that all closure landforms ensure the safety and health of workers and the general public; and
- Final mine landform designs achieve long term geotechnical stability and effective containment of any toxic or other deleterious material(s).

Water

- To minimise impact to hydrogeological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including the ecosystem, are protected; and
- Any water runoff or leaching from rehabilitated WRDs, creek diversions/reinstatements and residual infrastructure will not result in a decline of surface water or groundwater quality.

Revegetation

- To utilise closure strategies that return relinquished leases/tenements to a self-sustaining condition with little or no need for ongoing care and maintenance;
- To rehabilitate all previously disturbed areas to a self-sustaining and functional ecosystem, comprised of locally occurring species, that where practically possible blends with the surrounding landscape; and
- Soil properties of rehabilitated disturbed areas will be appropriate to support target ecosystems.

Waste

- All reagents, hydrocarbons and chemicals are removed from site with any residual site contamination neutralised or remediated through treatment such as not to detrimentally impact on future land use and water resources.

Post-Mining Land Use

- All Infrastructure associated with the mine will be removed unless value to the local community and/or landowners is recognised in which it is to be retained in an operational condition for transfer to local and regional authorities or appropriate stakeholder. Ongoing maintenance and liability for such structures shall be passed to the approved stakeholder;
- Where possible items of Aboriginal heritage value that were removed prior to mining are returned to their pre-mining location as agreed by the Aboriginal stakeholders; and

- Mine closure planning includes effective internal and external stakeholder consultation ensuring that all concerns/issues are considered during the development and implementation of the MCP.

Mine closure for the Proposal will be managed in accordance with the requirements of the Mining Act as regulated by DEMIRS. Where possible, rehabilitation will be undertaken progressively during the operational phase of the Proposal through phasing of works.

Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Native Title groups and the objectives of the PMCP, as required under the Mining Act. HPPL will back fill the pit voids to ensure backfill is above the water table after settlement, and as such permanent pit lakes after closure will be avoided. This will be further informed by future infield study work as part of the closure planning process.

HPPL has been in early consultation with key stakeholders, including pastoralists, during exploration and pre-feasibility studies. These consultations have included discussions relating to post mining land use and mine closure. From discussions held with stakeholders to date, the expectation is that, on completion of mining, the Development Envelope will be rehabilitated and returned to pastoral and low intensity cattle grazing land-use. HPPL will continue to consult with key stakeholders, including Traditional Owners, throughout the development of the Mine Closure Plan (MCP) on post mining land use and mine closure.

HPPL will liaise with key stakeholders to investigate opportunities to diversify into activities that utilise resources occurring naturally in the rangelands (e.g., seed collection for revegetation). HPPL will also engage with the Shire of Ashburton, Pilbara Development Commission and other stakeholders, including Traditional Owners, to understand any potential for retaining assets at closure (i.e. airstrip and mining infrastructure). Consultation with Traditional Owners will be undertaken regarding the burying of concrete, and the abandonment of buried infrastructure.

2.2.3.9 Rehabilitation

Where possible, topsoil and vegetation will be removed prior to construction or development and stockpiled in adjacent well-drained areas. Topsoil stockpiles will be managed so the material will be available for future rehabilitation operations. Rehabilitation will occur progressively across the LoM where feasible.

Each element of the Proposal will be rehabilitated as described below.

Open Pits

HPPL will back fill the pit voids to ensure backfill is above the water table after settlement, and as such pit lakes after closure will be avoided. This will be further informed by future infield study work as part of the closure planning process.

Waste Rock Dumps

Waste rock will be used to backfill open pits with excess located in waste landforms of maximum 35 m height that will be reprofiled to minimise lift height to a slope angle of ≤20°. WRDs will be designed to minimise erosion and the potential for surface water to pond. Consultation on the final WRDs at closure will be undertaken with Traditional Owners.

Processing Plant

The RoM will be reprofiled to a slope angle of ≤20°. The process plant will be removed and concrete footings either removed or buried at least 1 m below ground level. Consultation will be undertaken with Traditional Owners regarding the burying of concrete, and the abandonment of buried infrastructure.

Ancillary Infrastructure

All surface infrastructure not subject to a sequential use agreement will be removed. Suspected contaminated sites will be investigated as per the *Contaminated Sites Act 2003* (CS Act). Any culverts will be removed, and the surface will be re-shaped to blend into adjacent ground levels, reinstating natural drainage lines where feasible.

Consultation will be undertaken with Traditional Owners regarding the repurposing, removal, or the reallocation of ancillary infrastructure.

Rehabilitation Performance Monitoring

The environmental performance of rehabilitated landforms will be monitored until all completion criteria have been met. HPPL will select preliminary analogue rehabilitation monitoring sites which will be communicated to DEMIRS and the Department of Water and Environmental Regulation (DWER). Monitoring will be established as required throughout the LoM as rehabilitation progresses. Site inspections and general observations will be taken at rehabilitation sites. Regular monitoring of rehabilitated areas will be carried out where necessary and may include:

- Vegetation community structural attributes such as cover and species density;
- Vegetation community composition including the presence of desired species and weeds species;
- Soil assessment including development of erosion features, infiltration/runoff, and nutrient cycling;
- Habitat complexity assessment and vertebrate/invertebrate fauna abundance and richness (including pest species);
- Assessment of vegetative and soil structures of rehabilitated sites against that of nearby undisturbed areas, analogue sites, or landforms of best achievable rehabilitation; and
- Assessment of the stability and function of the rehabilitated soil profile against that of appropriate analogue sites.

As required under the Mining Act, the Mining Proposal (MP) and MCP will include completion criteria that has been developed based on a framework for developing mine-site completion criteria in Western Australia (Young et al. 2019). HPPL will consult with the Banjima People on the proposed completion criteria for the Proposal.

2.2.3.10 Fauna Habitat Exclusion Zone and Corridor

The Proposal includes areas of moderate and high value habitat for conservation significant fauna, including Rocky Hills, Drainage Line/ Floodplains, and Stony Spinifex Plains and Hillslopes habitats. These habitats provide foraging habitat proximal to the Category 4 nocturnal roosts for the Pilbara Leaf-nosed Bat and Ghost Bat, and also provide potential foraging habitat to other conservation significant species (refer to section 10.3.4) . HPPL has identified two areas that represent increased fauna habitat value that will not be developed:

- Fauna Habitat Exclusion Zone (FHEZ) - comprising an area of 1,320.82 ha. This area was excluded from the referred Development Envelope under a section 43A application (see Section 2.3.3.3).

- FHEZ Corridor - comprising an area of 991.45 ha within the Development Envelope.

The FHEZ and FHEZ Corridor have been identified as areas that represent increased fauna habitat value and play a key role in maintaining fauna values within the wider region. The purpose of the FHEZ and FHEZ Corridor is to mitigate, through avoidance, impacts to conservation significant fauna. The value of the FHEZ is enhanced and maintained by the inclusion of the FHEZ Corridor which comprises similar and supporting habitats. The purpose of the FHEZ Corridor is to ensure connection of the high value habitat within the FHEZ to habitat outside of the Development Envelope, to allow for the dispersal of fauna from the FHEZ to the Chichester Ranges and preventing fragmentation of terrestrial fauna habitat for MNES species such as the Northern Quoll.

The FHEZ is outside of the Development Envelope and will not support any Proposal activities. The FHEZ Corridor will remain within the Development Envelope and will accommodate minor, low impact activities including an un-sealed light vehicle access road to support infrequent light vehicle access to a communications tower (which will be located approximately 200 m south of the FHEZ Corridor) and monitoring activities. An infrastructure corridor is also proposed within the FHEZ Corridor however this will only be developed if the related Mulga Downs Hub and Rail Spur Proposal (Assessment No. 2358) is approved. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal.

The FHEZ and FHEZ Corridor will be subject to ongoing monitoring, see the Conservation Significant Fauna Management Plan (CSFMP) (**Appendix 12**).

2.2.4 Timeframes

The anticipated timeframes for the key Proposal construction, operation, decommissioning and rehabilitation dates are presented in **Table 2-3**. Note that all timeframes are subject to obtaining necessary approvals.

Table 2-3: Expected Timeframes

Activity	Timeline
Construction of associated mine infrastructure	FY 2026 – FY 2027
Construction of mine pits	Commencing in FY 2026
Operation	FY 2027 – FY 2045
Decommissioning	Progressively over the LoM
Rehabilitation	Progressively over the LoM

2.2.5 Exclusions

The scope of the Proposal which is under assessment (Part IV) of the EP Act specifically excludes the following:

- Investigative activities, including drilling and associated activities, for the purposes of resource evaluation, geotechnical assessment and hydrogeological investigations required to inform assessment of the Proposal. These activities are managed under other assessment and approval processes;
- Development and use of bores and monitoring sites to support studies and early works described above;
- Murray's Hill (EPA Assessment number: 13-243207) (refer to **Section 2.2.5.1**); and

- Mulga Downs Hub and Rail Spur (EPA Assessment number 2358) (refer to **Section 2.2.5.2**).

Separate approvals will be submitted for these activities / projects, as required.

2.2.5.1 Murray's Hill Project

The Murray's Hill Project (Murray's Hill) is a stand-alone, 5 Mtpa direct shipping ore (DSO) mine with a life of up to five years (including decommissioning and rehabilitation) proposed by HPPL. Murray's Hill involves only the above water table mining portion of the Murray's Hill pit, crushing and screening, associated mining infrastructure, accommodation camp and roads. The project comprises a disturbance footprint of up to 890 ha within a 3,018 ha Development Envelope. Up to 100 ha of the 890 ha footprint was already disturbed, therefore a total of 790 ha of native vegetation clearing is required to facilitate the project.

The Murray's Hill Project was referred to the EPA in 2013 (reference number 13-0000243207 EPA 2013). The EPA's decision was that it did not require environmental assessment under Part IV of the EP Act (Do Not Assess). It was determined that the Proposal was unlikely to result in a significant effect on the environment.

Impacts from Murray's Hill can be managed under Part V, Division 2, of the EP Act (Native Vegetation Clearing Permit) and the Mining Act administered by the DEMIRS. HPPL may commence construction of the Murray's Hill component earlier than the Proposal dependent on the granting of all necessary approvals (noting it forms part of the Commonwealth assessment).

The assessment of impacts for Murray's Hill was based on the Development Envelope within which an Indicative Footprint was used to indicate the likely extent of disturbance. The impact assessment was based on both a worst case (i.e., up to 890 ha disturbance anywhere within the Development Envelope, with a maximum of 790 ha of native vegetation clearing) and an indicative (i.e., clearing only within the Indicative Footprint) scenario. As such, the assessment approach for flora and vegetation and terrestrial fauna provided flexibility in terms of the final Disturbance Footprint for the Murray's Hill Project, provided:

- The Disturbance Footprint and maximum extent of clearing remains within the specified limits; and
- Environmental values that were to be avoided, are not impacted by the revised location.

Based on the above, the Murray's Hill Disturbance Footprint is consistent with the Murray's Hill Proposal referred to the EPA in 2013 and upon which a 'not assessed' decision by the EPA was based.

Given Murray's Hill (5 Mtpa DSO, above the water table mine) has been previously referred under the EP Act, it is specifically excluded from the assessment of the Proposal. As such, the MDIOM Indicative Footprint excludes the Murray's Hill Project. Within the Development Envelope for the Proposal, 394.60 ha of clearing is attributable to the Murray's Hill project and has therefore been removed from the impact assessment calculations for the Proposal. As the current Proposal includes dewatering there is an opportunity to access ore from below the water table within the Murray's Hill pit. Access to below the water table ore at Murray's Hill pit is therefore included in the current Proposal.

2.2.5.2 Hub and Rail Spur

The Mulga Downs Hub and Rail Spur (Hub and Rail) Project is a stand-alone project proposed by Roy Hill Infrastructure Pty Ltd (RHI).

RHI is undertaking planning for the Hub and Rail to service iron ore mining and export developments in the Pilbara region. The Hub and Rail Project will support the Proposal and other future ore developments and facilitate export opportunities for third party stranded ore from the region. The Hub and Rail is subject to a separate and independent assessment and approval process.

The Hub and Rail project includes:

- A Hub that will facilitate ore receival via truck unloading from third parties and via conveyor from the (adjacent) Proposal;
- Train loading and product rehandling facilities;
- Stockyards; and
- A connecting rail spur of up to approximately 63 km, to where it will connect with the existing Roy Hill Railway at approximate chainage 185 km.

The Hub and Rail project will support the export of approximately 45 Mtpa of iron ore.

The Hub and Rail was referred under both the EP Act and EPBC Act in December 2022. On 7 March 2022, the EPA determined the project should be assessed on referral Information (ARI) (additional information required) (EPA Assessment: 2358). DCCEEW determined on 8 March 2022 that the project is a 'Controlled Action' with an accredited assessment approach (EPBC 2022/09425).

2.3 Proposal Alternatives

2.3.1 Proposal Justification and Benefits

The Proposal will supply ore for approximately 18 years and will contribute to the supply of ore to the global market from HPPL's Pilbara Operations. The ore from the Proposal will ensure continued supply of tonnes and optimal product blending.

There are a number of significant social, economic and environmental benefits to be gained from the Proposal, including:

- Capital expenditure to benefit the economy;
- Earnings which generate royalties and taxes to government;
- Permanent employment positions;
- Direct and indirect employment and training opportunities;
- Opportunities for indigenous employment; and
- Baseline environmental studies that have been undertaken to support this Proposal and ongoing environmental monitoring during the life of the mine, which expands on the knowledge base of the flora and fauna in the Pilbara region of WA.

The Proposal is anticipated to provide approximately 438 permanent positions during operation with additional personnel required during construction.

2.3.2 Feasible Alternatives

2.3.2.1 Not Proceeding with the Proposal

Not proceeding with the Proposal would result in no impacts to key environmental factors aside from that which has already occurred through use of the land for pastoral purposes and exploration activities. The disadvantage in the short, medium, and long term would be the unrealised social and economic benefit from employment, and direct and indirect revenue generated from the mine. Given this, HPPL has designed the Proposal to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope to the extent possible through consideration of alternatives. These measures are discussed further in **Section 2.3.2.2**.

2.3.2.2 Alternative Location and Designs Considered

The location of the Proposal is determined by the iron ore mineralisation as identified by the mineral exploration program undertaken by HPPL since 2009. HPPL has undertaken comprehensive baseline studies and investigations to understand the environmental and social values surrounding and within the Development Envelope. These studies have informed the design of the Proposal and ensured potential impacts are avoided or minimised as far as possible. The Proposal is therefore the result of an iterative design and review process that has optimised specific elements, balanced with a precautionary approach to avoid, mitigate and manage potential environmental impacts.

The location of the Proposal allows for the utilisation of the proposed Mulga Downs Hub and Rail Spur, which (if approved) will facilitate transport of ore via rail from the Proposal (and other third party mines) to Port Hedland. The location of the open pits is fixed mine site assets as their location is determined by the prevailing geology and mineralisation. The area that the Proposal will permanently disturb may be reduced through outcomes of baseline studies, iterative mine planning, and consideration of closure options including in-pit backfilling with mine waste.

Non-fixed mine assets that have greater flexibility in terms of location within the Development Envelope include:

- Processing plant(s) and WRDs;
- Mine infrastructure: haul roads, conveyors, light vehicle roads, airport, landfill, WWTPs;
- Supporting infrastructure: accommodation camps, workshops, storage facilities, telecommunications, offices; and
- Energy supply infrastructure: diesel, gas, solar farm.

The location of these non-fixed assets has been optimised within the Development Envelope through applying the risk management hierarchy and minimising habitats that may support MNES. This process included consideration of:

- Land access;
- Heritage values (both archaeological and ethnographical sites);
- Environmental values (e.g. environmentally sensitive areas, threatened and priority flora, significant fauna habitats);
- Water management;
- Geotechnical and geomorphological risks;
- Materials availability;

- Economics;
- Constructability; and
- Ongoing stakeholder engagement.

The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since the referral of the Proposal on 24 December 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal on key environmental factors. An overview of each application is provided in **Section 2.3.3**. In summary, the key changes / alternatives have been made to the Proposal since the referral of the Proposal that avoid or minimise impacts include:

- A total reduction in the Development Envelope and Indicative Footprint of 23,804.47 ha and 5,288.84 ha respectively since referral of the Proposal in 2021.
- The addition of a Fauna Habitat Exclusion Zone (FHEZ). The area of the FHEZ also increased from 793.51 ha to 1,320.82 ha to protect a greater number of known Category 4 roosts and high-quality foraging habitat for the Pilbara Leaf-nosed and Ghost Bats. The area also provides important habitat for the Northern Quoll. The FHEZ is located within the boundary of the Development Envelope; however, has been excluded from, and does not form part of the 16,848.53 ha Development Envelope.
- The addition of a FHEZ Corridor within the Development Envelope. The Corridor will contain limited, low impact infrastructure and will provide connectivity between high value habitat within the FHEZ and the boundary of the Development Envelope. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal.
- Removal of the Mulga West Borefield and associated infrastructure, reducing the Indicative Footprint and avoiding habitat suitable for breeding by the Night Parrot (EN) and Grey Falcon (VU). In addition, by removing the Mulga West Borefield, the potential impacts to the dispersal of any Northern Quoll population on Mt Florance were reduced.
- Removal of the Malay Well tenement from the Development Envelope (E47/2117 and western section of R47/12), therefore removing the lodged Mungurrdu heritage site from within the Development Envelope.
- Removal of the southern mine access road referred to as ‘Fenceline Road’ and inclusion of an alternate haul road alignment from the MDIOM to Great Northern Highway (Northern Haul Road Access);
- Dry ore crushing and screening only (no wet processing) of up to 12 Mtpa;
- Waste rock volume reduced from 800 Mt to 160 Mt;
- Removal of Anticline South and Horseshoe South pits (a reduction from nine pit domains to seven pit domains), the reduction resulting in reduced associated lighting, noise and vibration;
- Removal of Malay Well tenement borefield removing the requirement for any mining infrastructure in the Mungurrdu lodged heritage site and any potential barriers to the movement of fauna across this area;
- A reduction in peak groundwater abstraction rate from 36.5 GL/a to 12 GL/a for water supply and mine dewatering, resulting in a reduction in the maximum extent of drawdown and mounding over the life of mine; and
- No requirement for in pit or ex pit Tailings Storage Facilities (TSF), removing any potential impacts to surface water, fauna habitat (including that for Migratory Birds) or sensitive areas as a result of contamination.

As the design of the Proposal develops, HPPL will continue to ensure impacts are minimised as far as practicable. Further detail around specific alternatives considered are outlined in **Table 2-4**.

Table 2-4: Consideration of Alternatives

Aspect	Proposal Description	Alternatives Considered	Justification for Chosen Option
Development Envelope	16,848.53 ha	Referred Development Envelope was 40,653 ha (reduced by 23,804.47 ha) and comprised: • Mulga West Borefield to the west; • Malay Well to the south, which intersects the recently Mungurrdu lodged heritage site; • Fenceline Road corridor to Great Northern Highway; and • Intersection with the Wittenoom Asbestos Management Area (WAMA).	As mine design progressed the Development Envelope (and elements and activities within the Development Envelope) was reduced wherever possible to reduce the area of potential disturbance to environmental and cultural values.
Indicative Footprint	4,339.16 ha	Referred Indicative Footprint was 9,628 ha (reduced by 5,288.84 ha) and comprised: • Infrastructure associated with Mulga West Borefield to the west; • Infrastructure associated with Malay Well to the south, which intersects the recently Mungurrdu lodged heritage site; • Clearing and disturbance associated with Fenceline Road haulage route to Great Northern Highway; • Three additional Pit domains: Murray's Hill West pit (now the FHEZ); Anticline South and Horseshoe South; and • Infrastructure and activities with the WAMA.	The alternatives to the Indicative Footprint are a direct result of continued mine design and updated information on the resource base knowledge, consultation with key stakeholders (including Traditional Owners) and to reduce potential environmental impacts associated with the Proposal, the Proposal has been amended to a reduced scale mine with a reduced Indicative Footprint.
Mining rate	12 Mtpa dry iron ore with an operational life of 18 years.	The referred mine was to produce 20 Mtpa (dry) iron ore with an operational life of 30 years.	The final option selected allows reduced potential environmental impacts as a direct result of continued mine design and updated information on the resource base knowledge, consultation with key stakeholders (including Traditional Owners) associated with the Proposal, and the most appropriate ore quality/ blending and pit optimisation.

Aspect	Proposal Description	Alternatives Considered	Justification for Chosen Option
Mine Pit Design	Seven pit domains, up to a depth of 1 bench (15 m) of Below Water Table (BWT).	The referred Proposal comprised 10 pit domains, three of which have now been removed. The proposed pit depth was up to 9 benches (108 m) of BWT.	The reduced pit deign is a direct result of consultation with key stakeholders (including Traditional Owners) and to reduce potential environmental impacts associated with the Proposal. The reduced pit scale reduces the Indicative Footprint and the extent of potential impacts to subterranean fauna and associated impacts from dewatering and MAR.
Tailings and processing	No wet processing of ore required. No tailings will be produced with DSO product (dry process), therefore no facility required to store tailings or wet waste product	The referred Proposal included wet processing of ore to produce 20 Mtpa (dry) iron ore product. Tailings was proposed to be initially stored in an above ground tailings facility for a maximum capacity of seven years. As an alternative, where possible mining will be scheduled to in-pit tailings disposal to provide a long-term solution.	The alternatives to the Indicative Footprint are a direct result of continued mine design and updated information on the resource base knowledge, consultation with key stakeholders (including Traditional Owners) and to reduce potential environmental impacts associated with the Proposal, the Proposal has been amended to a reduced scale mine. This has resulted in the following: Reduction in clearing footprint (construction and operations) to reduce impact to flora and vegetation and fauna habitat; Reduced closure requirements especially for the tailings facility; Removed the risk of contamination from TSF facilities; and Reduced water supply for processing of ore.
Site layout	The layout of infrastructure associated with the mine has been designed to avoid significant environmental and heritage assets, where possible.	The referred Proposal impacted the following: • Fauna habitat, including caves within the FHEZ; • Mungurrdu lodged heritage site; • Buffers of claypans know to support Migratory Bird species, when inundated.	The site layout has been developed to: • Avoid significant fauna habitat features; • Avoid significant heritage assets where possible; • Enable the establishment of a FHEZ corridor; • Minimise clearing requirements; • Reduce haul distances; and • Minimise cumulative impacts with the Mulga Downs Hub and rail Project by sharing infrastructure and haulage routes.
Transport Options	Northern Haulage Road (co-located with haulage for the Mulga Downs Hub and Rail Spur Project which minimises cumulative disturbance).	The referred Proposal proposed Fenceline Road for transport of ore from the mine to Great Northern Highway as an option in addition to transport via the Mulga Downs Hub and Rail Spur Project.	Removal of Fenceline Road is a direct result of consultation with Traditional Owners to reduce potential environmental impacts associated with the Proposal. The removal of Fenceline Road avoids areas of cultural significance to Traditional Owners.

Aspect	Proposal Description	Alternatives Considered	Justification for Chosen Option
Excess water disposal	Peak groundwater abstraction rate reduced to 12 GL/a for water supply and mine dewatering, resulting in a reduction in the maximum extent of drawdown and mounding over the life of mine. Up to 11 GL/a of mine dewater to be disposed of through Managed Aquifer Infiltration (MAR) and/or pit infiltration within the Development Envelope.	Peak groundwater abstraction rate of 36.5 GL/a for water supply and mine dewatering. Up to 33 GL/a of mine dewater to be disposed of through MAR.	Peak groundwater abstraction rate reduced resulting in a reduction in the maximum extent of drawdown and mounding over the life of mine and associate impacts on subterranean fauna.

2.3.3 Changes to the Proposal during Assessment

As a result of ongoing mine design and with greater knowledge gained from the studies and investigations undertaken to inform the environmental impact assessment, HPPL has made applications under Section 43A (s43A) of the EP Act to change the Proposal under assessment.

2.3.3.1 Section 43A Application – March 2023

As a result of ongoing mine design and with greater knowledge gained from the studies and investigations undertaken to inform the environmental impact assessment, HPPL submitted an application to amend the Proposal under s43A of the EP Act in March 2023. The amendments included the following:

- An overall reduction in the total area of the Development Envelope by 2,375.16 hectares (ha) to 38,277.84 ha (5.8% reduction). This reduction includes a 1,455.67 ha portion of the Development Envelope that was located within the Wittenoom Asbestos Management Area (WAMA).
- Overall reduction of the Indicative Footprint by 869.15 ha to 8,758.85 ha (9.0% reduction). This net reduction includes removing the Mulga West Pit (902.75 ha) and moving the evaporation pond(s) into pit void(s) (354.62 ha), as well as several minor additions to the Indicative Footprint.
- Reduction in waste rock extracted by 1,755.5 million tonnes (Mt) to 800 Mt (54.4% reduction).
- Surface water discharge will not be used, and surplus water will be managed through managed aquifer reinjection.
- Increase the abstraction of groundwater from 25 gigalitres per annum (GL/a) to 36.5 GL/a.
- Realigning the pipeline route to follow existing roads.
- Addition of a solar farm, an access road, and associated ancillary infrastructure.
- Excision of 791.91 ha from the Development Envelope for a Fauna Habitat Exclusion Zone.

The change to Proposal was approved on 29 May 2023. The assessment of impacts of the Proposal described in detail in this ERD incorporates these changes.

2.3.3.2 Section 43A Application – December 2023

A s43A was submitted to the EPA in December 2023 for the removal of the Mulga West Borefield. Based on the hydrogeological and groundwater quality constraints identified by the 2021 work, in combination with heritage and engineering challenges, the Mulga West tenure is no longer being considered as a contingency MAR option and as such, the Mulga West borefield is no longer proposed as part of the Proposal. The current process water demand can be met from the Mulga East tenure, given there is no shortage of similar quality groundwater within this area. The proposed approach for the Proposal is to limit impact and conserve water through “local” aquifer re-injection on the Mulga East and Malay Wells tenure, and therefore, these areas have become a key component of the current water management strategy, removing the requirement for the Mulga West borefield contingency area. The s43A application submitted in December 2023 was approved on 23 February 2024 and therefore this revision of the ERD incorporates the approved changes.

2.3.3.3 Section 43A Application – September 2024

The requested amendments to the Proposal are the result of ongoing mine design, increased knowledge gained from studies and investigations being undertaken to inform the impact assessment and continual investigation into application of the mitigation hierarchy to reduce potential environmental impacts from the Proposal. The following changes to the Proposal were approved under this s43A application:

- An amendment to and reduction of the extent of the Development Envelope as follows:
  - An overall reduction in the Development Envelope of from 24,851.5 ha to 16,848.53 ha (a difference of 8,003.47 ha);
  - An increase in the Fauna Habitat Exclusion Zone (FHEZ) from 793.51 ha to 1,320.82 ha;
  - Removal of the Malay Well tenement from the Development Envelope (E47/2117 and western section of R47/12), therefore removing the lodged Mungurrdu heritage site (DPLH reference 40484) from the Development Envelope; and
  - Inclusion of a haul road alignment from the MDIOM to Great Northern Highway (Northern Haul Road Access) to facilitate mine access.
- An amendment to and reduction of the extent of the Indicative Footprint as follows:
  - A reduction in the extent of the Indicative Footprint from 8,422.5 ha to 4,339.16 ha (a difference of 4,081.30 ha);
  - Removal of Anticline South and Horseshoe South pits (a reduction from nine pit domains to seven pit domains);
  - Removal of Malay Well tenement borefield, removing the requirement for any mining infrastructure in the Mungurrdu lodged heritage site (DPLH reference 40484); and
  - Inclusion of the Northern Haul Road Access for mine access.
- An amendment to the following key Proposal operational elements:
  - Dry ore crushing and screening only (no wet processing) of up to 12 Mtpa;
  - A reduction in peak groundwater abstraction rate from 36.5 GL/a to 12 GL/a for water supply and mine dewatering, resulting in a reduction in the maximum extent of drawdown and mounding over the LoM;
  - Up to 11 GL/a of mine dewater to be disposed of through MAR and/or pit infiltration within the Development Envelope;
  - No requirement for in pit or ex pit TSF, removing any potential impacts to inland waters, subterranean fauna or social surroundings from contamination;
  - Reduced greenhouse gas emissions; and
  - Waste rock volume reduced from 800 Mt to 160 Mt.

The s43A application submitted in September 2024 was approved on 4 October 2024 and therefore this revision of the ERD incorporates the approved changes.

3 Local and Regional Context

The information presented in the following sections has been sourced from the various baseline surveys desktop reports undertaken for the Development Envelope since 2018 and publicly available datasets. These sections are provided to describe the regional and local context of environmental values across the Development Envelope.

3.1 Interim Biogeographic Regionalisation of Australia

The Proposal occurs entirely within the Pilbara region (assigned the IBRA7 code PIL) as defined by the Interim Biogeographic Regionalisation of Australia (IBRA). IBRA is a national framework for establishing conservation planning and management which uses attributes to delineate boundaries and define regions, identifying key conservation values, types of threats and other attributes (Thackway & Cresswell 1995).

The Pilbara bioregion is divided into four IBRA subregions – Chichester (PIL01), Fortescue (PIL02), Hamersley (PIL03) and Roebourne (PIL04). The Development Envelope lies predominantly in the Fortescue subregion with very small sections in the Chichester subregion (**Table 3-1; Figure 3-1**).

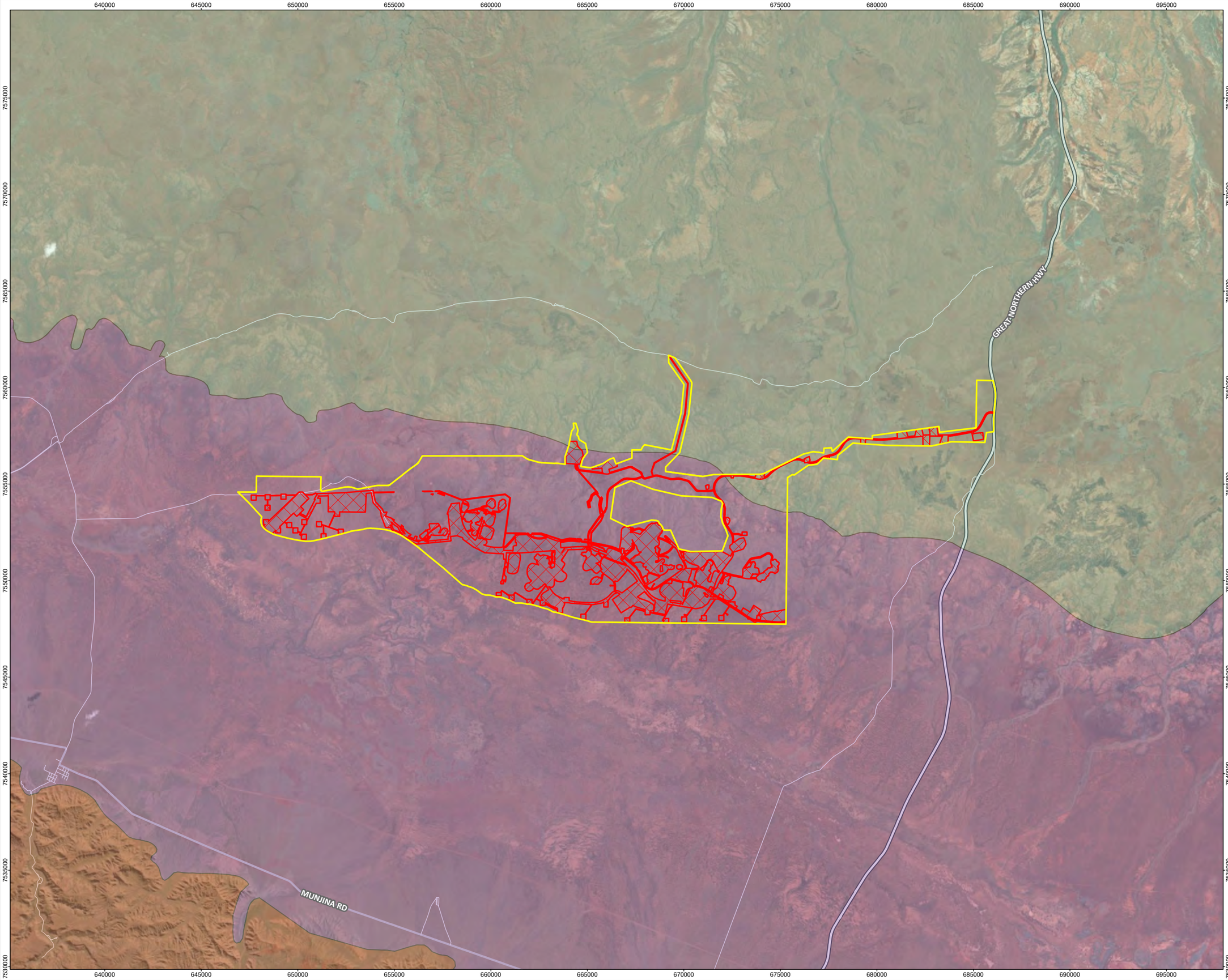
The Pilbara IBRA region occupies 17, 823,126 ha of Western Australia. It is bordered to the west and east by the more recent sedimentary Carnarvon and Canning basins respectively. The southern boundary of the Pilbara region is the biogeographic boundary known as the *Acacia-Triodia* line. This line, or more accurately transition zone, marks the transition from a landscape dominated by woody *Acacia* vegetation in the south to one dominated by spinifex vegetation in the north (Beard 1975, Beard 1990, Maslin & van Leeuwen 2008).

Table 3-1: The IBRA Bioregion and Subregions within the Development Envelope (IBRA7)

Bioregion	Biogeographic Subregion	Total Area (ha)	Extent within the Development Envelope (ha)
Pilbara Characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges. Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin, 2008).	**Chichester (PIL01)** Comprises the northern section of the Pilbara Craton (Kendrick & McKenzie, 2001). Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. The basalt plains host a shrub steppe characterised by *Acacia inaequilatera* over *Triodia* spp. hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The Chichester subregion drains to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock).	8,374,728.00	1,703.00

Bioregion	Biogeographic Subregion	Total Area (ha)	Extent within the Development Envelope (ha)
	Fortescue (PIL02) Characterised by alluvial plains and river frontage. The Fortescue Plains contains extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains, and river gum woodlands fringing major drainage lines (Kendrick & McKenzie, 2001The significant and dominant feature of this subregion is the Fortescue Marsh (the Marsh) – an ephemeral wetland which is the terminus of the Upper Fortescue River (EPA, 2013). The Lower Fortescue River arises from streams draining the Chichester and Hamersley Ranges below the Marsh and west of the Goodiadarrie Hills.	1,951,435.00	15,145.53
Total		**10,326,163.00**	**16,848.53**

Figure 3-1: Pilbara IBRA Subregions



Legend

- Development Envelope
- Indicative Footprint

IBRA Sub-regions (DCCEEW, 2020)

- Chichester
- Fortescue
- Hamersley

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PILBARA IBRA SUBREGIONS

FIGURE 3.1

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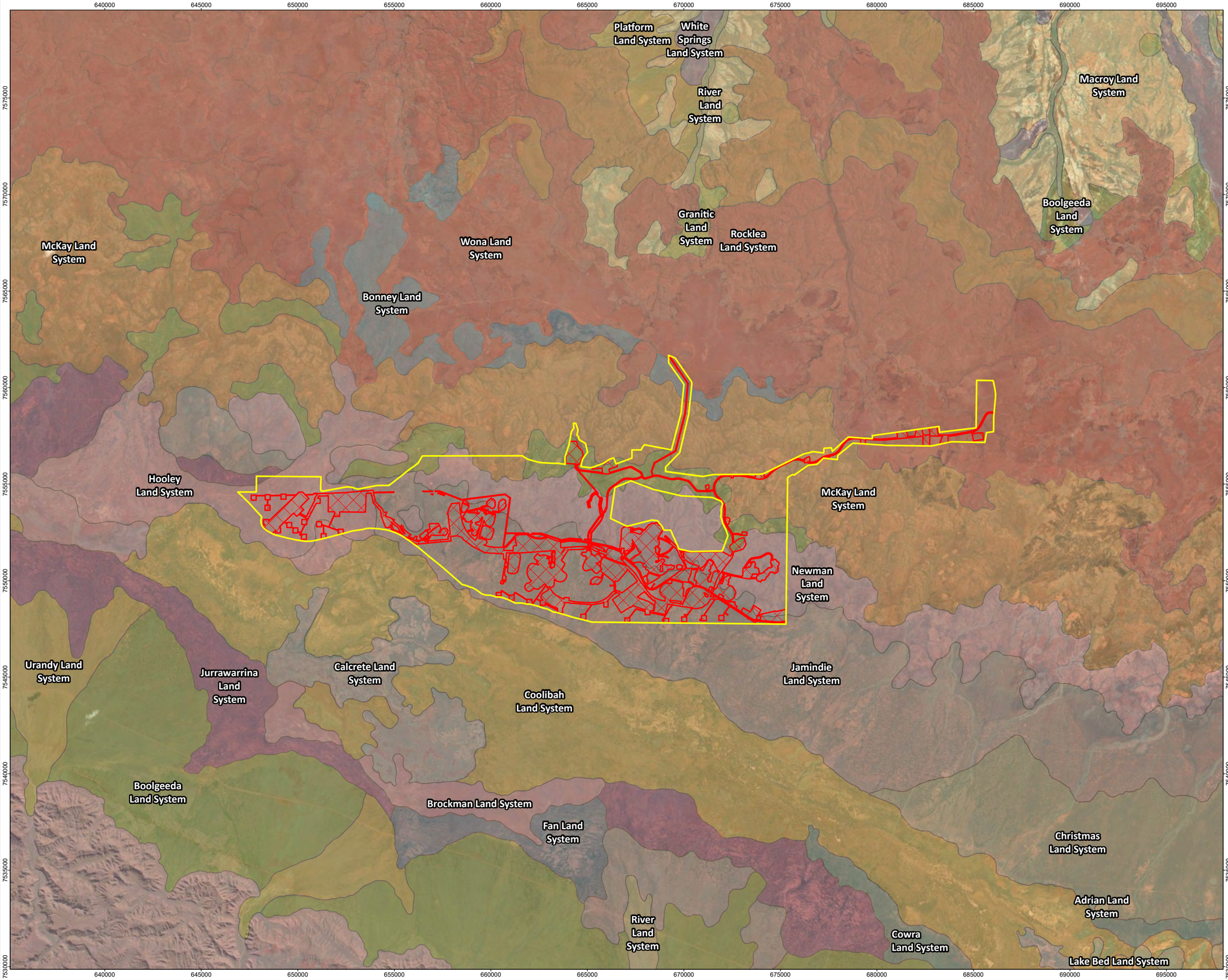
3.2 Land Systems

The Department of Primary Industries and Regional Development (DPIRD) has mapped and described the land systems of WA rangelands, providing a comprehensive description of biophysical resources, including soil and vegetation condition (DPIRD 063). The Development Envelope contains ten land systems as described in **Table 3-2** and shown in **Figure 3-2**.

Table 3-2: Land Systems within the Development Envelope

Land System	Description	Current Extent in the Pilbara Bioregion (ha)	Extent within Development Envelope (ha)	% of mapped extent in the Pilbara Bioregion that occurs within Development Envelope
Bonney System	Low rounded hills and undulating stony plains supporting soft spinifex grasslands.	74,940.55	61.07	0.08
Boolgeeda System	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	961,637.09	1,681.94	0.17
Brockman System	Level non-saline alluvial plains with clay soils and gilgai microrelief and flanked by slightly more elevated hardpan wash plains.	74,108.02	91.39	0.12
Hooley System	Level plains of clayey and stony alluvium as a mosaic of surfaces with gilgai microrelief, sometimes stony and non-gilgaied surfaces with abundant stony mantles.	59,081.14	1,578.16	2.67
Jamindie System	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	192,227.17	6,881.74	3.58
Jurrawarrina System	Plains receiving overland sheet flow and with prominent drainage groves.	66,474.69	17.79	0.03
McKay System	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.	426,144.89	1,514.26	0.36
Newman System	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,744.45	4,282.30	0.21
Rocklea System	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.	2,881,635.56	156.49	0.005
Wona System	Basalt upland gilgai plains supporting Roebourne Plains grass and Mitchell grass tussock grasslands, minor hard spinifex grasslands or annual grasslands/herbfields.	194,821.41	583.40	0.30
TOTAL		**6,924,814.97**	**16,848.54**	**0.24**

Figure 3-2: Land Systems within the Development Envelope



Legend

- Development Envelope
- Indicative Footprint

Landsystems (DPIRD-063)

- Adrian Land System
- Bonney Land System
- Boolgeeda Land System
- Brockman Land System
- Calcrete Land System
- Christmas Land System
- Coolibah Land System
- Cowra Land System
- Fan Land System
- Granitic Land System
- Hooley Land System
- Jamindie Land System
- Jurrawarrina Land System
- Lake Bed Land System
- Macroy Land System
- McKay Land System
- Newman Land System
- Platform Land System
- River Land System
- Rocklea Land System
- Urandy Land System
- White Springs Land System
- Wona Land System

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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LAND SYSTEMS WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 3-2

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3.3 Vegetation Associations

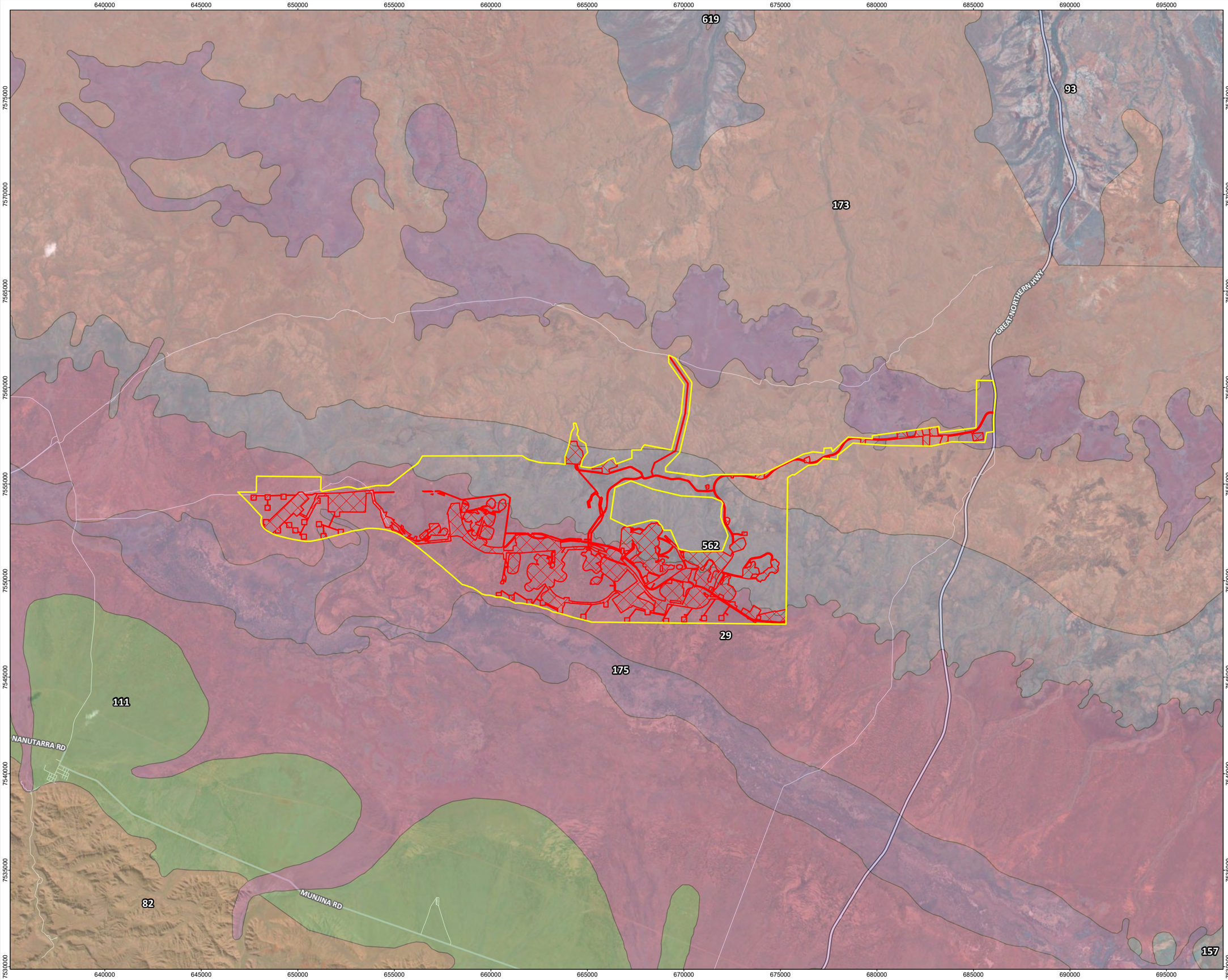
Vegetation at a pre-European regional scale has been described by Beard (1975). These vegetation units (vegetation associations) are broad scale and are aligned with landform, soil and topography. The Development Envelope comprises four broad pre-European vegetation associations (Beard 1975).

The pre-European and current extent of the vegetation associations mapped, and the extent of these vegetation associations within the Development Envelope are summarised in **Table 3-3** (Maia 2022) and shown in **Figure 3-3.**

Table 3-3: Vegetation Associations within the Development Envelope

Vegetation Association	Description	Pre-European Extent in the Pilbara IBRA (ha)	Current Extent Remaining in Pilbara IBRA (ha)	Extent remaining in the Pilbara IBRA (%)	Extent within the Development Envelope (ha)	% Represented in the Development Envelope
29	Low woodland, open low woodland or sparse woodland. Mulga (*Acacia aneura*) and associated species.	1,133,219.76	1,131,712.01	99.87	9,194.77	0.81
173	Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee. *Triodia spp., Acacia spp., Grevillea spp*., and *Eucalyptus spp.*	1,752,520.89	1,747,677.63	99.72	1,220.52	0.07
175	Grasslands, short bunch-grass savanna. Flora: Annual grasses *Enneapogon spp., Aristida spp*. etc on dry plains and saltwater grasses, *Sporobolus virginicus* on the coast.	507,860.16	507,466.80	99.92	466.42	0.09
562	Low tree-steppe. Flora: Hummock grassland with scattered bloodwoods and snappy gum *Triodia spp., Corymbia dichromophloia* and *Eucalyptus leucophloia*	103,606.82	103,606.82	100	5,966.82	5.76
Total		**4,049,940.67**	**4,043,141.76**		**16,848.53**	

Figure 3-3: Beard Vegetation Associations within the Development Envelope



Legend

- Development Envelope
- Indicative Footprint

Pre European Vegetation (DPIRD-006)

- 29,Low woodland, open low woodland or sparse woodland
- 82,Low tree-steppe
- 93,Shrub-steppe
- 111,Shrub-steppe
- 157,Grass-steppe
- 173,Shrub-steppe
- 175,Grasslands, short bunch-grass savanna
- 562,Low tree-steppe
- 619,Woodland other
- Highway
- Major road
- Minor Road

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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

BEARD VEGETATION ASSOCIATIONS WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 3.3

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3.4 Climate

The Proposal is located within the inland portion of the Pilbara which has a semi-arid climate with hot dry summers and mild winters, low rainfall and high evaporation. The region may experience periods of more than12 months of dry weather. Rainfall is typically associated with cyclonic and storm weather systems (van Vreeswyk et al 2004).

Additional climate information for the Development Envelope is further discussed in the Groundwater and Surface Water Impact Assessment (AQ2 2024a). An assessment of climate trends is also provided in the Mulga Downs Ecohydrology Study (AQ2 2024b).

3.5 Temperature

Prior to the establishment of a weather station at Mulga Downs circa 2022, the closest Bureau of Meteorology (BoM) weather station with climate recording data is Wittenoom (station number 005026), approximately 35 km south-west of the south-western section of the Development Envelope. Wittenoom station closed in 2019 and Karijini North (station number 005098), approximately 13 km southeast of Wittenoom and 32 km south-west of the Development Envelope, is now the closest and used for the most recent climate trends in the region. Data from both stations was used to provide temperature statistics for the Proposal (Maia 2021a).

Average daily maximum temperatures across the Pilbara are typically around 20°C in winter and exceed 30°C across the region in summer and early autumn. Average daily maximum temperatures tend to exceed 35°C from October to March and it is not uncommon to see temperatures more than 40-45°C (AQ2, 2024a).

3.6 Rainfall

Rainfall across the Pilbara region may be described as seasonal and highly variable. It is possible for significant rainfall events to be recorded in one location with minimal rainfall being recorded at the nearest alternative weather station. Rainfall is typically associated with cyclonic and storm weather systems (van Vreeswyk et al 2004). AQ2 (2024a) define three broad climatic periods:

- From 1900 until approximately 1970, there is an increasingly negative deviation from the long-term average rainfall, which indicates a dry period. There was a similarly increasingly negative deviation from the long-term average maximum temperature. Over this time only, average rainfall at Mulga East was 321 mm/year (compared with 359 mm/year as the long-term SILO average rainfall).
- For a circa 25-year period from 1970 to 1995, actual rainfall appeared to be close to the long-term average. Average rainfall at Mulga East over this period was 378 mm/year. Average maximum temperature was relatively stable.
- From 1995 to the present, the cumulative deviation became increasingly less negative indicating a wetter than average period. Average rainfall at Mulga East over this period was 445 mm/year. Maximum temperature shows a strongly increasing trend, and mean annual maximum temperature was 0.5˚C greater than preceding periods.

Rainfall has been recorded at Mulga Downs station since 1898, however continuous recording ceased in 2018 and only intermittent data has been available since (BOM, 2023). Annual rainfall can vary significantly in this area, ranging from a minimum of less than 30 mm to a maximum of over 1,000 mm in a single year. The average

annual rainfall across the Mulga Downs record was 363 mm (**Table 3-4**). A plot of the annual rainfall over the Mulga Downs rainfall record is shown in **Figure 3-4** and a time series is shown in **Figure 3-5.**

Table 3-4: Average Rainfall, Mulga Downs BoM Station 1898 – 2018 (AQ2, 2024a)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Annual
Mean Rainfall (mm)	84.2	77.3	61.4	23.6	24.1	23.2	13.2	6.8	2.4	2.9	8.5	35.1	**362.7**

The highest mean monthly rainfall is experienced between December and March with the mean highest monthly rainfall of 84 mm occurring in July. The lowest rainfall period typically falls between February and May, with a mean rainfall < 5 mm in March and April.

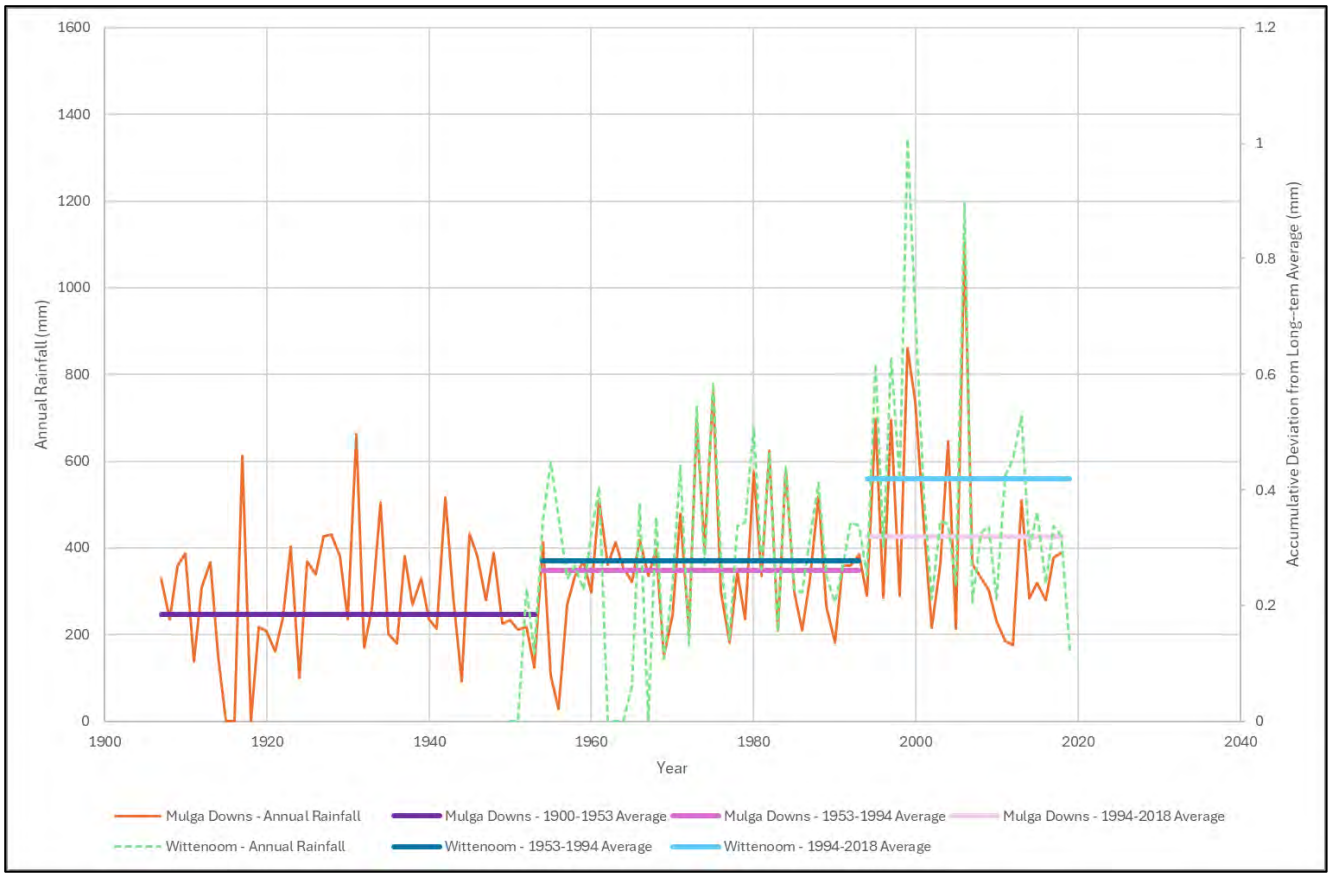
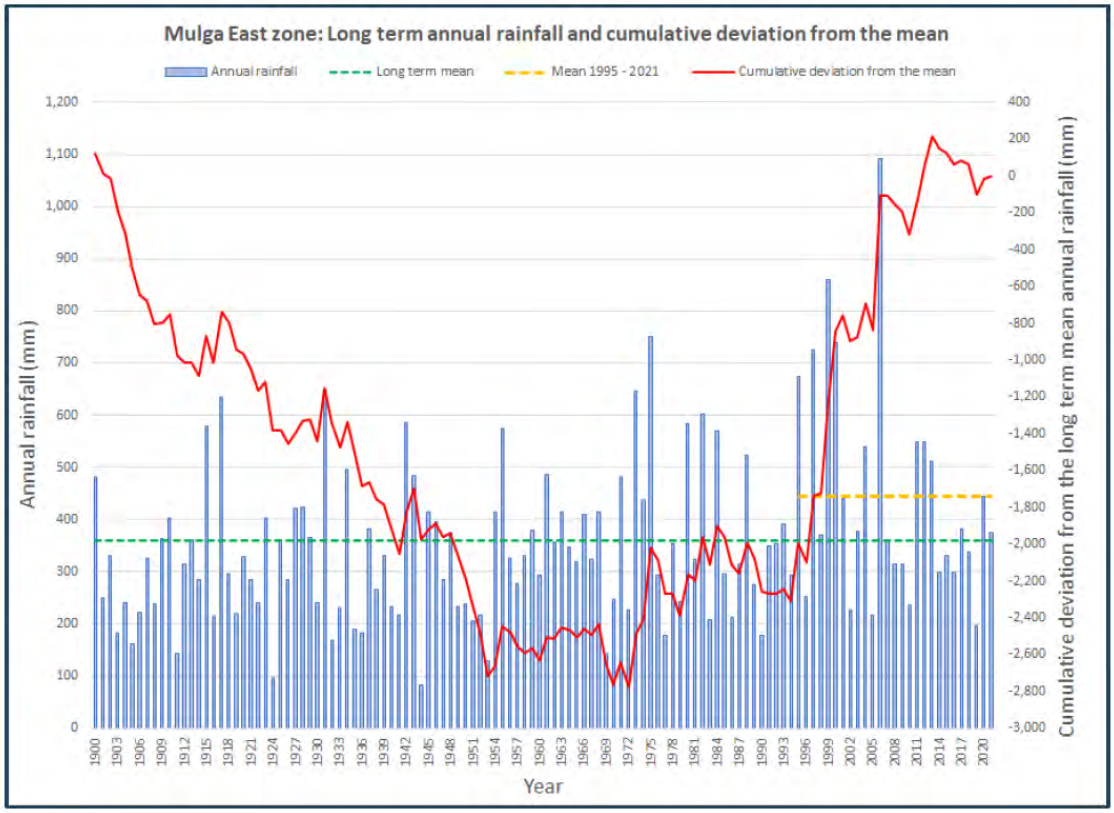


Figure 3-4: Annual Rainfall – Mulga Downs (AQ2 2024a)



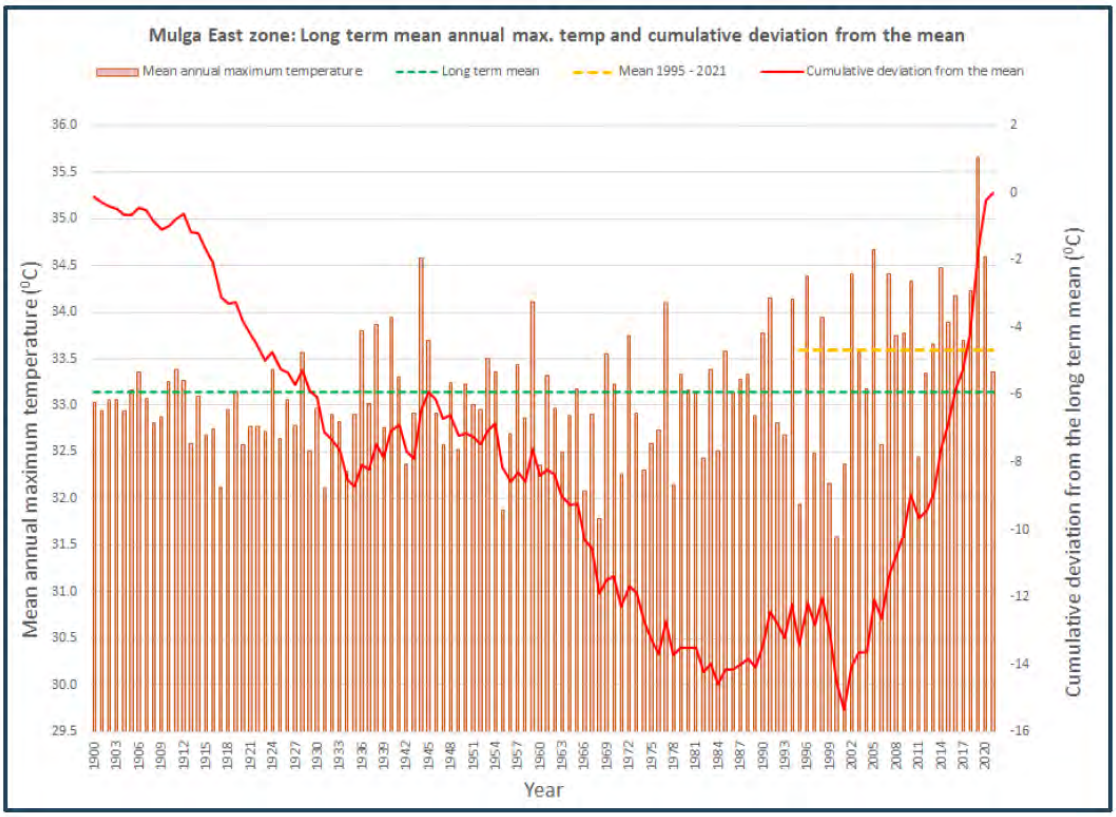


Figure 3-5: Time series of rainfall and temperature at Mulga East (AQ2, 2024a)

3.7 Wind

Wind rose data is only available from the Karijini North weather station. The wind roses in **Figure 3-6** and wind speed frequency in **Figure 3-7** suggest then the dominant winds are typically from the east and south-west, with little variation between the wet and dry seasons (SLR 2021a).

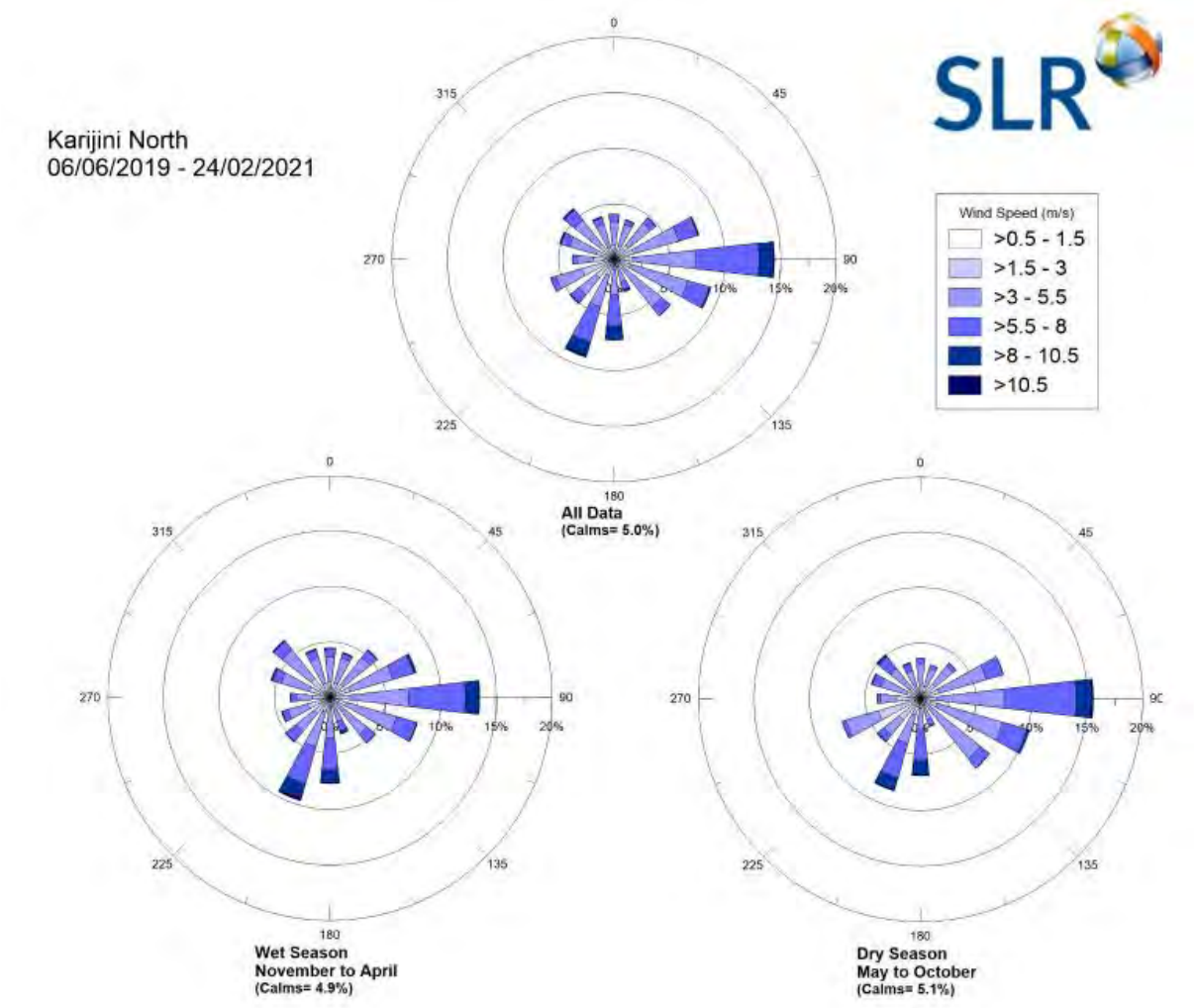
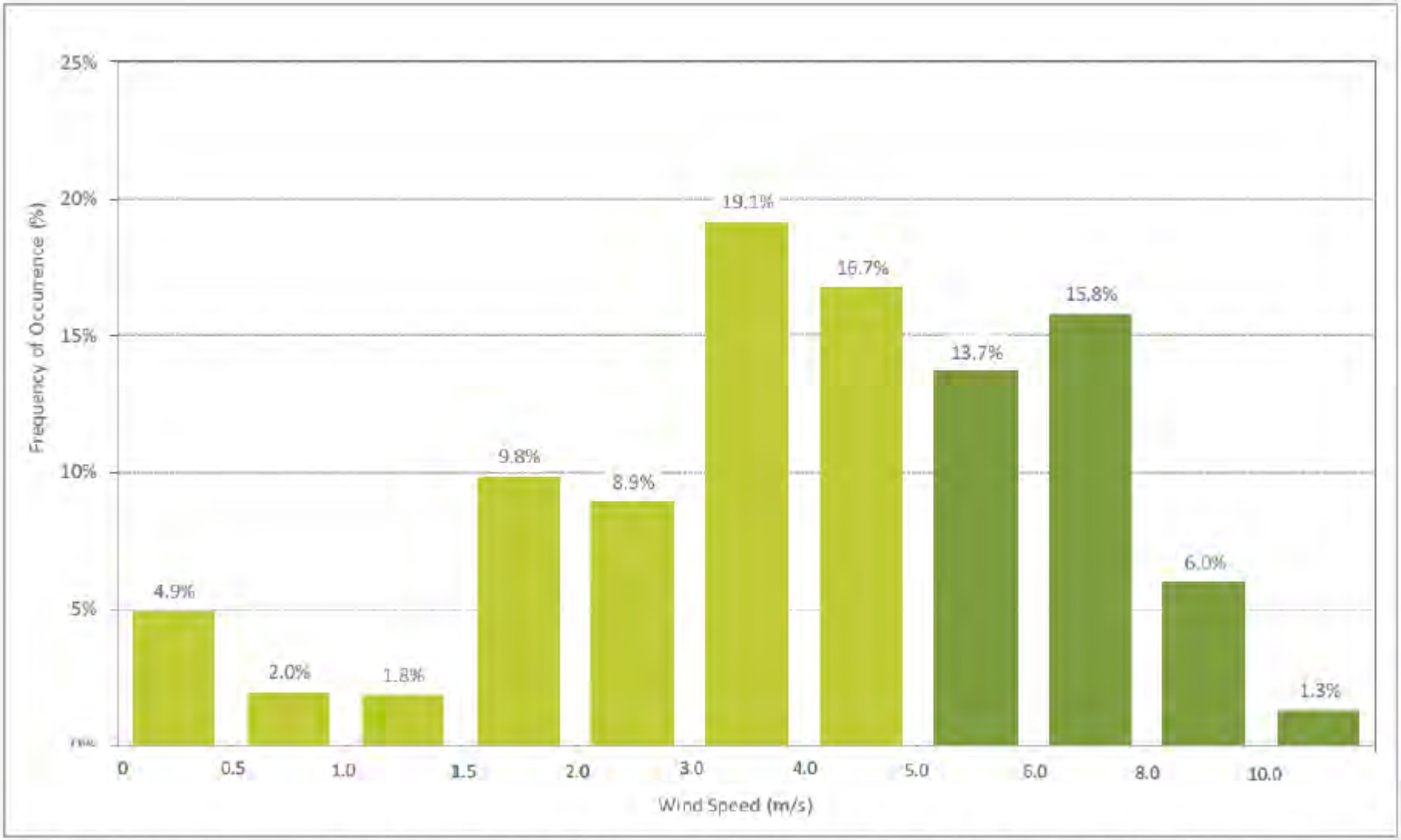


Figure 3-6. Wind data from Karijini North (Station 05098) (Source SLR 2021a)

Figure 3-7: Karijini North Wind Speed Frequencies June 2019 to February 2021. (Source: SLR 2021a)



Note: wind erosion of exposed surfaces is generally accepted to occur at windspeeds greater than 5 m/s, indicated here by the darker bars.

3.8 Evaporation

Evaporation is the most important factor regarding water loss across the region. Potential evaporation exceeds annual rainfall by a factor of at least eight and has a significant influence on both flora and fauna (McKenzie et al. 2009). Average pan evaporation data across Australia is illustrated in **Figure 3-8**. In the Pilbara pan evaporation rates vary between 3,200 mm and 4,000 mm per year. Average monthly and annual pan evaporation values obtained from BoM are presented in (BoM 2023) (**Table 3-5**) (AQ2 2024a).

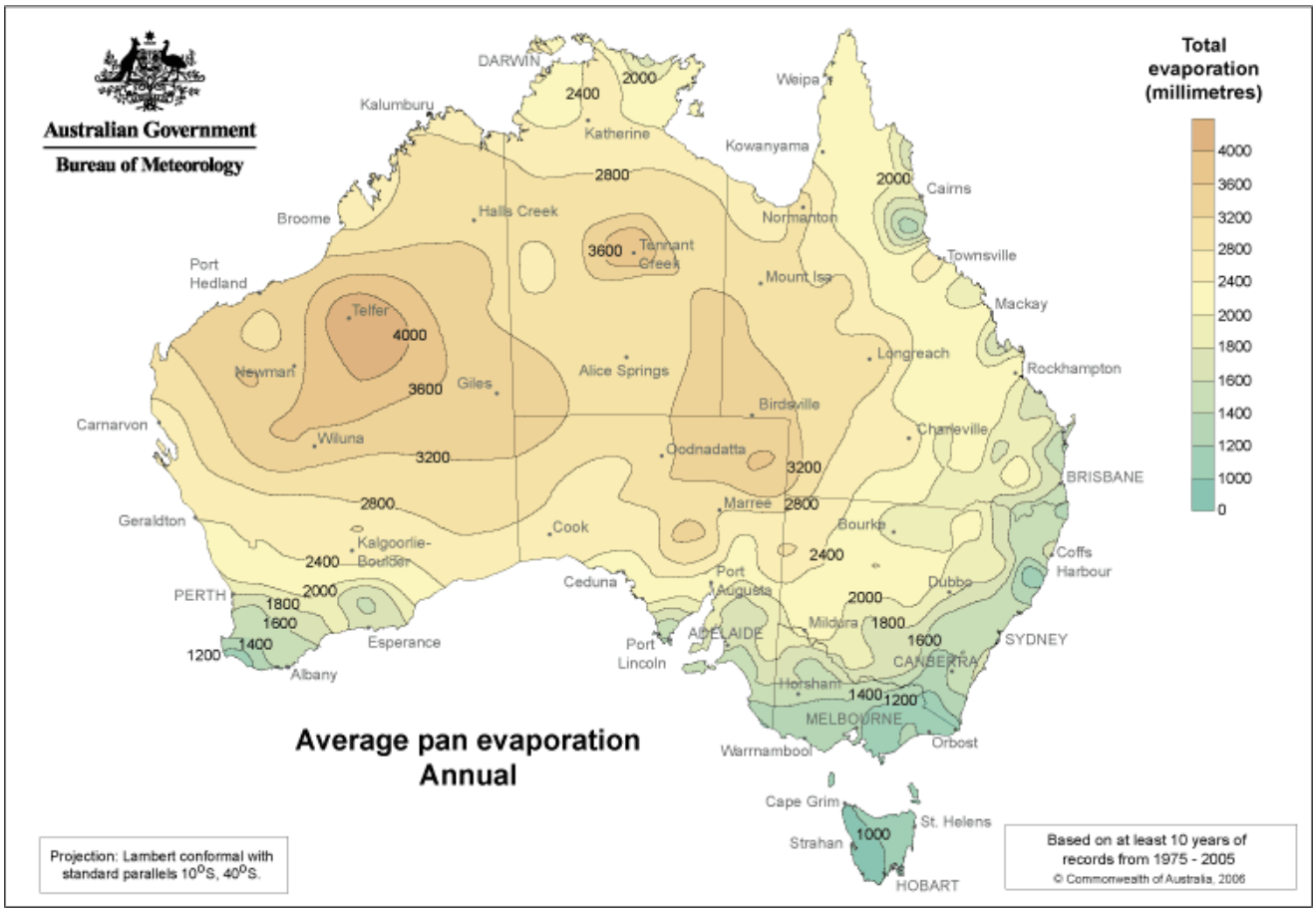


Figure 3-8: Annual Average Pan Evaporation Rate (Source: BoM, 2023)

Table 3-5: Wittenoom Mean Pan Evaporation (BoM) (AQ2, 2024a)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Annual
Mean Pan Evaporation (mm)	149	189	258	344	372	384	350	274	279	231	177	135	3,143

3.9 Geology

The Pilbara region occupies the northernmost portion of the ancient Western Shield (Beard 1990). The region is defined by the underlying sedimentary, volcanic, and igneous rocks of the Pilbara craton some of which are up to 3.72 billion years old (Pepper et al 2013).

To the north, the Archaean granites and metamorphosed volcanic rocks of the Pilbara Block form the undulating hills and plains observed throughout the Abydos Plain and Yule and De Grey River catchments. To the south, these older rocks are stratigraphically overlain by Archaean and Proterozoic basalts and iron rich sedimentary rocks (Banded Iron Formation – BIF) that comprise the Hamersley Basin (Beard 1990, van Vreeswyk et al 2004, Van Kranendonk et al 2002 in Pepper et al 2013). The Fortescue Valley forms part of the larger Hamersley Basin.

The Hamersley Basin comprises the geological strata that is key to the iron ore sector: the Marra Mamba and Brockman Formations. Both are hard and resistant and typically form dominant features in the landscape. The Hamersley Range forms the dominant geological (and topographic feature) to the south of the Development Envelope.

The Proposal is within the Fortescue Valley which is between the Hamersley Basin Province to the south and Pilbara Terrain to the north. **Figure 3-9** illustrates the spatial area occupied by these geological provinces. Local geology is further discussed in **Section7.3.5**.

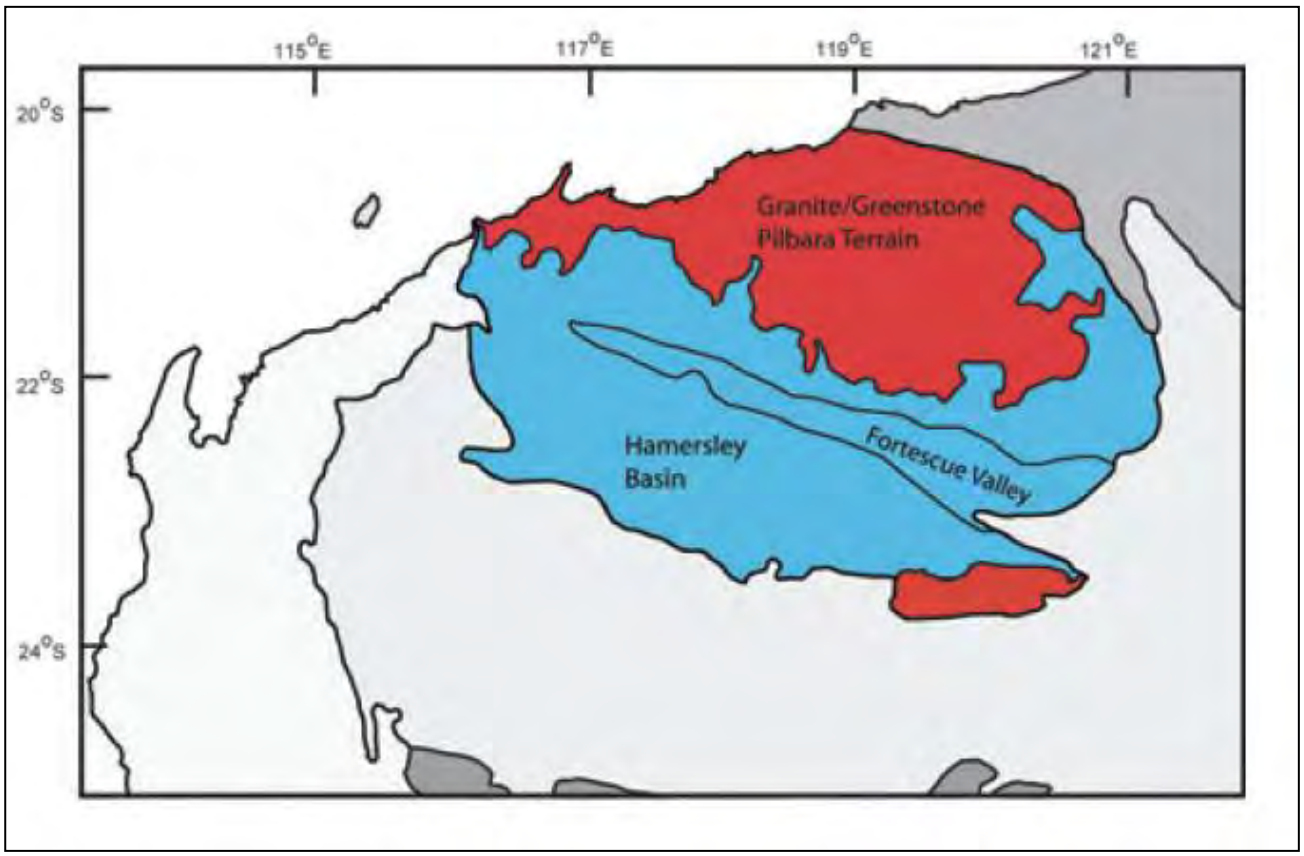


Figure 3-9: Simplified Pilbara Geology (Source Pepper et al 2013)

3.10 Soils

In general terms, soil development across the Pilbara region and associated ranges is poor. This is especially the case in the highest areas in the landscape. Soils are typically skeletal, shallow and stony having been derived either in situ or deposited as colluvial or fluvial materials with finer grained soils being more prevalent in the valleys. The parent geology and subsequent deep weathering of these rocks and leaching of the weathered materials has resulted in the soil being low in nutrients, slightly acidic, and of low fertility (Beard 1990, McKenzie et al 2009). Shallower soils were typically found in upland areas, with lowland soil profiles tending to be deeper (Landloch 2009; Mine Earth 2021).

The most extensive soils within the region comprise shallow stony soils on hills and ranges and sand on the sandplains (Landloch 2009, Mine Earth 2021). With reference to the landforms and assessment by van Vreeswyk et al (2004). The dominant Soil Groups occurring in the Land Systems across the Development Envelope are:

- Stony soils;
- Red shallow loams;
- Red loamy earths;
- Calcareous shallow loams; and
- Red-brown hardpan shallow loams.

Soils are classified as moderately permeable and tend to be moderately well-drained with water movement being limited by underlying rock. All soils are likely to have moderate plant availability water holding capacity (Mine Earth 2021).

3.11 Hydrology and Hydrogeology

3.11.1 Surface Water

The Fortescue Valley is dissected by the Goodiadarrie Hills into the Fortescue Marsh to the east, and the Goodiadarrie Swamp to the west (**Figure 3-10**). The Upper Fortescue River terminates at the Fortescue Marsh and the Lower Fortescue River rises to the west of Goodiadarrie Hills.

The Proposal is fully contained within the Goodiadarrie Swamp catchment. The Goodiadarrie Swamp comprises a series of variably interconnected ephemeral swamps, claypans, and floodplains that form a wetland mosaic over a distance of 70 km. Collectively, the Goodiadarrie Swamp catchment has an area of approximately 4,138 km². The Goodiadarrie Swamp catchment is bounded by the Chichester Range to the north and the Hamersley Range to the south (AQ2 2024b). Following rainfall events, surface water runoff reports to the Fortescue Valley from the northern Chichester Range and the southern Hamersley Range for a short duration.

Runoff from smaller rainfall events is likely to be contained within the Goodiadarrie Swamp area. Larger rainfall events may result in discharge to the Lower Fortescue River Valley which flows in a westerly direction towards the Indian Ocean (located approximately 500 km to the west). No permanent surface water sources are mapped within the Development Envelope; however, numerous non-perennial water courses are mapped across the area.

The incised drainage lines exit from the Chichester Range across a series of alluvial fans and across the sheetwash plains characterised by the Jamindie Land System. These drainage lines spread out and become braided as they flow into and across the various alluvial fans and claypans that exist along the valley. The multiple discharge points have contributed to the complex surface water environment that exists in this section of the Lower Fortescue River Valley.

The alluvial outwash fan deposits from the various drainage channels (and calcrete deposits) have influenced the evolution of the river valley and location of claypans (**Figure 3-11**). These have interrupted, diverted, and blocked the flow of water leading to the development of the swamp as observed today.

Further discussion on surface water is provided in **Section 7.**

Figure 3-10: Fortescue Valley including Goodiadarrie Swamp (SourceAQ2 2024a) *(Development Envelope no longer falls in E47/135)*

610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000

7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000 7520000

E 47/1315-I

E 47/2044-I

M 47/1621

NANUTARRA RD

Koodjeepindarranna Pool Extents

Central Claypan Flood Extent

GREAT NORTHERN HWY

MUNJINA RD

MUNJINA-ROY HILL RD

Legend

- Development Envelope
- Indicative Footprint
- Tenement boundary
- Potential Claypan Inundation Area (AQ2)
- Appoximate Goodiadarrie Swamp Region (AQ2)
- BHP rail
- TPIG rail
- Roy Hill rail
- Highway
- Major road
- Minor Road

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Scale 1:310,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

FORTESCUE VALLEY INCLUDING GOODIADARRIE SWAMP (SOURCE AQ2 2024A (DEVELOPMENT ENVELOPE NO LONGER FALLS IN E47/1315)

FIGURE 3.10

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 3-11: Surface water flows including claypans of the Fortescue River Valley

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000 688000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000 7538000

GREAT NORTHERN HWY

KOODJEEPINDARRANNA CLAYPAN

GNALKA GNOONA CLAYPAN

Legend

- Development Envelope
- Indicative Footprint
- Claypans (AQ2)

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes [WA066]
- Surface Water Flow Direction (AQ2)

Roads (LGATE-195)

- Highway
- Minor Road

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Drawn By: droberts	Checked By: VC

Scale 1:123,686 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

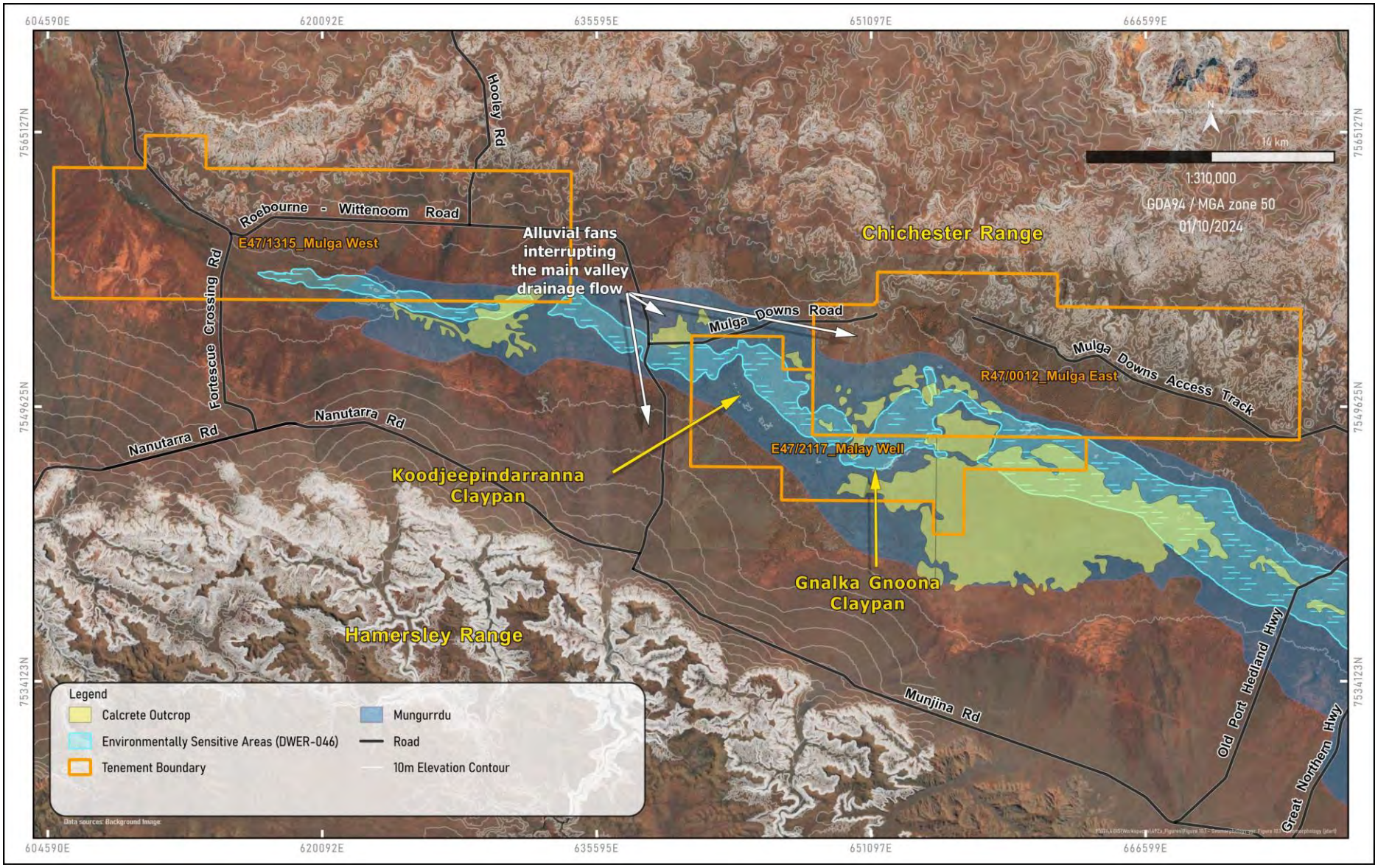
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SURFACE WATER FLOWS INCLUDING CLAYPANS OF THE FORTESCUE RIVER VALLEY

FIGURE 3.11

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 3-12: Geomorphology influencing claypans (Source AQ2 2024a)


604590E
620092E
635595E
651097E
666599E
7565127N
7549625N
7534123N
Roebourne - Wittenoom Road
Hooley Rd
Fortescue Crossing Rd
E47/1315_Mulga West
Alluvial fans interrupting the main valley drainage flow
Chichester Range
Mulga Downs Road
Mulga Downs Access Track
R47/0012_Mulga East
E47/2117_Malay Well
Nanutarra Rd
Nanutarra Rd
Koodjeepindarranna Claypan
Gnalka Gnoona Claypan
Hamersley Range
Munjina Rd
Old Port Hedland Hwy
Great Northern Hwy
14 km
1:310,000
GDA94 / MGA zone 50
01/10/2024
Legend
Calcrete Outcrop
Environmentally Sensitive Areas (DWER-046)
Tenement Boundary
Mungurrdu
Road
10m Elevation Contour
Data sources: Background Image

3.11.2 Claypans

The Koodjeepindarranna Claypan and Gnalka Gnoona Claypans are not located within the Development Envelope, however, the Development Envelope is located within their catchment areas **(Figure 3-12**). These two claypans are hydraulically linked by an overflow channel with surface flows from east to west following high rainfall events. Overflow from Gnalka Gnoona claypan into Koodjeepindarranna claypan would occur when water levels are above 402.75 m, Australian Height Datum (AHD).

The Gnalka Gnoona Claypan can form into an extensive (> 1,000 ha) waterbody that may persist for extended periods. There are records of these claypans being inundated for several years following continuous favourable climate sequences. In combination with channels and smaller depressions, the claypans form an interconnected mosaic of wetlands supporting biological metacommunities. This is characteristic of arid zone wetlands and the pattern of delayed emergence of dormant biota. These areas are considered significant habitat for migratory, transient and resident birds. They also form vital refugia for many invertebrates (Pinder et al. 2017; Biologic 2023). Maintaining the connection between the two claypans is important in maintaining biodiversity values with a more resilient population developing from a greater gene pool than if isolated for extended periods.

The claypans appear to be inundated on a regular basis and it is likely that hydrologic responses from average, relatively frequent rainfall events are important in maintaining ecosystem function at the claypans (i.e. ecosystem function does not just rely on high magnitude low frequency runoff events).

3.11.3 Groundwater

Hydrogeology across the Development Envelope and surrounding area is dominated by four units within the stratigraphic sequence (**Figure 3-13** and **Figure 7-13** to **Figure 7-16**; AQ2 2024a):

- Tertiary and Quaternary cover (comprising Basal Crete, CID/Pisolite, Undifferentiated Tertiary and Upper Calcrete);
- Dolomite of the Wittenoom Formation;
- Altered Marra Mamba Iron Formation (including the West Angela member); and
- Fresh Jeerinah and Marra Mamba Iron Formations.

These bedrock and valley units host the groundwater system across the Development Envelope and surrounding area. Secondary permeability, which is typically related to mineralisation of the bedrock, fracturing, and weathering was observed throughout the majority of the Marra Mamba Iron Formation and the overlying West Angela Member. The baseline studies and conceptual model indicates these units are in hydraulic connection and form a transmissive basement aquifer.

The permeable bedrock units are sandwiched between the two aquitards: the underlying Jeerinah Formation and Nammuldi Member, and the overlying Wittenoom Formation within the valley area (as identified during the baseline survey and from the exploration geological records).

The Jeerinah Formation comprises black, pyritic and carbonaceous shales with minor chert beds which weather to a pink, brown and white clay. Together with the overlying Marra Mamba Member it forms the basement aquitard. The overlying aquitard comprises the light grey, fresh, crystalline and hard Wittenoom dolomite the

majority of which has low permeability. Locally there may be areas or zones of higher permeability as a result of localised weathering and fracturing of the Paraburdoo Member of the dolomite sequence. Elsewhere in the Pilbara the Paraburdoo Member is considered as a regional aquifer. The baseline survey has demonstrated this is not the case in the vicinity of the Development Envelope.

The bedrock sequence is overlain by the Tertiary (and later Quaternary) materials that have been derived from the erosion of the adjacent Chichester and Hamersley Ranges and deposited within the Fortescue River valley, hence their collective name: detritals. The Tertiary detritals form an unconfined aquifer.

Recharge to the groundwater system occurs through infiltration or seepage following rainfall events, typically during the summer wet season (AQ2 2024a).

The groundwater levels across the Development Envelope vary between 398 metres Relative Level (mRL) to 420 mRL. Depths to groundwater vary between 3 to 4 m below existing ground level across the river valley to in excess of 40 m across the upper areas of the Chichester Range. Groundwater flows are, as expected, from the topographically higher areas in the north and north east to the river valley in the south, which in turn flows in a westerly direction along the valley (**Figure 3-14**). The groundwater gradient is low in response to the transmissivity of the materials across the Proposal and surrounding area.

Groundwater across the Development Envelope has the following water quality characteristics (AQ2 2024a):

- Groundwater quality varies from fresh to saline. The fresher groundwater (total dissolved solids (TDS) 180 mg/L or EC 330 µS/cm) was observed in the upper areas of the groundwater system whilst the more saline groundwater was observed in the valley (TDS 18,000 mg/L or 23,000 µS/cm).
- The saline groundwater is caused by the evaporation in the claypans following periods of rainfall and surface water runoff to the claypans. Further, mobilisation of salts in the unsaturated zone contributes to saline groundwater.
- Groundwater down gradient of the orebodies, in the valley area, is generally chloride and sodium dominant, indicative of an end point (“older”) water, suggesting the groundwater has been subject to evapotranspiration and / or mineral dissolution since it was recharged or it has been affected by the leaching of salts from the claypan areas .

Figure 3-13: Hydrogeological Cross Sections in Mulga East (AQ2 2024a)

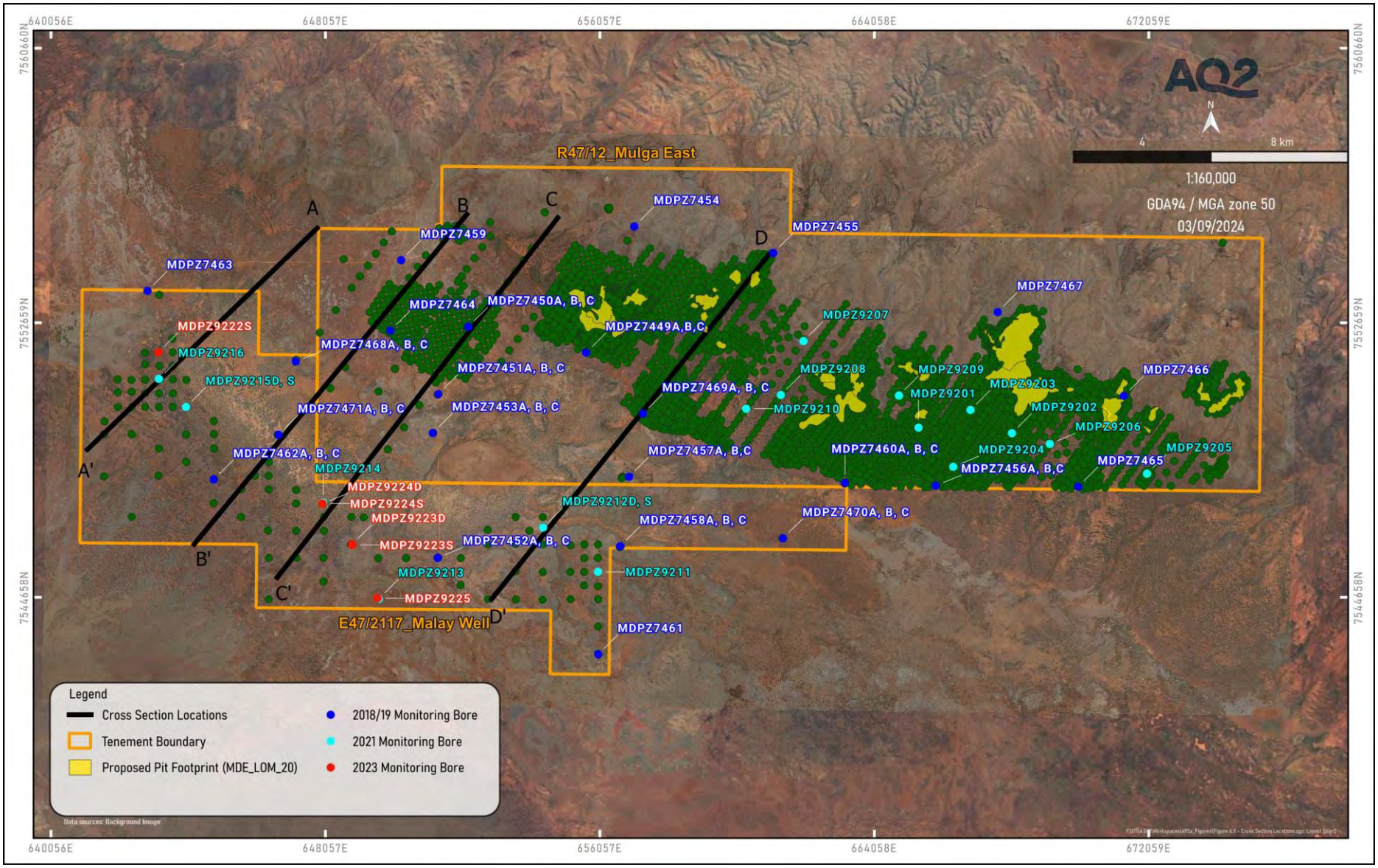
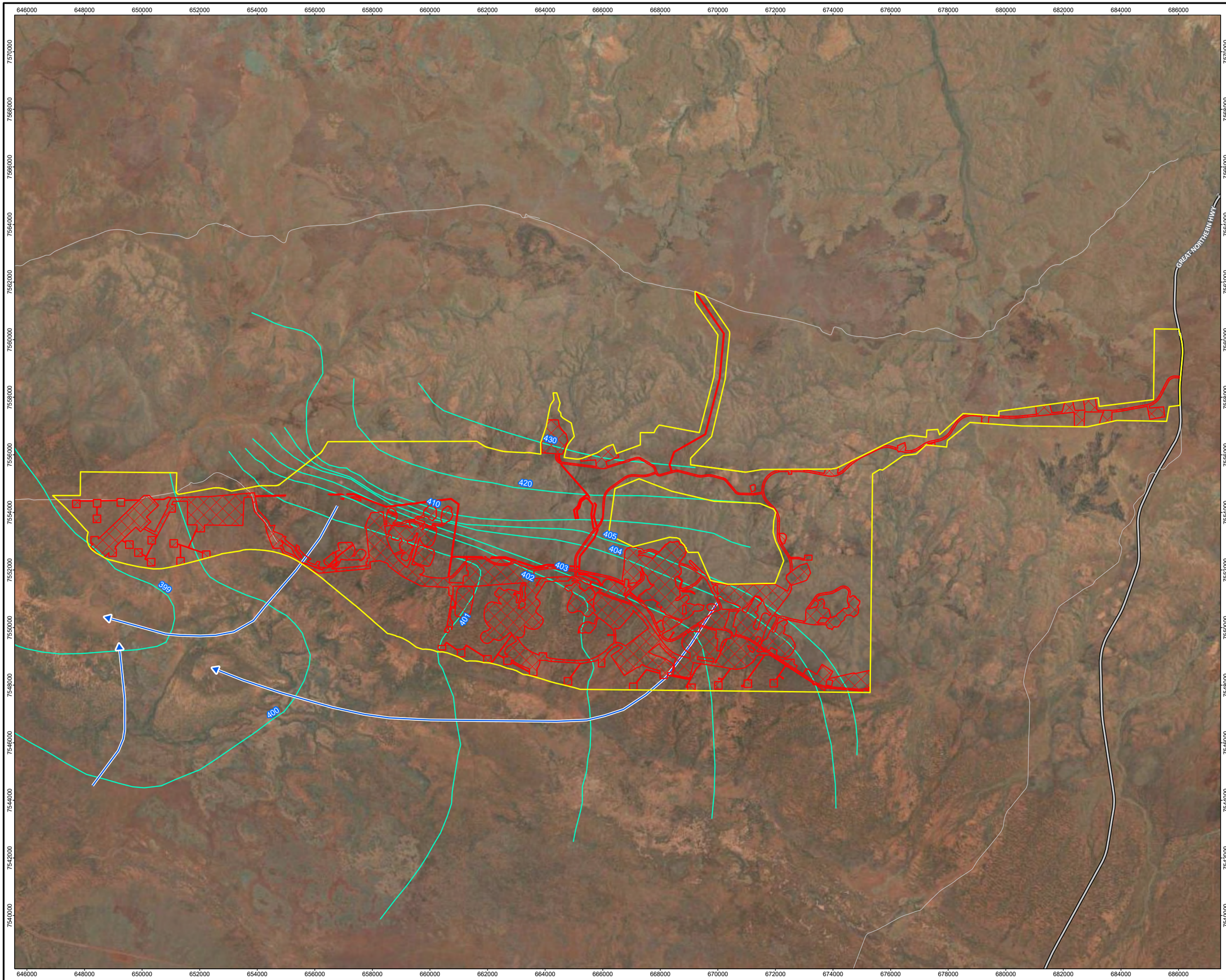

640056E
648057E
656057E
664058E
672059E
7560660N
7552659N
7544658N
AQ2
N
4
8 km
1:160,000
GDA94 / MGA zone 50
03/09/2024
R47/12_Mulga East
E47/2117_Malay Well
A
A'
B
B'
C
C'
D
D'
MDPZ7454
MDPZ7455
MDPZ7459
MDPZ7463
MDPZ7464
MDPZ7450A, B, C
MDPZ7449A,B,C
MDPZ7467
MDPZ9207
MDPZ9222S
MDPZ9216
MDPZ7468A, B, C
MDPZ7451A, B, C
MDPZ9208
MDPZ9209
MDPZ7466
MDPZ9215D, S
MDPZ7469A, B, C
MDPZ9203
MDPZ9201
MDPZ9210
MDPZ9202
MDPZ7471A, B, C
MDPZ7453A, B, C
MDPZ9206
MDPZ7462A, B, C
MDPZ7457A, B,C
MDPZ7460A, B, C
MDPZ9204
MDPZ9205
MDPZ9214
MDPZ7456A, B,C
MDPZ7465
MDPZ9224D
MDPZ9224S
MDPZ9212D, S
MDPZ9223D
MDPZ7458A, B, C
MDPZ7470A, B, C
MDPZ9223S
MDPZ7452A, B, C
MDPZ9213
MDPZ9211
MDPZ9225
MDPZ7461
Legend
Cross Section Locations
Tenement Boundary
Proposed Pit Footprint (MDE_LOM_20)
2018/19 Monitoring Bore
2021 Monitoring Bore
2023 Monitoring Bore
Data sources: Background Image

Figure 3-14: Groundwater Level Contours (AQ2 2024a)



Legend

- Development Envelope
- Indicative Footprint
- Groundwater flow direction
- Groundwater contours (m AHD)

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Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GROUNDWATER LEVEL CONTOURS

FIGURE 3.14

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

3.12 Land Use and Heritage

3.12.1 Conservation Reserves and Wetlands

The Development Envelope does not overlap any recognised conservation areas. Two land areas managed for conservation purposes by Department of Biodiversity and Conservation and Attractions (DBCA), Karijini National Park and the Mungaroona Range, occur in close proximity to the Proposal.

The Development Envelope is located to the north of the Fortescue Valley, a designated ESA (Fortescue Marshes WA066 – DIWA, refer to **Section 3.12.2**). The Development Envelope is offset from and completely avoids this ESA (**Table 3-6; Figure 3-15**). There are no Ramsar listed wetlands within the Development Envelope or that the Proposal intersects. There is no nomination for a Ramsar listing within or immediately adjacent to the Development Envelope.

Table 3-6: Managed Lands within proximity to the Development Envelope

Type	Name	Description	Consideration
National Park	Karijini	Karijini National Park occupies an area of 627,422 ha. The park comprises a high plateau with mountains and escarpments which is dissected by steep sided, deep gorges.	Approximately 16 km from southern Development Envelope boundary. No impacts anticipated as a result of the Proposal; however, the location of the park in proximity to the Proposal is considered where relevant.
Nature Reserve	Mungaroona Range	The Mungaroona Range occupies an area of 105,842 ha.	Approximately 13 km to the north of the Development Envelope boundary. No impacts anticipated as a result of the Proposal, however, the location of the range in proximity to the Proposal is considered where relevant.
Nature Reserve	Fortescue Marsh	Fortescue Marsh Nature Reserve occupies an area of approximately 107,000 ha.	Approximately 43 kilometres from the closest point of the Development Envelope. No impacts anticipated as a result of the Proposal, however, the location of the reserve in proximity to the Proposal is considered where relevant.
Aboriginal Community / Pastoral Station	Yandeyarra Reserve	Yandeyarra (also referred to as Mugarinya) is a large Aboriginal community, with a population of over 400 people. The community is located within the Yandeyarra pastoral station.	Approximately 6 km from the closest point of the Development Envelope (where the haul road meets the GNH). No impacts anticipated as a result of the Proposal, however, the location of the reserve in proximity to the Proposal is considered where relevant.
ESA	Fortescue Valley	The area of the Fortescue Valley, located in proximity to the Development Envelope, is a wetland of national importance and is listed (WA066) in the Directory of Important Wetlands (DIWA) (national). Refer to **Section 3.12.2**.	The Development Envelope is offset from and avoids the ESA. Potential impacts to the Fortescue Valley are discussed throughout this ERD.

Figure 3-15: Conservation Reserves and Wetlands

625000 630000 635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000 700000 705000 710000

7585000 7580000 7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000 7525000

Mungaroona Range Nature Reserve

YANDEYARRA ABORIGINAL RESERVE

NANUTARRA RD

MUNJINA RD

GREAT NORTHERN HWY

Karijini National Park

MUNJINA-ROY HILL RD

Legend

- Development Envelope
- Indicative Footprint
- Yandeyarra Aboriginal Reserve (LGATE-227)
- Environmentally Sensitive Areas (DWER-046)

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes [WA066]

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

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Job No: 67751

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Drawn By: droberts	Checked By: VC

Scale 1:250,000 at A3

0 4 8
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION RESERVES AND WETLANDS

FIGURE 3.15

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

3.12.2 Fortescue Valley

The Fortescue Valley contains two consecutive Fortescue Rivers: the Upper Fortescue which terminates at the Fortescue Marsh (the Marsh) and the Lower Fortescue which starts below the Marsh eventually discharging to the ocean. Above the permanent pools of Millstream National Park, the Fortescue River flows episodically only after significant rains so that for the majority surface water in only present in isolated pools (Pinder et al 2017).

The Fortescue Valley is split by the Goodiadarrie Hills (a ~5 m barrier that forms a surface water and potential groundwater divide) into the (eastern) Fortescue Marsh and the (western) Goodiadarrie Swamp. The Fortescue Marsh is the largest ephemeral wetland in the Pilbara region and is recognised as a nationally important wetland. A second groundwater and surface water divide exists to the west of the Goodiadarrie Swamp, separating the Goodiadarrie Swamp from the Lower Fortescue River (AQ2 2024b). Downstream of Goodiadarrie the Fortescue starts a new catchment receiving intermittent flows from the Chichester and Hamersley Ranges. The Fortescue River does not form distinct continuous channels until 90 km downstream of Mt Florance Station (Pinder et al 2017).

The Marsh is located approximately 60 km from the Development Envelope and is the largest ephemeral wetland in the Pilbara with the water regime supporting a number of environmental values (EPA 2013). The Marsh is currently managed by the DBCA in accordance with the Fortescue Marsh Management Strategy 2018-24 (DBCA 2018). The Marsh is considered to be geographically, hydrologically and hydrogeologically separate to the Lower Fortescue River system.

In respect to being recognised as a wetland of national significance, the Fortescue Valley is listed in the Directory of Important Wetlands in Australia (DIWA). The DIWA boundary extends well west of Goodiadarrie Hills and includes the floodplains and the wetland complexes of the Mulga Downs area up until the Roebourne – Wittenoom Road (Pinder et al 2017). This area is listed in DIWA as the Fortescue Marshes - WA066.

The Fortescue Marsh (DIWA - WA066) above the Goodiadarrie Hills, was previously proposed to be nominated as a potential Ramsar site providing refuge, habitat and feeding areas for waterbirds, including many migratory species, when inundated (Trainor *et al*. 2016; EPA 2013). The RAMSAR nomination is no longer being pursued, however following an exercise to excise targeted parcels of lands from pastoral leases, a Nature Reserve was created in September 2024.

The Fortescue Marsh Management Strategy 2018-2024 (the strategy) was developed by the State Government and provided interim guidance during the creation of the nature reserve. The objective of the strategy was originally intended to "*develop an ecological character description and Ramsar Information Sheet to progress a recommendation to the Commonwealth for nomination*". The Strategy will now be replaced by a Management Plan developed to support future management via a Nyiyaparli ranger program, alongside the Department of Biodiversity, Conservation and Attractions. The Development Envelope is offset from, and does not intersect with the Nature reserve boundary.

3.13 Local Development

The Development Envelope is located within the Shire of Ashburton. The nearest town is Tom Price, which is located approximately 110 km to the southwest of the Development Envelope. Port Hedland is located approximately 210 km to the north, whilst Newman is located approximately 180 km to the east.

Transport infrastructure, notably the Great Northern Highway connects to the east of the Development Envelope, and the Wittenoom-Mujina Road is 17 km south of the southern westerly boundary. The Roebourne-Wittenoom Road is approximately 8 km west of the Development Envelope. There are several existing rail alignments. The Pilbara Infrastructure (TPI) Solomon Rail traverses north of the Proposal before crossing the Great Northern Highway.

3.13.1 Pastoralism

Land uses surrounding the Proposal are shown on **Figure 3-16.** The primary land use within the vicinity of the Proposal is currently pastoral, involving free-range grazing of stock. In the Pilbara, pastoralism commenced in the 1860s and continued to contribute to the Pilbara economy to provide employment in the region. The Development Envelope is located within the boundaries of the Mulga Downs Pastoral Station. Access agreement negotiations are proposed to be undertaken for areas of the Proposal within the Mulga Downs Pastoral Station.

3.13.2 Tourism

The nearest major tourist attraction is the Karijini National Park. The northern boundary of the National Park is located approximately 16 km to the southwest of the Development Envelope and the park covers almost 630,000 ha of the Hamersley Range. This conservation area is an important tourism asset with accommodation, hiking trails and other ecotourism facilities. The Mungaroona Range Nature Reserve is approximately 13 km north of the Development Envelope and extends over an area of 105,842 ha.

The Auski Roadhouse, which includes overnight accommodation and camping facilities, is located 23 km to the south west of the Development Envelope at the junction of Great Northern Hwy and Nanutarra-Munjina Road.

These areas, and their proximity to the Proposal are shown in **Figure 3-16**.

3.13.3 Communities, Traditional Ownership and Cultural Heritage

There are two remote communities within the vicinity of the Development Envelope: Youngaleena and Wirrilimarra located 10 km south and 7.5 km southeast of the Development Envelope respectively (**Figure 3-16).** In addition, there are several named meeting places of significance and heritage restricted zones within and outside the Development Envelope. The Yandeyarra Reserve is located approximately 6 km to the north of the Development Envelope and comprises an area of 473,529 ha managed by the Mugarinya Community Association Incorporated. The Mugarinya (Yandeyarra) Community is located 87.5 km to the northeast of the Development Envelope.

The Proposal is within one Native Title determination area, discussed in **Section 5.2.2.**

3.13.4 Wittenoom Asbestos Management Area

Wittenoom Asbestos Management Area (WAMA), a registered contaminated site located approximately 4.3 km to the west of the Development Envelope. There is no community at Wittenoom as the town was degazetted in 2007 and closed in 2013 (**Figure 3-16**). The Development Envelope does not intersect the WAMA.

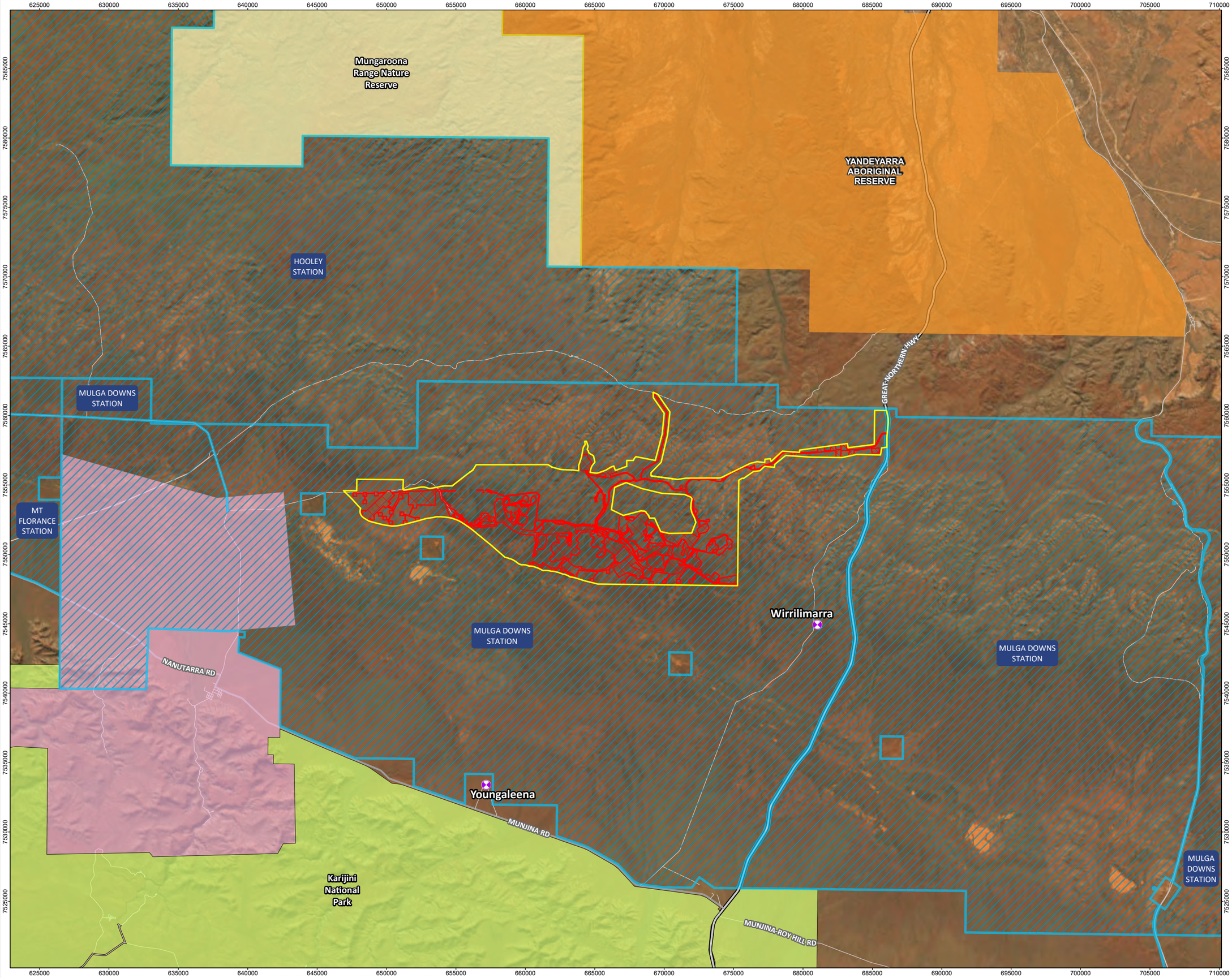
3.13.5 Other Nearby Projects

There are several existing and reasonably foreseeable projects within 100 km of the Proposal (as specified in the ESD), including:

- Gudai-Darri (Koodaideri) Iron Ore Mine and Infrastructure Project;
- Roy Hill Iron Ore Mine;
- Roy Hill Infrastructure Mulga Downs Hub and Rail;
- Fortescue Metals Group (FMG) Christmas Creek Iron Ore Mine;
- FMG Cloudbreak Iron ore Mine;
- FMG Eliwana Railway Project
- FMG Solomon Mine and Railway; and
- FMG Eliwana Mine and Railway;
- BHP Strategic Assessment area current and future projects.

These projects are considered in the cumulative impact assessment for the Proposal and further details are provided in **Section 17**.

Figure 3-16: Land Use within/adjacent to the Proposal



Legend

- Development Envelope
- Indicative Footprint
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)
- Yandeyarra Aboriginal Reserve (LGATE-227)
- Pastoral station boundaries (DPIRD-018)

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve
- Aboriginal Communities and Town Reserves (DPLH-002)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 31-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:250,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LAND USE WITHIN/ADJACENT TO THE PROPOSAL

FIGURE 3.16

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

4 Legislative Context

4.1 Environmental Impact Assessment Process

The Proposal is being assessed under Part IV of the EP Act. The Proposal has also been separately referred for assessment under the EPBC Act (EPBC 2021/09255). The assessment process by the Commonwealth is not an accredited assessment. This ERD has been prepared for assessment under Part IV of the EP Act and provides an assessment of key environmental factors which fall under the EP Act. MNES are being assessed separately by the Commonwealth under the EPBC Act.

EPA guidance which has been considered in the preparation of this ERD is listed in **Table 4-1.**

Table 4-1: EPA Procedures and Guidance for EIA.

Date	Title
EPA 2014	Cumulative environmental impacts of development in the Pilbara region: Advice of the Environmental Protection Authority to the Minister for Environment under Section 16(e) of the *Environmental Protection Act 1986*
EPA 2021a	Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures; (Administrative Procedures)
EPA 2021b	Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual (Procedures Manual).
EPA 2021c	Statement of Environmental Principles, Factors and Objectives
EPA 2021d	Instructions – How to identify the content of a Proposal
EPA 2021e	Instructions – How to prepare an Environmental Review Document
EPA 2021f	Instructions – Environmental outcomes and outcomes-based conditions
EPA 2021g	Instructions on how to prepare EP Act Part IV Environmental Management Plans (EMPs)
EPA 2021h	Instructions for the referral of a Proposal to the Environmental Protection Authority under Section 38 of the *Environmental Protection Act 198*6

4.2 Environmental Protection Act 1986 (Part IV)

The EP Act is the primary environmental legislation governing environmental protection and impact assessment in Western Australia. Environmental impact assessment (EIA) for the development of Proposals is undertaken by the EPA in accordance with Part IV Division 1 of the EP Act and the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016.*

Part IV of the EP Act provides for the consideration and assessment of Proposals that may, or will, have a significant impact on the environment. The Part IV process is administered by EPA Services of DWER.

The Proposal was referred to the EPA on 24 December 2021. On 24 February 2022 the EPA provided notice that the Proposal would be assessed (Assessment Number 2326) under Part IV of the EP Act and the level of assessment was set at PER with a 6-week public review period for the ERD. The EPA identified the preliminary key environmental factors for the Proposal as:

- Inland Waters;
- Subterranean Fauna;

- Flora and Vegetation;
- Terrestrial Fauna;
- Terrestrial Environmental Quality;
- Greenhouse Gas Emissions;
- Air Quality; and
- Social Surroundings.

The ESD, prepared by HPPL, was approved by the EPA on 24 August 2022. This ERD has been prepared in accordance with the ESD, Administrative Procedures (GoWA 2016) and the Procedures Manual (EPA 2021b) to meet the requirements of s 40(2)(b) of the EP Act. This ERD is required to be published for a period of six weeks, during which time the public is invited to comment on the ERD.

An invitation to make a submission is outlined at the beginning of this document for guidance on how to make a submission, including the closing date for submissions. After the public review period, the EPA will assess the Proposal, considering the ERD, any submissions received, and HPPL's responses to submissions. The EPA also considers relevant policies and guidelines and may seek advice from relevant government agencies.

The EPA will prepare an assessment report recommending whether the Proposal should be approved and, if recommending approval, any implementation conditions that should apply. The EPA Report and Recommendations will be made public and is subject to appeal. Following the determination of any appeals by the Minister for Environment (the Minister), the Minister will then decide whether the Proposal may be implemented and, if so, any implementation conditions and procedures which will apply in consultation with other relevant decision-making authorities (DMA).

4.3 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key environmental legislation, which enables protection of MNES. The EPBC Act is administered by the DCCEEW. The Proposal was referred to DCCEEW as a Proposed Action under the EPBC Act in May 2022 and the Commonwealth Minister for the Environment determined the Proposed Action to be a 'Controlled Action' under s75 of the EPBC Act on 6 August 2022 (ref. EPBC 2022/09255) with an assessment approach set at Public Environmental Report (PER).

The Proposed Action referred under the EPBC Act differs slightly from the Proposal being assessed under the EP Act (i.e. the subject of this ERD). The Proposed Action being assessed by DCCEEW includes the Murray's Hill Project, which does not form a part of the EP Act Proposal. The Murray's Hill Project is a stand-alone, 5 Mtpa direct shipping ore (DSO) mine with a life of up to five years (including decommissioning and rehabilitation) proposed by HPPL (refer to **Section 2.2.5.1**).

Murray's Hill was referred to the WA EPA in 2013 as a stand-alone project and was deemed not required to be assessed. As a result, Murray's Hill and impacts associated with this project has been removed from the WA EPA referral of the Proposal. At the time, Murray's Hill was not referred to the Commonwealth under the EPBC Act as the project was not considered to have a significant impact on MNES. Consultation with DCCEEW during 2022 (prior to referral of the Proposed Action) indicated that Murray's Hill was considered part of the larger action

and is required to be considered during the assessment of the Proposed Action under the EPBC Act. As such, the area of Murray's Hill forms part of the Proposed Action.

The relevant MNES (the controlling provisions) identified in the decision on assessment are:

- Listed threatened species and communities (sections 18 and 18A); and
- Listed migratory species (sections 20 and 20A).

DCCEEW issued PER guidelines to HPPL in October 2022. DCCEEW identified the following MNES as relevant to the assessment of the Proposed Action, as the Proposed Action may have a significant impact on these MNES species:

- Northern Quoll (*Dasyurus hallucatus*) – Endangered;
- Greater Bilby (*Macrotis lagotis*) – Vulnerable;
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) – Vulnerable;
- Ghost Bat (*Macroderma gigas*) – Vulnerable;
- Pilbara Olive Python (*Liasis olivaceus barroni)* – Vulnerable;
- Night Parrot (*Pezoporus occidentalis*) – Critically Endangered;
- Grey Falcon (*Falco hypoleucos*) – Vulnerable; and
- Blind Cave Eel (*Ophisternon candidum*) – Vulnerable.

The following listed migratory species (sections 20 & 20A) were also identified:

- Common Greenshank (*Tringa nebularia*) – Migratory;
- Wood Sandpiper (*Tringa glareola*) – Migratory;
- Red-necked Stint (*Calidris ruficollis*) – Migratory;
- Glossy Ibis (*Plegadis falcinellus*) – Migratory; and
- Fork Tailed Swift (*Apus pacificus)* – Migratory.

The significance of potential impacts from the Proposed Action on MNES will be assessed separately by DCCEEW. Following the assessment of the Proposed Action, the Commonwealth Minister for the Environment will make an approval decision. On approval, a Decision Notice will be issued, including implementation conditions to be applied to the Proposed Action.

4.4 Native Title Act 1993

The *Native Title Act 1993* (Cth) recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters according to their traditional laws and customs.

The Proposal is located within the Banjima Native Title determination area. The Banjima Traditional Owners hold native title rights and interests over approximately 10,185 km^2 as determined by the Federal Court in September 2018 WCD 2014/001/WAD6096/1998). Banjima Native Title Aboriginal Corporation RNTBC (BNTAC) hold the native title rights and interests on behalf of the Banjima People.

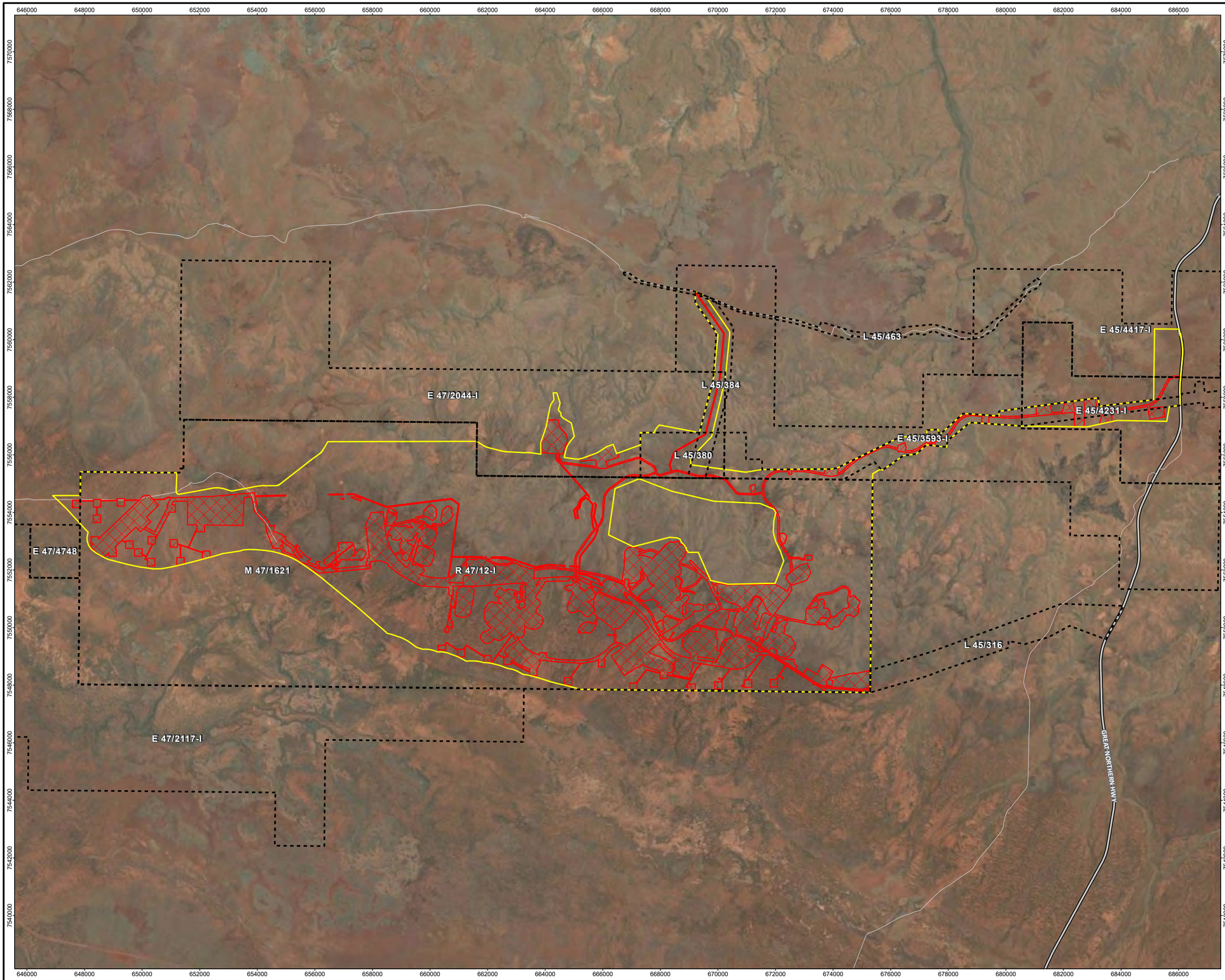
4.5 Land Tenure

The Proposal is located within the following tenements and leases which are held by HPPL or one of a series of wholly owned subsidiary companies. These have been granted or are pending under the Mining Act (refer **Figure 4-1, Table 4-2**). Tenement types will be amended as necessary for the required activities.

Table 4-2: Tenement Holder Details

Tenement	Tenement Holder	HPPL Stake	Area (ha)
R47-12-I (pending) (Mine Area)	Mulga Downs Iron Ore Pty Ltd	100%	22,186.41
M47/1621 (pending) (Mine Area)	Mulga Downs Iron Ore Pty Ltd	100%	22,186.41
L 45/384	Mulga Downs Iron Ore Pty Ltd Mulga Downs Investments Pty Ltd	100%	397.23
G45/358 (pending) (solar farm)	Mulga Downs Iron Ore Pty Ltd	100%	654.57
L 45/380 (haul road)	Mulga Downs Investments Pty Ltd Mulga Downs Iron Pty Ltd	100%	1,785.65
L45/652 (pending) (haul road)	Mulga Downs Iron Ore Pty Ltd	100%	2,331.24
L45/654 (pending) (haul road)	Mulga Downs Iron Ore Pty Ltd	100%	904.81
L45/655 (pending) (haul road)	Mulga Downs Iron Ore Pty Ltd	100%	815.42
L45/687 (pending) (powerline)	Mulga Downs Iron Ore Pty Ltd	100%	511.49
L45/823 (pending) (haul road-(GNH intersection connection)	Mulga Downs Iron Ore Pty Ltd	100%	50.08

Figure 4-1: Tenement Boundaries



Legend

- Indicative Footprint
- Development Envelope
- Mining tenements (DMIRS-003)

Roads (LGATE-195)

- Highway
- Minor Road

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 11-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TENEMENT BOUNDARIES

FIGURE 4.1

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

4.6 Other Approvals and Regulation

The key environmental legislation and associated approvals applying to the Proposal are identified in Table 4-3.

Table 4-3: Other relevant approvals (Decision making authorities)

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
DWER	EP Act Environmental Protection Regulations 1987 (WA) Environmental Protection (Noise) Regulations 1997 (WA)	Under Part V of the EP Act a works approval is required for the construction of a premises listed as prescribed under the EP Act and associated Regulations.	The works approval application process administered by DWER can mitigate the following potential impacts of the Proposal on the environment: • Emissions to air (dust) causing amenity impacts to nearby sensitive receptors; • Emissions of noise causing impacts to nearby sensitive receptors; • Discharges of sewage or environmentally hazardous liquids causing contamination; and • Contamination from landfilling of inert or putrescible materials.	There are aspects of the Proposal considered to be a prescribed premise under the Environmental Protection Regulations 1987 and, therefore, will be regulated under Part V, Division 3 of the EP Act. Section 52 of the EP Act specifies that "The occupier of a premises who carries out any work on or in relation to the premises, which causes the premises to become, or to become capable of being, a prescribed premises, commits an offence unless [the occupier] does so in accordance with a works approval." Therefore, HPPL will apply to DWER for a works approval before constructing relevant aspects of the Proposal. Works approval applications will be supported by detailed information regarding the premises, including: • Infrastructure, equipment, and activities (construction, environmental commissioning and operation); • Emissions, discharges and waste; and • Siting and location. This information will be supported by specific plans and assessments, including, but not limited to, air quality and noise assessments and environmental commissioning plan. The EP Act requires applications for works approvals that meet DWER's requirements and are accepted for assessment to be advertised for public comment. DWER advertises applications including publication of supporting documentation on its website for a period of 21 days. DWER can also seek comments from any public authority or person who is considered to have a direct interest in the subject matter of the application. Post decision, appeals can be lodged by third parties against granted works approvals within 21 days of the applicant being notified of the decision.	DWER regulates to ensure that there is not an unacceptable risk of harm to public health or the environment, consistent with the EPA's objectives for environmental factors. The DWER assessment and decision-making processes are governed by relevant legislation and DWER policies, guidelines and procedures. Consistent with the EIA process under Part IV of the EP Act, DWER's regulatory functions under Part V of the EP Act are guided by the statutory object and principles of the EP Act and the following principles of good regulatory practice: • Risk-based regulation; • Evidence-based decision making; • Application of Environmental Standards; • Appropriate conditions; • Fair and equitable decision making processes; • Engagement, consultation and transparency; and • Competitive neutrality. DWER uses the following risk assessment process, which has been mapped to the relevant elements of the EIA process to demonstrate consistency: • Establish the context of the risk (receiving environment); • Identify emissions (Proposal content); • Identify risk events through source-pathway-receptor analysis (potential environmental impacts) and applicant controls (mitigation); • Apply a risk rating using consequence and likelihood criteria (assessment and	Section 62 of the EP Act allows the Chief Executive Officer (CEO) of DWER to apply conditions to works approvals and licences that are considered to be necessary or convenient for the prevention, control, abatement or mitigation of pollution or environmental harm. DWER will set conditions to give effect to determined regulatory controls in accordance with its regulatory guidance. It is expected that granted works approvals for the Proposal will specify the infrastructure (works) that HPPL can construct and will regulate emissions and discharges associated with construction and commissioning, including dust, noise, emissions to air and discharges of wastewater and potentially contaminated stormwater. The works approval can also apply conditions to regulate the time limited operation of the premises while DWER assess the application for a licence. The works approvals may include conditions relating to compliance and commissioning reporting, atmospheric discharge points, air emission monitoring requirements, stack emission limits, emissions abatement equipment, and secondary containment of environmentally hazardous liquids. DWER undertakes proactive compliance inspections of activities regulated under the EP Act to ensure that they do not pose unacceptable risks to water, the environment and public health. Compliance inspections of prescribed premises also focus on determining whether emissions and discharges are managed by the current instrument and assessing compliance with the instrument and relevant associated legislation.	The EPA's objectives for the identified environmental factors are likely to be met through this decision making process.	The Part V process, through the completion of the works approval, associated commissioning works and licence, will provide adequate regulation of emissions and discharges from the Proposal. The provisions of Part V of the EP Act will meet the EPA's objectives with respect to the following environmental factors: • Terrestrial Environmental Quality; • Inland Waters; and • Air Quality.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
					significance of residual impact); • Determine the risk rating (assessment and significance of residual impact); and • Determine the regulatory controls (EPA report on assessment and Ministerial statement). The assessment criteria used to determine the risk rating (consequence) will be the same as those identified for the EIA of the Proposal. In most cases, the technical experts providing advice for the assessments will be the same for DWER as for the EPA.			
DWER	EP Act Environmental Protection Regulations 1987 (WA) Environmental Protection (Noise) Regulations 1997 (WA)	On completion of construction and commissioning, a licence is required to allow the operation of a prescribed premise.	The licence applications will consider the same potential impacts as the works approval and any specific operational requirements.	Section 57(2) of the EP Act requires works completed under a works approval to be completed to the satisfaction of the CEO (of DWER) in accordance with the relevant conditions of the works approval before a licence application for the premises can be assessed by the department. However, DWER recognises that proponents will want to start operations as soon as construction of works is complete, during the time taken to assess the licence application. To facilitate this, the department uses a risk-based approach to determine whether a premises can undertake environmental commissioning and operate under a works approval, while the department assesses the licence application. The licence applications will be based on the information provided for the works approval and will also include an Environmental Compliance Report confirming that what has been installed is authorised by the works approval, and an Environmental Commissioning Report confirming that the premises can operate to the specification detailed in the works approval and that emissions and discharges from the premises meet the required specifications. Licence applications are advertised for public comment and granted licences are available for appeal.	The licence applications will be assessed in accordance with the same regulatory framework described above for works approval.	It is expected that the licences will include conditions relating to the specification and operation of infrastructure and equipment, authorised emission points and parameters, emissions limits, and emissions monitoring and reporting. It is noted that licences granted by DWER under Part V of the EP Act do not currently regulate Greenhouse Gas (GHG) emissions. It is understood that this is typically because these emissions (where significant) are assessed by the EPA and regulated through implementation conditions on Ministerial statements. However, as an emission to air, it is understood that GHG emission could be regulated by a licence if deemed necessary by an appropriate risk assessment. The kinds of conditions that could be attached to a licence (as provided in section 62A of the EP Act) include, but are not limited to, the following: • Meet specified criteria or comply with specified limits as to the characteristics, volume and effects of GHG emissions;	The EPA's objectives for the identified environmental factors are likely to be met through this decision-making process.	The licensing process administered by DWER can mitigate the potential impacts of the operation of the Proposal. The provisions of Part V of the EP Act will meet the EPA's objectives with respect to the following environmental factors: • Terrestrial Environmental Quality; • Inland Waters; and • Air Quality.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
						• Comply with requirements set by specified programs; • Monitor operations; • Conduct analysis of monitoring data; • Investigate options for measures for preventing, controlling or abating GHG emissions; • Provide reports on monitoring data, and analysis of it; and • Prepare, implement and adhere to, GHG management plans. These kinds of condition are consistent with those applied to Ministerial Statements regarding GHG emissions, including the setting of five-yearly emission limits, preparation and implementation of GHG management plans, and monitoring and reporting of emissions. In addition to proactive compliance of activities carried out by DWER, licences typically include conditions for annual licence-holder audit of compliance. These Annual Audit Compliance Reports (AACRs) are submitted to DWER and published on the department's website.		
DWER	Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)	Clearing permits may be required to facilitate the completion of investigative, minor or preliminary and early works associated with the Proposal development ahead of formal approval being granted. DWER has delegated powers, under the Clearing Regulations, to DEMIRS for clearing activities within mining and related tenements and under exploration permits. The clearing of native vegetation will be assessed	The potential impacts to flora and vegetation and terrestrial fauna for these types of works can be mitigated through the decision-making process associated with clearing permits.	If required, HPPL will apply for a permit to clear native vegetation unless a valid exemption applies. The application will be made using the appropriate form and will be accompanied by all the required information. Under the EP Act, statutory requirements apply to clearing permit applications, including advertising, and seeking public submissions. The decisions on applications are also subject to appeal.	Clearing permit applications are assessed according to environmental risk. The risk-based assessment approach is based on the size and location of the area to be cleared, sensitivity of the environment and the environmental values that occur within or adjacent to the area under application, the purpose of the clearing and public interest. DWER, in deciding about a clearing permit has regard to the clearing principles contained in Schedule 5 of the EP Act. The clearing principles are consistent with the EPA's objectives for the	Clearing permits may be subject to conditions. The types of conditions that are placed on a clearing permit depend on the outcome of the environmental assessment. Conditions are used to prevent, control, abate or mitigate environmental harm or to offset the loss of the cleared vegetation. Conditions can relate to record keeping, reporting, revegetating or other actions.	The EPA's objectives for the environmental factors Flora and Vegetation and Terrestrial Fauna are likely to be met through this decision-making process.	The Proposal is being formally assessed under Part IV of the EP Act. No permit will be required for the clearing of native vegetation associated with the Proposal under assessment. Clearing permits may be required to facilitate the completion of investigative, minor or preliminary and early works associated with the Proposal development ahead of formal Part IV approval being granted. If a clearing permit is required for early works (or similar), HPPL is of the view that the clearing of native vegetation can be adequately regulated through the NVCP process. The

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
		against the 10 clearing principles. Native vegetation should not be cleared if the clearing is assessed to be at variance with the clearing principles.			environmental factors Flora and Vegetation and Terrestrial Fauna.			native vegetation clearing assessment process as administered by the DEMIRS will ensure the EPA's objectives for flora and vegetation are achieved. The provisions of Part V of the EP Act meet the EPA's objectives with respect to the following environmental factors: • Flora and Vegetation; • Terrestrial Fauna; and • Inland Waters.
DBCA	*Biodiversity Conservation Act 2016* (BC Act) and Biodiversity Conservation Regulations 2018	Licence to take flora or fauna	An Act to provide for: • The conservation and protection of biodiversity and biodiversity conservation; • Components in Western Australia; • The ecologically sustainable use of biodiversity components in Western Australia; • The repeal of the Wildlife Conservation Act 1950 and the Sandalwood Act 1929; and • Consequential amendments to other Acts, and for related purposes.	Provides authorisations to take or disturb threatened flora or fauna species.	No additional licence under the BC Act to take flora or fauna is required where clearing is approved under an EP Act Part IV approval, or where the clearing is for an exempt purpose under the EP Act. Where the flora to be taken is threatened flora, an authorisation to take threatened flora will also be required (under section 40 of the BC Act).	Licence to take contains conditions which must be adhered to.	The EPA's objectives are likely to be met through this decision-making process.	The BC Act provides coverage of important habitats and communities and provides for their protection. The BC Act requires Ministerial authorisation for the taking of threatened fauna and flora (section 40) and may include offset conditions for mitigating or offsetting impacts as part of the authorisation. The BC Act provides for assurance that threatened species or communities are reported from EP Act EIA surveys and consider their conservation. The provisions of the BC Act will meet the EPA's objectives with respect to the following environmental factors: • Flora and vegetation; and • Terrestrial fauna.
DEMIRS	Mining Act	An Act to provide for the completion of mining and extractive works. DEMIRS requires the completion of Mining Proposal (MP) and Mine Closure Plan (MCP) for all mining Proposals. These documents regulate: • Mine infrastructure; • Permanent surface water diversion structures to ensure	The purpose of the Mining Act is to control mining land tenure (tenements), mineral exploration and mining operations. Prior to undertaking mining operations on mining land tenure, a proponent is required to prepare a MP and a MCP in accordance with relevant DEMIRS guideline documents, with the DEMIRS to then determine approval of the documents on behalf of the State Minister for Mines and Petroleum.	DEMIRS assesses mineral, petroleum and geothermal exploration and development applications within WA. The division also conducts environmental compliance audits and inspections to ensure approved activities comply with legislation, regulations, policies, and approval commitments and conditions.	**Mining Proposal** Impacts associated with the Proposal can be considered to ensure environmental outcomes are achieved. **Mine Closure Plan** The MCP will identify post-activity land use outcomes, stakeholder consultation and rehabilitation planning. The MCP ensures adequate closure planning and provisions are in place to manage	HPPL will be required to implement the Proposal in accordance with tenement conditions and as described in the Mining Proposal and MCP.	The EPA's objectives are likely to be met through this decision-making process.	The Mining Act requires HPPL to complete a Mining Proposal and MCP, which will be submitted to DEMIRS for assessment. The provisions of the Mining Act, through the completion of the above documents, enables DEMIRS to regulate mining activities and meet the EPA's objectives with respect to the following environmental factors:

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
		they are stable and non-polluting; and • Mine closure, decommissioning and rehabilitation.			agreed closure commitments until final relinquishment. **Tenure** The title issued defines the rights and obligations of the government and the tenement holder. It ensures HPPL (as the tenement holder) complies with the conditions of the land that their tenement is based on and rehabilitates the land after operations have finished.			• Flora and vegetation; • Terrestrial fauna; • Inland Waters; • Landforms; and • Terrestrial Environmental Quality.
DEMIRS	Dangerous Goods Act 2004 (DG Act)	Dangerous Goods site licence	Licences are required for the storage, transportation and use of Dangerous Goods dependent on the quantities of materials/goods involved.	The DG Act relates to the manufacture, storage, possession handling, transport and use of dangerous goods (both non-explosives and explosives), including the operation of major hazard facilities across Western Australia The Dangerous Goods legislation covers the following Classes and Divisions of dangerous goods that may be required by the Proposal: • Class 1 explosives; • Class 2 gases; • Class 3 flammable liquids; • Class 4 flammable solids, substances liable to spontaneous combustion; • Class 5 oxidising substances; • Division 6.1 toxic substances; • Class 8 corrosive substances; • Class 9 miscellaneous dangerous goods and articles; • Goods too dangerous to be transported; and • C1 combustible liquids. Separate regulations may also apply.	The Dangerous Goods legislation is limited to specific substances and regulates the storage, handling and transport of them with a focus on minimising risk to minimising risk to people, property and the environment.	Dangerous Goods site licences contain requirements as to the types and quantities of substances that can be stored and how they must be stored. Safety reports follow a prescribed standard and template and include risk assessment and safety management systems.	The EPA's objective for the identified environmental factor is likely to be met through this decision-making process.	Compliance with the DG Act reduces the risk to the environment from dangerous goods (transport, storage, use and disposal) by regulating the user and ensuring correct use and adherence to standards. The provisions of the DG Act allow DEMIRS, through the licencing process, to regulate mining activities and meet the EPA's objectives with respect to the following environmental factors: • Inland Waters; and • Terrestrial Environmental Quality.
DWER	*Rights in Water and Irrigation Act 1914* (RiWI Act)	5C Licence to Take Water; and 26D Licence to Construct or Alter Well Section 11/17/21A Permit (Beds and Banks)	The RiWI Act provides for the regulation, management, use and protection of water resources. A 5C licence allows the licence holder to take water from a watercourse, well, and or, underground source. A 26D licence is required to:	Licences and permits are regulatory instruments which define how much water can be taken and specify required management conditions. Policies and water allocation plans provide further guidance on specific licensing requirements and, where relevant, are identified through this document.	Assessment of the construction of bore(s) to access water during construction and operation; • Assessment of the abstraction of groundwater associated with water supply for the Proposal;	Conditions of: • 5C Licence to Take Water; • 26D Licence to Construct or Alter Well; and • Section 11/17/21A Permit (Beds and Banks).	The EPA's objective for Inland Waters identified environmental factor is likely to be met through this decision-making process.	The RiWI Act provides protections to the State's water resources to maintain the hydrological regimes and quality of groundwater and surface water. The provisions of the RiWI Act allow DWER, through the licencing process, to regulate activities and

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
			• commence, construct, enlarge, deepen or alter an artesian well [26A(1)]; or • commence, construct, enlarge, deepen or alter any non-artesian well in a proclaimed groundwater area. Permits are granted by the department to authorise interference or obstruction of the bed and banks of a watercourse or wetland.	The Western Australian Water in Mining Guideline (DoW, 2013) was prepared in recognition that proponents of mining projects may require approval from a number of government agencies. To reduce duplication, the guideline aligns with approval processes administered by the EPA, DBCA and DEMIRS. The guideline also links with the Administrative agreement between DEMIRS and DoW. It ensures an efficient pathway through the licence assessment process and aligns the licence assessment with other assessment processes, such as those established under the EP Act.	• Assessment of the interference with bed and banks of a watercourse..			meet the EPA's objectives with respect to the following environmental factors: • Inland waters; • Flora and vegetation; and • Terrestrial Fauna.
Department of Planning, Lands and Heritage (DPLH)	AH Act	The following may be required under the AH Act for impacts or disturbance to sites of Aboriginal significance: s.16 authorisation to enter, excavate, examine or remove anything on an Aboriginal site; s.18 consent where the impact on an Aboriginal site is unavoidable; and Access authority.	The AH Act provides a modern framework for the recognition, protection, conservation and preservation of Aboriginal cultural heritage while recognising the fundamental importance of Aboriginal cultural heritage to Aboriginal people.	Under the AH Act it is an offence to excavate, destroy or damage a site unless the person is acting with the authorisation of the Registrar under section 16, or the consent of the Minister under section 18 of the AH Act.	The following approvals may be required under the AH Act for impacts of disturbance to sites of Aboriginal significance: • s.16 authorisation to enter, excavate, examine or remove anything on an Aboriginal site; • s.18 consent where the impact on an Aboriginal site is unavoidable. Consultation with Traditional Owners in respect of impacts to Aboriginal heritage is addressed in Section 5.2.2.	Conditions of approval.	The EPA's objective for the identified environmental factor is likely to be met through this decision-making process.	The provisions of the AH Act regulate activities and meet the EPA's objectives with respect to the following environmental factors: • Social surroundings.
DPLH	*Land Administration Act 1997* (LA Act)	S91 licence	Access authority.	A licence may be granted for an unmanaged reserve or Crown land under certain circumstances by the Minister for Lands under the LA Act. A licence does not grant an exclusive right to the land and members of the public cannot be excluded from licensed Crown land.	Where required (temporary) access to Crown Land has been enabled through the s.91 permit as administered by DPLH under the LA Act.	The s91 permit as issued by DPLH is for a limited period of time and it does not grant HPPL an exclusive right to the land. Conditions can be applied to the access authority.	Access to the land is being sought from the relevant organisations, in addition to the obtaining of the s.91 LA Act permit	Ensures HPPL has authority to access and undertaken activities on unmanaged reserve or Crown land.
Department of Health (DoH)	Disposal of Effluent and Liquid Waste) Regulations 1974 (Health Regulations)	Install an Apparatus for the Treatment of Sewage	Assessment and regulation of WWTP and irrigation to land.	The requirements associated with onsite wastewater systems are specified in the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 (Wastewater Regulations). The Health Act requires all apparatus for the treatment of sewage to be approved by the Chief Health Officer (CHO). The Wastewater Regulations set out the approvals process for the construction,	Assessment and approval for the on-site WWTP will be required.	Conditions of approval can be applied to WWTP and irrigation specifications.	Ensures wastewater's generated from the Proposal are treated and discharged in an environmentally acceptable manner.	Provisions regulate WWTP's and meet the EPA's objectives with respect to the following environmental factors: • Inland Waters; and • Terrestrial Environmental Quality.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
				installation, use and operation of onsite wastewater systems. They also detail the specific design, sizing and construction/manufacturing requirements for primary treatment systems and the various receptacles for drainage.				
Shire of Ashburton	*Planning and Development Act 2005* Planning and Development (Local Planning Schemes) Regulations 2015 Planning regulation Amendment Regulations 2020.	Building and Health approvals.	An Act for a system of land use planning and development in the State and for related purposes.	Development approval applications are required to ensure a Proposal is consistent with the zoning for the area and complies with the local planning scheme and related Local planning policy requirements. The development application process and assessment of the Proposal against the relevant local planning schemes and policies can mitigate potential impacts to Social Surroundings, including nuisance aspects associated with air quality and noise.	Development application(s) will be assessed against the Shire's Local Planning Strategy and Local Planning Scheme. Allows for the Proposal to construct according to the local planning schemes as established by the Shire of Ashburton.	Most development approvals have conditions that form part of the development approval package and set out the circumstances in which the approved development may proceed. Often the purpose of conditions is to protect or reduce impacts on the environment and amenity. The conditions can include those, amongst others, for the mitigation of emissions of wastewater, waste, noise, fugitive dust and odour.	Construct of buildings and infrastructure in according with Shire of Ashburton local planning schemes and policies.	Provisions regulate WWTP's and meet the EPA's objectives with respect to the following environmental factors: • Social surrounds.
DWER	*Contaminated Sites Act 2003* Contaminated Sites Regulations 2006	Considered under Part V of the EP Act.	Under the Act the identification, recording, management and remediation of contaminated sites can be managed.	The Act and Regulations allow for the identification, recording, management and remediation of contaminated sites. The Regulation also provides direction on the Mandatory auditors report	The Proposal will intersect areas that are at risk of Asbestos Containing Material (ACM) contamination from historical anthropogenic activities. There is the potential to redistribute ACM through implementation of the Proposal and pre-mining activities.	Conditions can be applied through either Part IV or Part V of the EP Act.	Potential risks from contamination are identified, assessed, managed and remediation as required.	Provisions regulate the following environmental factors: • Air quality; and • Terrestrial Environmental Quality.
Clean Energy Regulator (CER)	*National Greenhouse and Energy Reporting Act 2007* (NGER Act)	Not applicable (reporting)	The Clean Energy Regulator is responsible for overseeing and enforcing the Safeguard Mechanism, which includes monitoring and regulating the greenhouse gas emissions of large industrial facilities, ensuring they meet specified emissions limits.	Under the NGER Act, companies are obligated to report on their GHG emissions in accordance with statutory requirements (CER 2021). The NGER Act provides a single national framework for the reporting and dissemination of information relating to GHG emissions, energy production and energy consumption in Australia governed by the CER.	HPPL will report GHG emissions for the Proposal under the NGER Act.	Not applicable	Established reporting requirements.	Reporting of emissions is required under the NGER Act.
	National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (as amended 2023)	Not applicable (reporting)	Statutory reporting requirements for GHG emissions. The Safeguard Mechanism was established to support Australia's emissions reduction commitments under the Paris Agreement and is part of the National Greenhouse and Energy Reporting (NGER) scheme.	Pursuant to the Australian Government's Safeguard Mechanism Rule, if a facility is anticipated to emit more than 100,000 t CO2-e of Scope 1 emissions per financial year (i.e., the 'safeguard threshold'), it qualifies as a designated large facility (or safeguard facility) and is required to keep	The Proposal involves Scope 1 emissions that are covered by the Safeguard Mechanism and those that are not. The emissions considered Scope 1 under the Safeguard Mechanism will not exceed the 100,000 t CO2-e per year threshold set for designated large facilities. However, the Scope	Not applicable	Established reporting requirements and emissions reduction targets.	Reporting of emissions is required under the Safeguard Mechanism against targets.

Decision-making authority	Legislation or Agreement regulating the activity	Approval required (and specify which Proposal element the approval is related to)	Whether and how statutory decision-making process can mitigate impacts on the environment					
			Ability	**Process**	**Relevant Consideration**	**Conditions**	**Likely Outcome**	**Overall Conclusion**
				its net emissions levels at or below its emissions baseline set by the CER. Under the reformed Safeguard Mechanism, implemented in July 2023, emissions from designated large facilities are required to be reduced to net zero by 2049-50 along a straight line trajectory, commencing with baselines determined by the CER, which will reduce by 4.9% per year to 2030. For new facilities baselines, best practice emissions intensities will also be required, with site specific emissions intensity established at commencement, transitioning to an industry average emissions intensity by June 2030. Together with the reporting obligations under the NGER Act, the Safeguard Mechanism provides a national framework for Australia's largest emitters to measure, report and manage their emissions.	1 emissions not covered by Safeguard Mechanism will exceed the 100,000 t CO2-e per year threshold set for assessment by the EPA. As assessment of GHG Emissions is provided in **Section 12**			

5 Stakeholder Engagement

5.1 Consultation Strategy

HPPL has actively engaged in stakeholder consultation throughout the planning of the Proposal. Stakeholder consultation will continue during the assessment of the Proposal, and through the detailed design, construction and operational phases, if approved. The methods of consultation vary depending on the forum, subject matter and purpose. The main forms of communication associated with the Proposal are:

- Broad Proposal briefings and presentations;
- HPPL/stakeholder meetings and discussions, including those undertaken on HPPLs' behalf by consultants;
- Environmental risk workshops;
- Written communications, distribution of updates and brochures;
- Specific native title discussions and briefings to Traditional Owners;
- Telephone discussions; and
- Distribution of environmental documentation.

The generalised strategies for engagement with key stakeholder groups are summarised below:

- Government agencies: ensure environmental acceptability (as determined through EP Act and EPBC Act) and meet the requirements of various regulatory approvals and legislation managed by various government agencies.
- Native Title groups: consultation to protect heritage, understand potential impacts on social surroundings, participation in planning of the Proposal to avoid or minimise potential impacts, compensation for impairment of rights and interests to land, participation in environmental surveys, employment opportunities and Proposal involvement.
- Pastoralists: management of access, planning to minimize disturbance to pastoral operations, compensation for identified and proposed activity losses, future land use requirements and water availability and use.
- Community groups and individuals: opportunities or community infrastructure upgrades, employment, enhanced environmental management, environmental research and community support/sponsorship, concerns with fly-in/fly-out workforce.

As well as regular stakeholder engagement, triggers for further specific engagement include, but are not limited to:

- Where new approvals are required;
- Where relevant conditions are received on approvals;
- Changes to the Proposal that may have significant impact on stakeholders; and
- Developing the closure strategy.

5.2 Key Stakeholders

The key stakeholders identified for the Proposal are detailed in the following sections. Consultation with these groups has commenced and will continue to be undertaken as required during the assessment, construction and operational phases of the Proposal.

5.2.1 Government Agencies

Consultation has commenced and is ongoing with the following key regulatory stakeholder groups:

- DWER (EPA Services; Part V; Water);
- DEMIRS - Environment and Mining Divisions;
- DBCA;
- DPLH;
- DCCEEW;
- Department of Jobs, Tourism, Science and Innovation (DJTSI);
- Main Roads Western Australia (MRWA);
- Pilbara Development Commission; and
- Shire of Ashburton.

5.2.2 Traditional Owners

Consultation has commenced and is ongoing with the relevant Traditional Owners and communities (**Table 5-1**). Detailed engagement plans are being prepared and agreed with these groups, to guide ongoing consultation. Traditional Owners and communities will continue to be engaged and consulted throughout the assessment, construction and operational phases of the Proposal. Key Traditional Owners and communities identified for the Proposal are as follows:

- Banjima Native Title Aboriginal Corporation RNTBC (BNTAC) is the registered native title body corporate which holds native title rights and interests in trust for the Banjima People ;
- Yindjibarndi Ngurra Aboriginal Corporation RNTBC (YNAC) is the Registered Native Title Body Corporate which holds native title rights and interests in trust for the Yindjibarndi People;
- Youngaleena Community; and
- Wirrilimarra Community.

The Development Envelope is located within the Banjima native title determination area.

HPPL submitted a s43A to the EPA in December 2023 for the removal of the Mulga West Borefield. The Mulga West Borefield and associated pipeline route was the only portion of the original Proposal located within the Yindjibarndi #1 native title determination area. Removal of this area removed any direct impact of the Proposal on the Yindjibarndi #1 determination area; however, HPPL has undertaken extensive consultation with Yindjibarndi People and will continue to consult with YNAC regarding any potential indirect impacts of the Proposal.

Consultation and engagement with the Banjima People has commenced. To date, the concept of Social Surroundings as a Key Factor for EPA assessment of Proposals under Part IV of the EP Act has been introduced and on-country consultation has occurred. In addition, numerous Perth-based consultations have also been conducted. Timeframes for consultation is subject to multiple factors including availability of Traditional Owners, ongoing negotiation of agreements and ongoing archaeological and ethnographical surveys.

HPPL is committed to ongoing consultation with the Banjima People that will continue throughout the life of the Proposal, including during operations and decommissioning/rehabilitation. A Social and Cultural Heritage Management Plan (SCHMP) will be co-developed between HPPL, and the Banjima People. Consultation will be used to explain the Proposal, identify concerns and impacts on country and culture, and discuss ways in which the Proposal can be aligned to avoid, minimise and/or manage potential impacts. The process includes an anthropologist and environmental consultant who can assist the Traditional Owners throughout the consultation process. It is anticipated a Social Surroundings report will be prepared based on the consultation which will identify and report the key outcomes of the consultation. The report will be used to inform the co-developed SCHMP.

HPPL is in consultation with the Banjima People through BNTAC. The parties will prepare a SCHMP that is designed to identify the issues that will require ongoing consultation and input. It is expected that a range of issues will need to be addressed in the SCHMP with an appropriate set of management actions identified to ensure active management of environmental issues based on ongoing consultation and input. The SCHMP is proposed to remain a 'live' document that details key outcomes of meetings and on-country consultations undertaken to date and those proposed through the life of the Proposal. HPPL acknowledge this consultation is in addition to Aboriginal heritage surveys and confirms all activities will be undertaken in compliance with the AH Act as applicable.

HPPL is committed to ongoing engagement over the life of the Proposal, as outlined in the engagement timeline plan presented in **Table 5-1.** The SCHMP will be considered confidential unless otherwise advised by BNTAC.

HPPL will provide notifications to Traditional Owners following submission of environmental approval documentation and other documentation as required. Traditional Owners are provided the ability to review and provide comments on submitted documentation, with HPPL taking into consideration these comments and updating documentation accordingly.

Table 5-1: Proposed ongoing communication and / or consultation schedule with Banjima Traditional Owners and Communities

Traditional Owner group	Type of Engagement	Proposed Timing[1]	Detail of Engagement
Banjima	Hancock Heritage and Environment Reference Committee (HHERC) Meetings	Quarterly. Subject to Traditional Owner availability.	Overview of the Proposal and any changes since the last HHERC meeting. Discussion/overview of potential impacts to Social Surrounding, environment impacts, heritage impacts and government approvals relevant to the Proposal. Consultation and formal decisions on key environmental and heritage matters under FPIC principles.
	Social surroundings consultation	As required. Subject to Traditional Owner availability.	Discussion of Proposal. Identification of concerns and impacts. Discussion of ways the Proposal can be aligned to avoid, minimise and/or manage impacts.
	Ethnographic/archaeological surveys	Ongoing.	On-site ethnographical/archaeological surveys Presence of Traditional Owners during surveys
	Ongoing consultation	Throughout the life of the Proposal.	Continual discussions of relevant aspects or concerns related to the Proposal
	Native Title agreement negotiations	Prior to implementation of the Proposal. Substantially progressed.	As per Project Negotiation Agreement.
	Agreement Implementation Committee	Throughout life of the Project	As per Native Title Agreement
Wirrilimarra	Community consultation	Bi-annually. Subject to willingness of the Community to engage with HPPL.	Discussion of Proposal. Identification of concerns and impacts. Discussion of ways the Proposal can be aligned to avoid, minimise and/or manage impacts to the communities. Provision of an operational management plan template to facilitate discussions.
	Ongoing consultation	Throughout the life of the Proposal. Subject to willingness of the Community to engage with HPPL.	Continual discussions of relevant aspects or concerns related to the Proposal
Youngaleena	Community consultation	Bi-annually. Subject to willingness of the Community to engage with HPPL.	Discussion of Proposal. Identification of concerns and impacts. Discussion of ways the Proposal can be aligned to avoid, minimise and/or manage impacts to the communities. Provision of an operational management plan template to facilitate discussions.

Traditional Owner group	Type of Engagement	Proposed Timing[1]	Detail of Engagement
	Ongoing consultation	Throughout the life of the Proposal. Subject to willingness of the Community to engage with HPPL.	Continual discussions of relevant aspects or concerns related to the Proposal

5.2.3 Industry

The following industry stakeholder groups have been identified and consultation will continue as required:

- Chamber of Minerals and Energy (WA);
- Chamber of Commerce and Industry;
- Regional Chambers of Commerce and Industry – Karratha, Port Hedland and Newman;
- Australian Miners and Mineral Associations;
- Association of Mining and Exploration Companies; and
- FMG.

5.2.4 Community

The following key community stakeholders have been identified and consultation is ongoing:

- Mulga Downs Station; and
- Auski Munjina Roadhouse.

The Mt Florance and Hooley Pastoral Stations are now outside of the Development Envelope; however, HPPL will continue to engage with these pastoral stations given their proximity to the Proposal.

5.3 Stakeholder Consultation Outcomes

Details of stakeholder consultation undertaken to date for the Proposal are shown in **Table 5-2**. Consultation has commenced (and will continue) with key regulatory bodies, Traditional Owners, Industry and community groups.

A pre-referral consultation with EPA Services (DWER) in relation to the Proposal was held on 1 December 2021.

Table 5-2: Consultation and Communication undertaken to date with Key Stakeholder Groups

Date	Department	Activity	Key Comments
Regulatory Stakeholders			
26/03/2025	EPA DWER	Discussion about request for further information	Meeting with EPA-S assessing officers to discuss updates to be made to the Environmental Review Document following the request for further information
21/03/2025	EPA DWER	Request for further information	EPA issue a request for further information following review of the Environmental Review Document
20/12/2024	EPA DWER	Submission of ERD	ERD issued to the EPA for review
19/12/2024	EPA DWER	Pre-ERD submission discussion	Meeting with DWER and the EPA to discuss Proposal updates prior to submission of the updated ERD.
10/12/2024	DCCEEW	Pre-PER submission discussion	Meeting with DCCEEW to discuss Proposal updates, and key impacts and proposed mitigation measures prior to submission on the updated PER.
03/12/2024	EPA DWER	Project introduction meeting with the EPA chairman	Meeting with DWER and the EPA to provide Proposal overview to the recently appointed EPA chairman, and discuss relevant project queries (i.e., updated GHG emissions guidelines).
16/10/2024 to 17/10/2024	DCCEEW	Mulga Downs site visit	Site visit with DCCEEW to provide understanding of the site, impacts and proposed mitigation measures.
3/09/2024	DCCEEW	Section 156A briefing	Meeting with DCCEEW to discuss the proposed s156A amendment from the 20 Mtpa mine to the reduced scale 12 Mtpa mine.
29/08/2024	EPA DWER	Section 43A briefing	Meeting with DWER and the EPA to discuss the proposed s43A amendment from the 20 Mtpa mine to the reduced scale 12 Mtpa mine.
19/07/2024	EPA DWER	Section 43A briefing	Meeting with DWER and the EPA to discuss the proposed s43A amendment from the 20 Mtpa mine to the reduced scale 12 Mtpa mine.

Date	Department	Activity	Key Comments
30/05/2024	DEMIRS	Mining Proposal Scoping Meeting	Meeting to brief DEMIRS on anticipated Part V/Mining Act approvals for the Mulga Mine, Hub and Rail and Murray's Hill.
28/05/2024	DWER	Part V Briefing	Meeting to brief DWER on anticipated Part V approvals for the Mulga Mine
27/07/2023	DEMIRS	Mining Proposal Scoping Meeting	Meeting to brief DEMIRS on anticipated Part V/Mining Act approvals for the Mulga Mine, Hub and Rail and Murray's Hill.
03/04/2023	DWER Contaminated Sites Branch	Targeted meeting / briefing	Provision of an update on the Proposal works proposed to be completed in relation to the WAMA and the TEQ environmental factor.
30/06/2022 – ongoing (monthly)	DWER	Monthly Proposal meetings	Monthly meeting to discuss Proposal updates and progress with DWER. Updates include management plans, studies and future approvals likely to be require. Items as discussed summarised in minutes.
28/02/2023	DCCEEW	Section 156A clarification	Clarification regarding the request for information provided to HPPL from DCCEEW on the s156A application.
21/02/2023	DWER State Water Team and DCCEEW	Surface and groundwater modelling meeting	Discussion regarding surface water and groundwater modelling requirements for the Proposal.
28/10/2022 – ongoing (monthly)	DCCEEW	Monthly Project Assessment Plan meeting	Monthly meeting to discuss the developments, guidance and queries relating to the PAP and the PER guidelines. Matter s discussed include the requirement for additional surveys, clarification of aspects in the PER guidelines. The monthly meeting also discusses timelines for both HPPL and DCCEEW.
13/07/2022	DWER Contaminated Sites Branch	Environmental Scoping Document and Terrestrial Environmental Quality meeting	Project overview was provided relating to terrestrial environmental quality factor (in relation to the WAMA. DWER recommended HPPL need to demonstrate that they have investigated the area to e disturbed by the Proposal. HPPL requested further information from DWER for information held by DWER on sites of possible asbestos that may occur across the MDIOM.

Date	Department	Activity	Key Comments
08/12/2021	DAWE (now DCCEEW)	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
01/12/2021	EPA	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
29/10/2021	DAWE (now DCCEEW) Office of Water Supply and Water Sciences	Follow up pre-referral meeting	HPPL presented information on the Proposal to staff from the Office of Water Supply and Science.
22/10/2021	EPA	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
21/10/2021	DAWE (now DCCEEW)	Pre-referral meeting	HPPL presented information to meet the Departments pre-referral engagement requirements.
16/07/2019	DWER (includes industry regulation)	Targeted meeting/briefing	Briefing for DWER Terrestrial Ecosystems Branch on proposed baseline subterranean survey.
2/04/2019	DWER (includes industry regulation)	Targeted meeting/briefing	HPPL project staff briefed DWER air quality and noise officers on proposed baseline survey. Sought guidance on and endorsement of approach in readiness for procurement of sampling equipment and mobilisation to site. DWER stated proposed methodology acceptable and provided some commentary to assist improve the works.
7/03/2019	DWER (includes industry regulation)	Targeted meeting/briefing	HPPL project staff sought guidance for schedule Level 2 flora, vegetation and terrestrial fauna surveys. Items specifically discussed summarised in the minutes.

Date	Department	Activity	Key Comments
22/11/2018	Department of Energy and Environment (DoEE) (now DCCEEW)	Briefing	HPPL provided a briefing on the Proposal which is in the early planning stage and hence Proposal scope is yet to be determined. It is expected that the Proposal will be referred under the EPBC Act. HPPL may decide to treat the rail as a separate referral if it is likely to have a different ownership to the mine. This is so each owner is only responsible for their own set of EPBC approval conditions (assuming approval is required). DoEE accepted the rationale for that approach and noted there were a number of precedents with other projects where this was done for the same reason. DoEE advised key matters for concern included MNES, Night parrot and migratory species.
7/11/2018	DWER (includes industry regulation)	Briefing	HPPL project staff provided an overview and update on Proposal. Requested guidance on content/approach for surveys in 2019 re-survey component, use of guidelines, key risk. DWER committed to arranging meeting Terrestrial Ecosystems Branch in December 2018 to further advice.
7/09/2018	DWER (includes industry regulation)	Briefing	DWER was briefed by HPPL project staff on the proposed groundwater drilling programme and surface water programme. Sought clarification on the extent of the Fortescue Marsh. Requested advice on which government department is responsible for approving work in the wetland area. DWER requested HPPL apply for a 26D licence for completeness. Work can start prior to approval on boreholes in non-confined aquifers (as these are exempt).
16/07/2018	DEMIRS	Targeted meeting/briefing	DEMIRS focus is mine Proposal and mine closure. Refer to and consult with EPA, DWER and others with respect to flora, fauna, water and provision of assistance on safety/engineering where relevant to EP Act Pt V licensing (e.g. TSF).

Date	Department	Activity	Key Comments
31/01/2018	DWER (includes industry regulation)	Targeted meeting/briefing	2013 referral decision for Murray's Hill (provide to HPPL) on 13 August project was "Not Assessed" as the significance of impact (on key factors including groundwater and subterranean fauna) was considered below the threshold of assessment. EPA and DWER suggested that unless the project has changed significantly, the referral decision would still be considered appropriate. EPA staff indicated that should HPPL submit an updated referral, the 2013 decision would become null and void. The EPA urged HPPL to consider a second submission until they finalise their commercial decisions.
30/01/2018	DEMIRS	Targeted meeting/briefing	DEMIRS stated questions regarding environmental baseline monitoring will largely be deferred internally to the EPA or DWER, including water quality, flora, fauna and air quality. HPPL highlighted the concerns Roy Hill has had with respect to inadequate waste characterisation, leading to significant 'incompetent material' from a slope stability perspective. Indicated that the mine TSF is of particular interest to the DEMIRS.
Banjima Traditional Owners and Community			
Various	Banjima Traditional Owners	Attendance during ecological surveys	Banjima Traditional Owners were invited to all and have attended the majority of ecological surveys.

Date	Department	Activity	Key Comments
14 February 2025	BNTAC Board of Directors BNTAC Representatives HPPL	Targeted meeting/briefing	HPPL presentation to BNTAC Board – update on scope of project and negotiation matters.
26/11/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Correspondence/notification	HPPL issued a draft Environmental Review Document to BNTAC for review and comment.
8/10/2024	BNTAC Representatives HPPL	Targeted meeting/briefing	BNTAC presentation on Banjima's closure principles. HPPL commit that Banjima's overarching goal "and disturbed by mining is rehabilitated and returned to the Banjima People in a condition that is physically safe, stable, non-polluting and consistent with restoration of Banjima's Native Title Rights" will be progressed with Banjima throughout the development of the detailed Closure Plan required under the Mining Act 1978.
03/10/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	HPPL-BNTAC MDIOP negotiation meeting with overview of MDIOPs revised base case (12Mtpa), including discussion of revised MDIOP parameters and impacts.

Date	Department	Activity	Key Comments
13/08/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/ briefing	Presentation of the MDIOP's revised base case (12Mtpa) to an internal session of BNTAC's negotiation committee. Description of revised MDIOP parameters and discussion of proposed impacts and mitigations.
14/05/2024 to 15/05/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved heritage sites, overview of approvals documentation and management measures and updates to the SCHMP.
6/05/2024 to 10/05/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	On-country consultation	On-country social surroundings consultation with Banjima and BNTAC to visit sites of significance on-country and to co-develop the SCHMP.
15/04/2024 to 16/04/2024	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved heritage sites, overview of approvals documentation and management measures.
27/02/2024	BNTAC Representatives BNTAC Technical Advisors HPPL	Workshop	Workshop to discuss BNTAC Technical Advisors review of the environmental approval documentation for the Proposal. Comments received from BNTAC have been updated within this ERD.
20/02/2024	BNTAC Representatives BNTAC Technical Advisors HPPL	Notification	Notification of s156A approval to remove Borefield West from the Proposal.

Date	Department	Activity	Key Comments
7/11/2023 to 8/11/2023	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved the Fortescue Valley buffer, rock shelter investigations and Proposal design elements such as the airport and the camp.
30/10/2023	BNTAC Representatives BNTAC Technical Advisors HPPL	Targeted meeting/briefing	Face to face meeting to provide BNTAC and BNTAC Technical Advisors with an overview of the rationale and approach to the Groundwater Management Plan prepared for the Proposal.
Fortnightly (dependent on availability)	BNTAC Representatives BNTAC Technical Advisors HPPL	Targeted meeting/briefing	HPPL meets weekly with BNTAC Representatives and Technical Advisors to discuss developments of the Proposal, identify key concerns and appropriate pathways for mitigating these concerns.
17/10/2023	Letters to BNTAC requesting access to the Youngaleena and Wirrilimarra Communities	Correspondence	HPPL provided letters to BNTAC outlining a request to access the Youngaleena and Wirrilimarra Communities prior to undertaking formal consultation with the communities in 2024. The access requested was to collect baseline environmental information and establish a 'meet and greet' with the communities. No response has yet been received from the communities. Formal consultation is proposed with the Youngaleena and Wirrilimarra Communities during 2024. This consultation will be facilitated through BNTAC.

Date	Department	Activity	Key Comments
5/09/2023 – 7/09/2023	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	On-country consultation	On-country consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Consultation discussed the Fortescue Valley buffer, rock shelter investigations and Proposal design elements such as the airport and the camp. An overview of a proposed heritage management pathway was discussed. Banjima Traditional Owners were provided the opportunity to provide feedback in relation to any key items discussed and identify any additional issues with the Proposal. HPPL requested formal resolutions from BNTAC with regards to surface water and claypan monitoring and rock shelter investigations. **Response**: Formal minutes were circulated to all attendees on 22/09/2023. BNTAC provided a formal letter outlining the resolutions discussed during the trip. These included access to heritage restricted zones for the purpose of claypan and surface water monitoring, and the ability of HPPL to begin the section 16 process for specified rock shelters.
15/08/2023	BNTAC	Correspondence	Letter provided to BNTAC providing notification of submission of environmental approval documentation relating to the Proposal.

Date	Department	Activity	Key Comments
24/07/2023 – 25/07/2023	BNTAC Representatives BNTAC Technical Advisors Banjima Traditional Owners HPPL	Targeted meeting/briefing	Perth-based consultation between HPPL and BNTAC Representatives, BNTAC Technical Advisors and Banjima Traditional Owners. Discussions involved environmental and heritage aspects, as well as provision of an overview of the Proposal. The consultation provides Banjima representatives the opportunity to engage and discuss important aspects of the Proposal as they relate to Banjima Traditional Owners. HPPL sought formal resolutions relating to water monitoring and other key environmental and heritage aspects of the Proposal. **Response**: Formal minutes were circulated to all attendees for approval.
24/05/2023	BNTAC	Targeted meeting/briefing	Water and ecohydrological studies presentation to BNTAC technical advisors. Overview of studies undertaken for the Proposal and key results. Proposed future works to inform key focus areas.
11/05/2023	BNTAC	Correspondence (email and attachments)	Provision of BNTAC with proposed presentation material for the following Social Surroundings and HHERC meeting (proposed for end of June 2023). Discussion on presentation and delivery of material.
16/03/2023	BNTAC	Correspondence (letter)	Letter requesting the establishment of the HanRoy Heritage and Environment Reference Committee (HHERC).

Date	Department	Activity	Key Comments
13/03/2023 to 17/03/2023	Banjima Traditional Owners, BNTAC	Targeted meeting/briefing On-country	The trip allowed interactive consultation with Banjima Traditional Owner representatives. The purpose was to discuss the Proposal with Banjima Traditional Owner representatives so that they could understand the Proposal. The trip provided an opportunity for Banjima Traditional Owner representatives to visit the country proposed to be impacted and understand the proposed works. Banjima Traditional Owner representatives also had the opportunity to provide feedback about the Proposal and how that may affect their relationship with the land, their cultural and social activities, and any indirect impacts on heritage sites. HPPL propose to work with Banjima Traditional Owners to address the concerns raised during the consultation and what impacts can be avoided, what will be reduced and managed and how this will be done.
2/02/2023	BNTAC	Correspondence (letter)	Letter requesting dates to be confirmed for the social surroundings consultation, noting the planned on-country consultation planned for 13-17 March 2023.
25/11/2022	BNTAC	Correspondence (letter)	Follow up letter to BNTAC requesting to schedule future social surroundings consultation.
13/07/2022	BNTAC	Correspondence (letter)	Introducing social surroundings consultation and eagerness for HPPL to engage with Banjima Traditional Owners. The letter requested HPPL to work with Banjima Traditional Owners to plan and schedule on country consultations and identify timing for preparation of key documents that are required for the relevant approvals.
10/06/2022 to 12/06/2022	Banjima Traditional Owners, BNTAC	Targeted meeting/briefing	Provision of the Banjima Negotiation Committee (BNC) (and advisors) the opportunity to visit Banjima Country for on the ground context and orientation of the Mulga Downs Iron Ore Project.

Date	Department	Activity	Key Comments
20/05/2022	BNTAC	Targeted meeting/briefing	HPPL and BNTAC Advisors meet and greet.
2/05/2022	BNTAC	Correspondence (document)	Letter requesting contact details for the appropriate persons/people within the Youngaleena and Wirrilimarra Communities to commence social surroundings consultation.
27/04/2022	BNTAC	Correspondence (letter)	Letter requesting contact details for the appropriate persons/people within the Youngaleena and Wirrilimarra Communities to commence social surroundings
13/07/2021	BNTAC Board, HPPL, Roe Legal, BNTAC	Targeted meeting/briefing	Presentation on the Proposal and requirement for a mining agreement.
1/10/2020	BNTAC Board, HPPL, Roe Legal, BNTAC	Targeted meeting/briefing	Presentation on the Mulga Downs Project including rail corridor and requirement for a mining agreement.
Yindjibarndi Traditional Owners and Community			
25/05/2023	YNAC (face to face meeting)	Targeted meeting/briefing	Continue to develop relationship with Yindjibarndi Traditional Owners. Provide expert hydrogeologist to provide overview of water management. Commence co-development of SCHMP. Promote discussion of Proposal in the context of SCHMPs. Listen and document matters of concern for inclusion in the SCHMP.
13/04/2023	YNAC (email)	Correspondence (email and attachments)	Email regarding field trip report from September on-country visit Email contained the report.
09/03/2023 and	YNAC (email)	Correspondence (email and attachments)	Request for the Yindjibarndi Social Surroundings report from the September 2022 on-country trip.

Date	Department	Activity	Key Comments
12/12/2022	Yindjibarndi People, YNAC (face to face meeting)	Targeted meeting/briefing	Continue to develop relationship with Yindjibarndi Traditional Owners. Present an update on the Proposal (design and approvals). Discuss planned field and investigative work. SCHMP presentation. Allow Yindjibarndi Traditional Owners to discuss the Proposal and SCHMP in private.
18/10/2022	Yindjibarndi People, YNAC (letter)	Targeted meeting/briefing	Proposal to undertake consultation for Social Surroundings Development of the SCHMP.
18/09/2022 to 22/09/2022	Yindjibarndi People, YNAC (face-to-face meeting (on-country))	Targeted meeting/briefing	Develop relationship with Yindjibarndi Traditional Owners. Identify important cultural associations between Yindjibarndi and their Country. The Yindjibarndi Traditional Owners were able to share their rich history and cultural connection with Country. HPPL were given opportunities to present the activities proposed to be conducted as per the Proposal. Identify the interests and concerns of the Yindjibarndi Traditional Owners.
24/11/2021	Yindjibarndi Aboriginal, Corporation Board, Yindjibarndi Ngurra Aboriginal Corporation Board, Yindjibarndi Elders, HPPL Roy Hill	Targeted meeting/briefing	Presentation on the Mulga Downs Project including water supply borefield
Pastoral Stations/Other Community Groups			
15/08/2023	Hooley Station (letter) Mt Florance Stations (letter) Mulga Downs Station (letter)	Correspondence (email and attachments)	Notification of submission of environmental approval document was provided via letter to Hooley Station, Mt Florance Station and Mulga Downs Station.

Date	Department	Activity	Key Comments
19/09/2022	Meeting (face to face) with Hooley Station and Mt Florance Station	Targeted meeting/briefing	Meeting to provide Hooley Station and Mt Florance Station with an overview of the Proposal. The meeting also provided opportunities for discussion and questions from the stations on the Proposal.
10/11/2022	Meeting with Mulga Downs Pastoral Station (Microsoft teams meeting)	Targeted meeting/briefing	Meeting to provide Mulga Downs Station with an overview of the Proposal. The meeting also provided opportunities for discussion and questions from Mulga Downs Station on the Proposal.
29/08/2023	Meeting the Town of Port Hedland	Targeted meeting/briefing	Meeting to provide an overview of the Mulga Down Iron Ore Projects and the status of approvals for each project.

6 Object and Principles of the Environmental Protection Act 1986

The objective of the EP Act is to protect the environment of the State through the establishment of a series of principles for environmental protection. HPPL has considered and/or addressed each of the principles regarding the Proposal and has therefore considered the object of the EP Act. The principles for environmental protection have been considered by HPPL and are summarised in **Table 6-1.**

Table 6-1: Principles of Environmental Protection

Principle		Consideration
1	**The Precautionary Principle** Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and An assessment of the risk-weighted consequences of various options.	The Proposal is being developed through a detailed process of review to ensure impacts to the environment are minimised through application of the mitigation hierarchy. HPPL is using existing environmental data for the region supplemented with site specific baseline and targeted data collected through the completion of the following studies: • Flora and vegetation; • Ecohydrological; • Terrestrial fauna including short range endemics; • Subterranean fauna; • Surface and groundwater; • Air quality; • Noise; • Visual assessments; • Heritage surveys; and • Soil and Materials characterisation. These studies have informed the design of the Proposal and modifications to the Development Envelope and Indicative Footprint to avoid and minimise environmental impacts to high value areas, where practicable. Consultation has been undertaken and is ongoing with key stakeholders to identify potential environmental impacts, appropriate measures to avoid and reduce impacts and management for the Proposal. HPPL also commits to implement specific management plans to ensure ongoing avoidance and minimisation of impacts to environmental values in the Development Envelope.
2	**The Principle of Intergenerational Equity** The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	The Proposal meets the principle of intergenerational equity by ensuring the health of the environmental values, maintaining ecological functions for future generations, whilst minimising any impacts on the environment. The Proposal has been designed to address the EPA's objectives for the key environmental factors, with mitigation measures to reduce residual environmental impacts and offsets proposed for any significant residual impacts. The Proposal responds to the growing demand for mineral resources and provides environmentally responsible and economically sustainable means of meeting this demand.

Principle		Consideration
		The Proposal can be implemented without unacceptable impacts on the health, diversity or productivity of the environment. The area is to be returned to pastoral land use on completion of mining.
3	**The Principle of the Conservation of Biological Diversity and Ecological Integrity** Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The conservation of biological diversity and ecological integrity is a fundamental consideration in the assessment of this Proposal. Wherever possible: • Non-fixed Proposal elements for mine infrastructure (e.g. WRDs, RoM pads, conveyors, roads, administration and maintenance buildings) will be located to minimise clearing and disturbance and maximise separation distances to sensitive receptors and known environmental values as identified by the baseline and targeted surveys; • Where practicable, the possibility of adopting separation distances has been and will be considered to minimise impacts to area of critical habitat and known environmental values as identified by the baseline and targeted surveys; • Identify possible areas that may be categorised as exclusion zones to avoid direct impacts. For example, sites of heritage significance, significant fauna habitat, and the claypans; • Ecological integrity outside of the footprint is expected to be maintained.
4	**Principles Relating to Improved Valuation, Pricing and Incentive Mechanisms** Environmental factors should be included in the valuation of assets and services. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Environmental constraint, avoidance and management costs will be considered in the planning and design of the Proposal. Detailed flora and vegetation and terrestrial fauna surveys have been undertaken to identify key environmental values within the Development Envelope. Survey findings have been used to review the Indicative Footprint to avoid and minimise impacts to significant values. HPPL also commits to implement specific management plans for the ongoing avoidance and minimisation of potential impacts. Following the application of the mitigation hierarchy, significant residual impacts are predicted. HPPL will be responsible for funding the cost of measures to avoid, reduce, mitigate and manage environmental impacts and commits to providing offset funds, where required, to the Pilbara Environmental Offsets Fund (PEOF), to maximise the benefit of offset expenditure. • The following validation, pricing and incentive measures are incorporated into the Proposal: • Reduction of waste to landfill through implementation of recycling schemes. • Minimisation of clearing which represents a cost saving associated with earthworks as well as a reduced environmental impact. Progressive rehabilitation to assist in restoring natural ecosystems, which reduces the costs associated with the Mining Rehabilitation Fund. Improve energy efficiency resulting in overall reductions in fuel consumption, costs and greenhouse gas emissions.
5	**The Principle of Waste Minimisation**	HPPL commits to minimising waste as far as practicable during construction, operation and closure by adopting the hierarchy of waste controls: avoid, minimise, reuse, recycle and safe disposal.

Principle		Consideration
	All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	

6.1 Identification of Key Environmental Factors

This section identifies the environmental factors and objectives relevant to the Proposal, outlines the overall assessment methodology presented in this document and the environmental impact assessment undertaken for each environmental factor.

Environmental factors are those parts of the environment that may be impacted by an aspect of a Proposal. The EPA has 14 environmental factors. The EPA has identified the following key environmental factors as relevant to the assessment of the Proposal (as identified in the ESD):

- Inland waters (**Section 7**);
- Subterranean fauna (**Section 8**);
- Flora and vegetation (**Section 8**);
- Terrestrial fauna (**Section 10**);
- Terrestrial environmental quality (**Section 11**);
- Greenhouse gas emissions (**Section 12**);
- Air Quality (**Section 13**); and
- Social surroundings (including Aboriginal heritage) (**Section 14**).

Consideration of other environmental factors occurred during the scoping and referral process. With the exception of Human Health and Landforms (**Section 15**) all other factors are not relevant to the Proposal and therefore do not require assessment in this ERD.

The key environmental factors associated with the Proposal are addressed in this ERD in the following format, and consistent with EPA's *Instructions on how to prepare an Environmental Review Document* (EPA 2021e):

- Statement of EPA objective;
- Discussion of relevant policy and guidance, and summary of how this guidance has been addressed;
- Description of the receiving environment relevant to the environmental factor;
- Definition of potential direct and indirect impacts on the environmental values for the environmental factor;
- Description of mitigation, including application of the mitigation hierarchy (i.e., avoid, minimise, rehabilitate and offset);
- Assessment of the extent and significance of residual impacts to the environmental values of the environmental factor;
- Description of the predicted environmental outcome as assessed against the EPA's objective for the environmental factor; and
- Cumulative and Holistic impact assessments are addressed in **Section 17** and **Section 18,** respectively.

7 Inland Waters

7.1 EPA Objective

The EPA's objective for the environmental factor Inland Waters is:

"To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected" (EPA 2018a).

For the purpose of this assessment inland waters includes groundwater, such as superficial and confined aquifers, and hydrology, such as waterways, wetlands and estuaries. A 'waterway' is any river, creek, stream or brook, including its floodplain and estuary or inlet. This includes systems that flow permanently, for part of the year or occasionally, and waterways that have been artificially modified (EPA 2018a).

7.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to this factor which have informed the planning for the Proposal are listed in **Table 7-1.** HPPL has specifically considered guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and the significance of that environment;
- Identification of activities which may lead to impacts to inland water; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 7-1: Inland Waters Policy and Guidance

Reference	Report
DoW 2010	Pilbara - Regional Water Plan 2010 - 2030
DoW 2013	Western Australian Water in Mining Guideline
EPA 2018a	Environmental Factor Guideline: Inland Waters
ANZECC/ARMCANZ 2000	National Water Quality Management Strategy
NHMRC 2004	Australian Drinking Water Guidelines 6; Endorsed by NHMRC 10-11 April 2003.
DMIRS 2020a	Statutory Guidelines for Mine Closure Plans

Specific additional work required for assessment of the Proposal, relating to Inland Waters was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

7.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to the Inland Waters factor, including details of the surveys and studies undertaken to support the Proposal.

7.3.1 Relevant Studies

HPPL has conducted numerous hydrological, ecohydrological, hydrogeological and modelling studies to inform the description of the receiving environment, with respect to inland waters, for the Proposal. **Table 7-2** lists the technical studies undertaken. Key study reports are provided in **Appendix 4** and **Appendix 5**.

Table 7-2: Completed Baseline Inland Water Surveys and Studies

Reference	Report Title	Description	Guidance
MWH 2008	Hydrology Study for the Mulga Downs project	Short report reviewing groundwater levels and water quality/supply.	Not Applicable (NA)
MWH 2009	Murray's Hill Groundwater Investigation – Stage 2	To expand and improve the Stage 1 understanding of the hydrogeology of the Murray's Hill deposit and surrounding environment by conducting Stage 2 field visit including site visit, installation of six data loggers, completion of two test pumping exercises, EC profiling and sampling.	Australian Drinking Water Guidelines 6, NHMRC 2004; Endorsed by NHMRC 10-11 April 2003.
MWH 2012a	Mulga Downs Project, Murray's Hill Minesite – Hydrology Assessment Report	Study undertaken to characterise the quantity and quality of the groundwater resources within the mining tenement.	NA
MWH 2012b	Hydrogeological Assessment of the Fence line Road Borefield Area (Mulga East)	Study undertaken to characterise the quantity and quality of the groundwater resources within the mining tenement.	NA
HPPL 2013	Mulga Downs Project – Section 38 Referral Supporting Document, Hancock Prospecting Pty Ltd, Perth	Referral document for Murray's Hill Mine.	NA
MWH 2014	Conceptual Hydrogeology of the Mulga East Deposit	Undertaken to develop a preliminary groundwater desktop study of the Mulga East deposit and compile a conceptual hydrogeological model of the area.	Australian Drinking Water Guidelines 6, NHMRC 2004; Endorsed by NHMRC 10-11 April 2003.
AQ2 2018a	Mulga East – Preliminary Conceptual Model	Stage 1 Desktop study review of all available data and previous work and develop a preliminary conceptual site model for the Development Envelope and current data gaps.	Environmental Factors Guideline Inland Water (EPA 2018a)
AQ2 2018b	Mulga East – Excess Water Management	Water management options for the anticipated excess water from dewatering at the Mulga East Project	Environmental Factors Guideline Inland Water (EPA 2018a)
AQ2 2020a	Mulga East Baseline Water Studies *(superseded by A)* ***Appendix 4 and Appendix 5))***	Baseline groundwater and surface water studies	Environmental Factors Guideline Inland Water (EPA 2018a)

Reference	Report Title	Description	Guidance
AQ2 2020b	Ecohydrological Baseline Study Superseded by **Appendix 4**	Baseline survey for GDV.	Environmental Factors Guideline Inland Flora and Vegetation (EPA 2016)
GHD 2023 **(Appendix 7a)**	Mulga Downs Water Studies: Groundwater & Surface Water Impact Assessment – Peer Review	Peer review of the AQ2 (2024a) Mulga Downs Water Studies: Groundwater and Surface Water Impact Assessment report as scoped in the Mulga Downs Iron Ore Mine ESD 2022. Note that only the surface water components of the report were reviewed in this study.	NA
HydroGeoLogic 2023 / Middlemis 2023 **(Appendix 7b)**	Mulga Downs Groundwater Modelling Independent Peer Review	Peer review into the groundwater modelling investigations conducted by Groundwater Consulting and AQ2 for the Mulga Downs Iron Ore Project	NA
AQ2 2025 **(Appendix 4)**	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies – Baseline Assessment (171X_492d)	Baseline groundwater, surface water and ecohydrological studies , to support the environmental assessment of the Project. This report details all baseline and conceptualisation work undertaken from 2018 until November 2023	Environmental Factors Guideline Inland Water (EPA 2018a); Environmental Factors Guideline Flora and Vegetation (EPA 2016)
AQ2 2024a (**Appendix 5**)	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies - Impact Assessment (171X_493a)	This assessment provides an environmental impact assessment of the Proposal, identifying key environmental assets and water management strategies.	Environmental Factors Guideline Inland Water (EPA 2018a); Environmental Factors Guideline Flora and Vegetation (EPA 2016)

7.3.2 Geomorphology and Hydrology

The Development Envelope is within the Chichester Ranges, on the northern flanks of the Lower Fortescue Valley. It is within the Goodiadarrie Swamp surface water catchment, which is approximately 4,138 km^2 (HPPL 2013; AQ2 2025) (**Figure 7-2**).

The Fortescue Valley (shown as the ESA) (**Figure 7-29**) is bound by the Chichester Range to the north and the Hamersley Range to the south. It comprises a network of interconnected ephemeral swamps, claypans and floodplains which extend further to the west into Mount Florance Station. The valley floor gently slopes to the west, is about 20 km wide and is bound to the south by the Hamersley Range (AQ2 2025).

The Chichester Range comprises hills which rise approximately 100 m above the Fortescue Valley floodplain. Surface water runoff into the Fortescue Valley is from the Chichester Range to the north and the Hamersley Range to the south. The hills of the Chichester Range are cross-cut by narrow, steep-sided gullies that feed into a series of alluvial fans extending into the valley floor. Numerous small tributaries cross the alluvial fan surfaces and deliver water into the Fortescue River valley wetland complex, including Goodiadarrie Swamp (AQ2 2025).

Runoff from smaller rainfall events is likely contained within the Goodiadarrie Swamp area, with discharge into the Lower Fortescue River requiring large rainfall events. The wide and gently sloping interfluvial zones are characterised by banded vegetation formations, indicating sheet flow behaviour in these areas. Similar (but

larger) drainage lines exist within the Hamersley Range to the south. The incised drainage lines are contained within larger gorges such as Wittenoom Gorge and Kalamina Gorge and discharge into large alluvial fans spread across the southern flank of the Lower Fortescue River valley.

East of the Development Envelope, the Goodiadarrie Hills form the western boundary of the Upper Fortescue River Catchment, separating the Fortescue Valley in the vicinity of the Proposal from the Fortescue Marsh to the east. The catchment terminus comprises the Fortescue Marsh, a vast endorheic wetland occupying an area of approximately 1,000 km^2. The Fortescue Marsh (the Marsh) is the largest ephemeral wetland in the Pilbara, the water regime supporting a number of environmental values (EPA 2013). The Marsh is currently managed by the Department of Biodiversity, Conservation and Attractions (DBCA) in accordance with the Fortescue Marsh Management Strategy 2018-24 (DBCA, 2018). The Fortescue Marsh is approximately 60 km east (upstream) of the Development Envelope, and is considered to be geographically, hydrologically and hydrogeologically separate to the Lower Fortescue River system.

With respect to being recognised as a wetland of national significance, the Fortescue Valley is listed in the Directory of Important Wetlands in Australia (DIWA) as Fortescue Marshes - WA066. This site comprises the more or less contiguous floodplain in the middle reaches of the Fortescue River, bisected by the Goodiadarrie Hills, but covering both the Fortescue Marsh and Goodiadarrie Swamp areas.

Locally, significant surface water features, the Koodjeepindarranna and Gnalka Gnoona Claypans (**Figure 7-2**), have developed at the interface of the alluvial fan margins and extensive shallow calcrete associated with the valley floor paleodrainage (AQ2 2025).

River and creek systems in the Pilbara generally only flow for a very short duration immediately following larger rainfall events which predominantly occur during the wet season (December through to March). Extended periods of no flow occur throughout the dry season. Multiple flood events are recorded across many years; however, in low rainfall years, or years where large rainfall events are absent, there may not be any flow responses in the main river/creek systems (AQ2 2025).

Sixteen surface water subcatchments have been delineated which have the potential to be impacted by the Development Envelope. Runoff from eleven of these catchments reports to the Fortescue Valley Environmentally Sensitive Area (ESA) as defined by DWER (AQ2 2025). The following datasets have been used to delineate the baseline catchment areas:

- 2023 LiDAR DEM;
- SRTM datasets;
- Aerial imagery; and
- Initial flood model results.

Baseline catchment areas are presented in **Figure 7-1**, with the size of each catchment area summarised in **Table 7-3**.

Table 7-3: Baseline Surface Water Catchment Summary

Catchment	Baseline Area (km^2)
1	23.1

Catchment	Baseline Area (km²)
2	164.4
3	39.8
4	28.4
5	33.8
6	13.5
7	29.0
8	11.9
9	43.3
10	53.9
11	65.5
12	1.7
13	6.3
14	2.1
15	4.5
16	7.3

Figure 7-1: Pre-development Catchment Areas

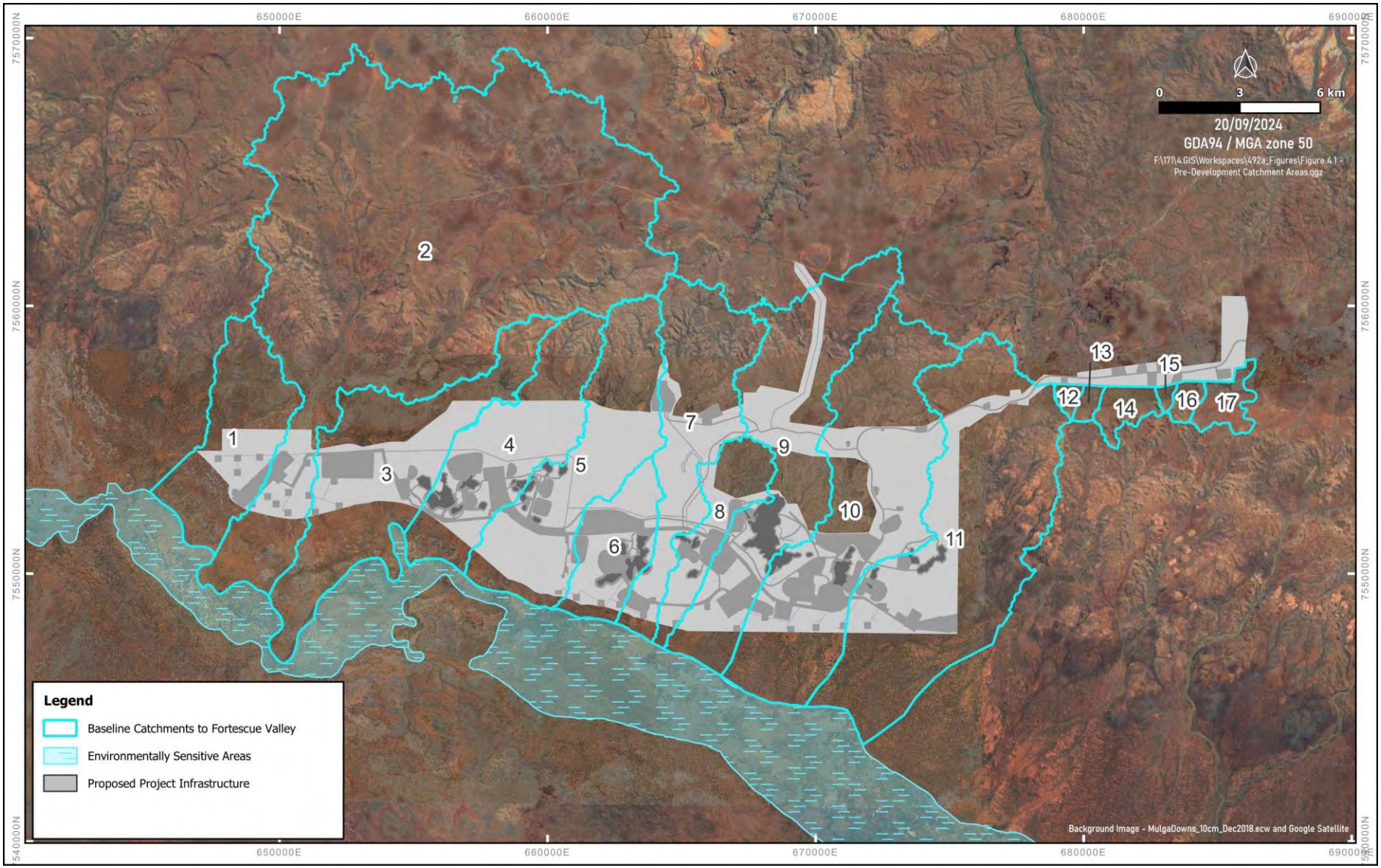

650000E
660000E
670000E
680000E
690000E
7570000N
7560000N
7550000N
7540000N
0
3
6 km
20/09/2024
GDA94 / MGA zone 50
F:\171\4.GIS\Workspaces\492a_Figures\Figure 4.1 - Pre-Development Catchment Areas.qgz
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Legend
Baseline Catchments to Fortescue Valley
Environmentally Sensitive Areas
Proposed Project Infrastructure
Background Image - MulgaDowns_10cm_Dec2018.ecw and Google Satellite

Figure 7-2: Geomorphology Overview (AQ2 2025)

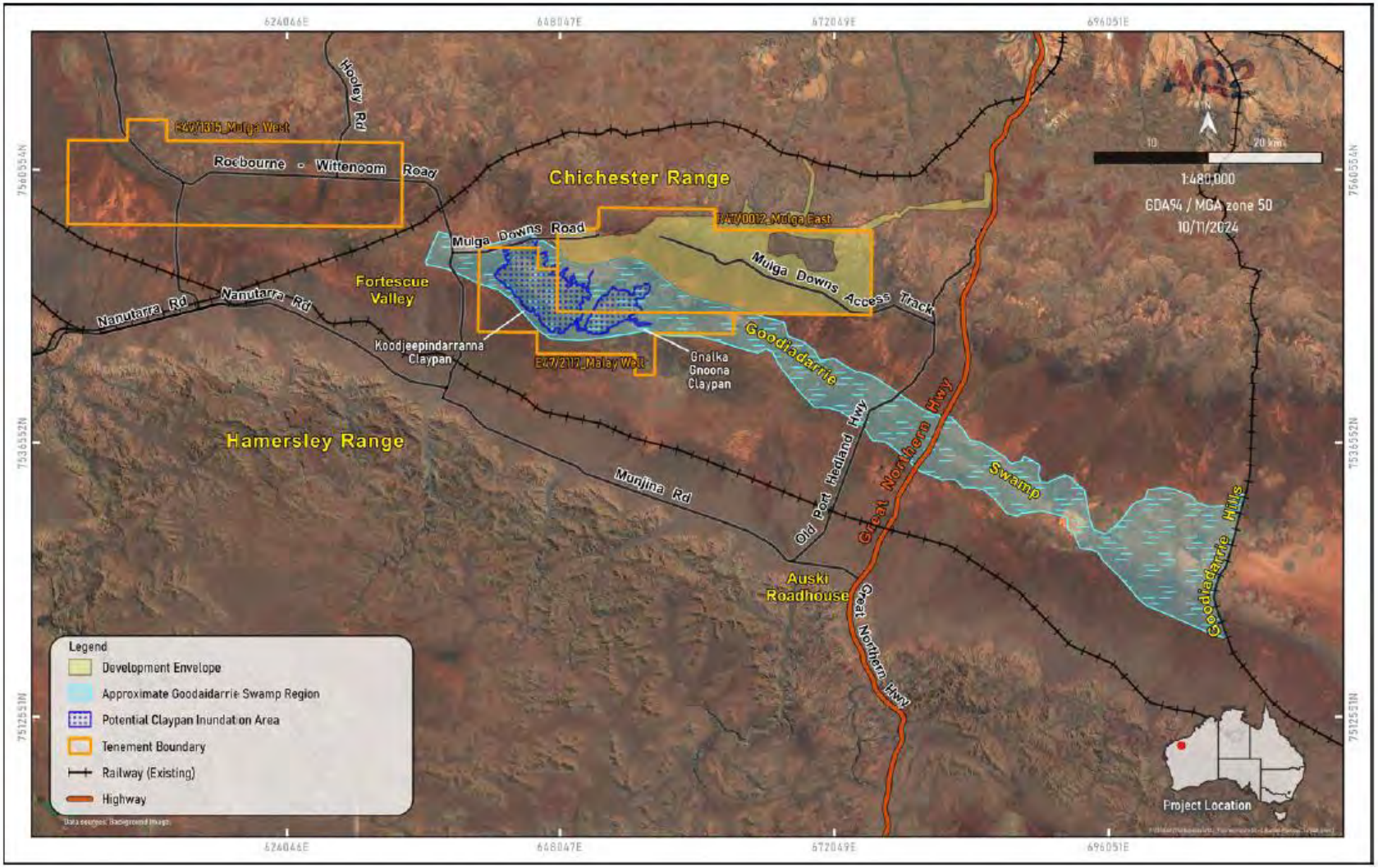

624046E
648047E
672049E
696051E
7560554N
7536552N
7512551N
Hooley Rd
E47/1815_Mulga West
Roebourne - Wittenoom Road
Chichester Range
E47/0012_Mulga East
Mulga Downs Road
Mulga Downs Access Track
Fortescue Valley
Nanutarra Rd
Nanutarra Rd
Koodjeepindarranna Claypan
E47/2117_Maley West
Gnalka Gnoona Claypan
Goodiadarrie
Hamersley Range
Munjina Rd
Old Port Hedland Hwy
Great Northern Hwy
Swamp
Goodiadarrie Hills
Auski Roadhouse
Great Northern Hwy
10
20 km
1:480,000
GDA94 / MGA zone 50
10/11/2024
Legend
Development Envelope
Approximate Goodaidarrie Swamp Region
Potential Claypan Inundation Area
Tenement Boundary
Railway (Existing)
Highway
Project Location

Figure 7-3: Regional Hydrology

645000 650000 655000 660000 665000 670000 675000 680000 685000 690000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000

WEST YULE RIVER
WALL CREEK
COCKERAGA RIVER
BEASLEA CREEK
JOFFRE CREEK
BRUMBY CREEK
FORTESCUE RIVER
MUNJINA CREEK

Legend

- Indicative Footprint
- Development Envelope

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes

Catchment boundaries (DWER-028)

- Fortescue River
- Fortescue River- Upper
- Watercourse (DWER-031)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 22-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:150,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

REGIONAL HYDROLOGY

FIGURE 7.3

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

7.3.3 Surface Water Quality

Surface water samples were collected within creek lines, channel pools and claypans between 2020 and 2023, for laboratory analysis (AQ2 2024a). Sample locations are shown in **Figure 7-4**. The following water quality samples were collected:

- SWML01 (Creekline) – 5 samples.
- SWML02 (Creekline) – 4 samples.
- SWML03 (Claypan) – 4 samples.
- SWML04 (Claypan) – 5 samples.
- SWML05 (Creekline) – 3 samples.
- SWML09 (water quality only) – 1 sample.
- SWML13 (water quality only) – 1 sample.

The results of these samples are documented in Section 4.5 of AQ2 2025 (**Appendix 4**) and summarised in Table 7-4**.** It is noted that samples collected in 2019 from drainage lines have not been included as these were collected using a different methodology which likely resulted in abnormally high TDS water quality results.

Table 7-4: Summary of Key Baseline Surface Water Quality Results (mg/L)

	Drainage Line Samples		Claypan Samples	
	Range	**Typical**	**Range**	**Typical**
TDS	18 to 240	100	120 to 19,000	~4,000
Calcium	1.6 - 21	10	3.9 – 35	5
pH (pH Units)	3.7 – 8	6.4	7 – 8.3	7.2
Bicarbonate	<5 – 47	20	50 – 130	100
Carbonate	<5	<5	<5	<5
Ammonia – N	<00.2 – 9.5	1	<00.2 – 6	1
Nitrate-N	0.02 – 28	2	<0.01 -1.6	1
Filterable Reactive Phosphorus	<0.01 -1.8	0.1	<0.01 -0.44	0.1
Magnesium	0.4 – 5.6	4	1.2-180	3
Sulfate	2 - 43	5	< 1 to 230	40
Sodium	0.8 -15	5	22 -950	40
Chloride	2 -17	<5	11 – 1,600	50
Aluminium (dissolved)	0.015 – 1.6	0.1	1.8 – 7.4	5
Iron (dissolved)	0.02 – 0.85	0.08	0.06 -14	8

Notes - Variable water quality in the claypans reflects evapo-concentration of water stored in the claypans following runoff events

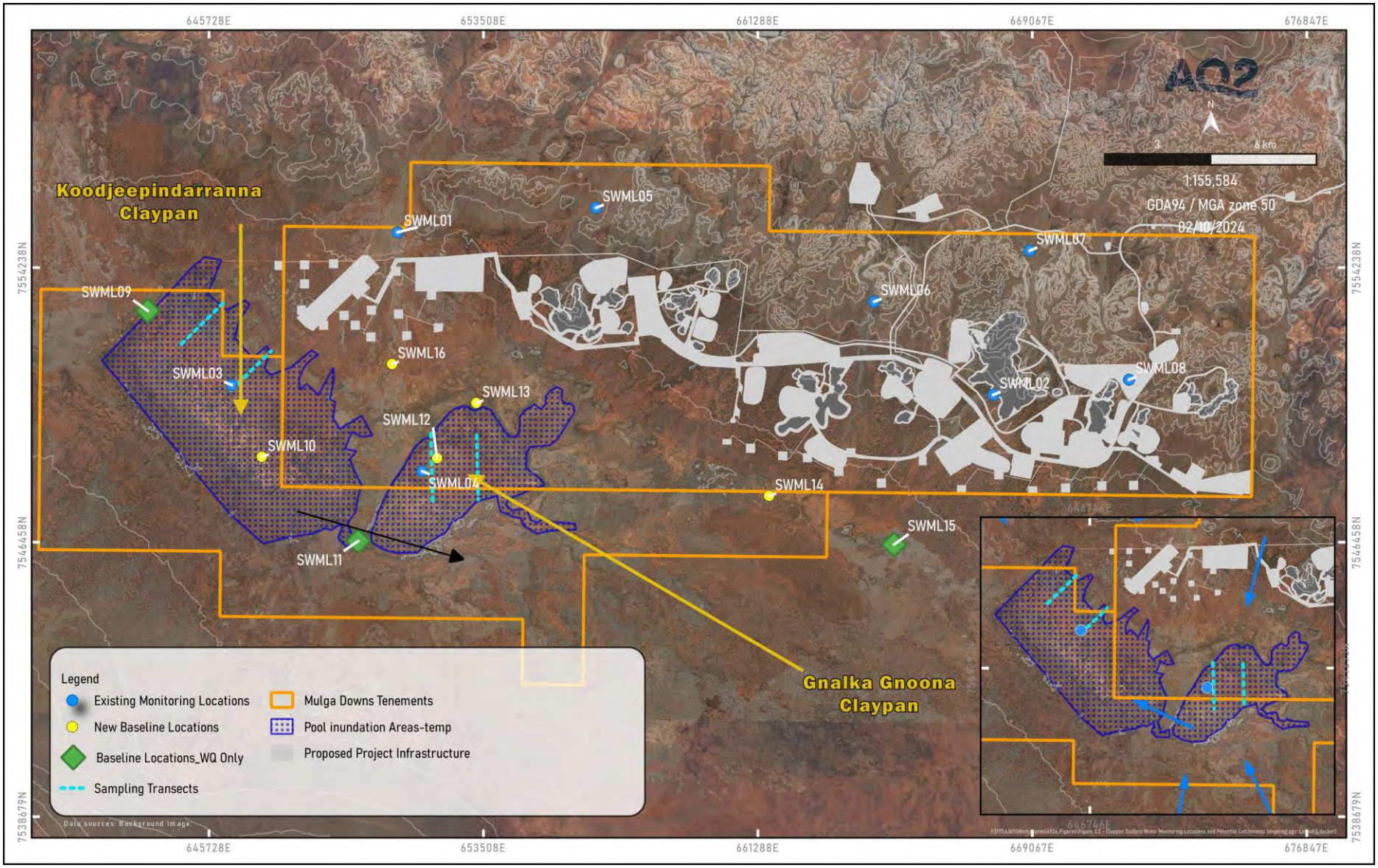
These water quality samples provide baseline water quality data within the Development Envelope. Given the naturally large variability in surface water runoff, additional samples are required to be collected over time to provide a more robust baseline dataset, and further characterise surface water quality for the Proposal.

The water quality sample results indicate that surface water runoff within the Development Envelope is fresh and generally pH neutral. There is the potential that the natural runoff can have high levels of suspended sediment. The salinity in the claypans tends to be fresh immediately following a runoff event, but salinity increases with time as the ponded water evapo-concentrates.

The baseline water quality data collected has been compared with the ANZECC Freshwater Aquatic Ecosystem trigger values, to show where runoff from the existing catchments exceeds them. The full provision and analysis of this data is detailed in AQ2 (2025) (**Appendix 4**).

The baseline data collected will provide a useful reference dataset to identify if any changes in surface water runoff quality occur following proposed catchment modifications as part of the Proposal. The potential impact of proposed catchment modifications are discussed in **Section 7.5**.

Figure 7-4: Surface Water Monitoring Locations (AQ2 2025)


645728E
653508E
661288E
669067E
676847E
7554238N
7546458N
7538679N
AQ2
N
3
6 km
1:155,584
GDA94 / MGA zone 50
02/10/2024
Koodjeepindarranna Claypan
Gnalka Gnoona Claypan
SWML01
SWML02
SWML03
SWML04
SWML05
SWML06
SWML07
SWML08
SWML09
SWML10
SWML11
SWML12
SWML13
SWML14
SWML15
SWML16
Legend
Existing Monitoring Locations
New Baseline Locations
Baseline Locations_WQ Only
Sampling Transects
Mulga Downs Tenements
Pool inundation Areas-temp
Proposed Project Infrastructure
Data sources: Background Image

7.3.4 Claypans

The Koodjeepindarranna and Gnalka Gnoona claypans are not located within the Development Envelope; however, they may be considered proximal. The mapped DBCA buffers for the claypans do intersect the Development Envelope, however when dry, the boundary of the claypans can be delineated by the unvegetated areas, as mapped by *ecologia* (2021a) (refer to **Figure 9-4**). These delineated boundaries fall outside of the Development Envelope.

The Ebathcalby Claypan (Priority 1) Priority Ecological Community (PEC) is located approximately 9 km south of the Development Envelope (**Figure 7-29**) and has an elevation which is 5m higher than the valley floor directly downstream of the Development Envelope. As such, no surface water runoff from the Development Envelope will report to this claypan. Given this, no specific studies into surface water dependence at Ebathcalby Claypan were deemed necessary (AQ2 2024).

Baseline studies (AQ2, 2025) on the hydrology and hydrogeology of the Koodjeepindarranna and Gnalka Gnoona claypans concluded that they are supported by direct rainfall and surface water flows and are not groundwater dependent. These claypans are illustrated in **Figure 7-5**, and the below summarises the hydrological function of these claypans.

Prior to development of the Project, surface water runoff from the Development Envelope would discharge to the Koodjeepindarranna and Gnalka Gnoona claypans (Priority 1) PEC (AQ2 2025). These claypans are hydraulically linked through an overflow channel which links the claypans during periods of high rainfall and inundation. Water flows between the claypans when water levels are above 402.9 m AHD (AQ2 2023a). To the east of the Gnalka Gnoona Claypan, there is evidence of surface water ponding on the northern side of the Fortescue Valley at the foot of the Chichester Range, indicating limited surface water connectivity with the Fortescue Valley to the east of the claypans.

The Koodjeepindarranna and Gnalka Gnoona claypans have catchments that drain from both the north (Chichester Range) and potentially the south (Hamersley Range) depending on the size of the rainfall event. The Development Envelope is confined to the Chichester catchments. The estimated catchment areas for the Koodjeepindarranna and Gnalka Gnoona claypans are illustrated in **Figure 7-6**; however, they are difficult to define, with contributions from different catchments likely to change depending on the size of the rainfall event. Catchment definition is also complicated by the behaviour of drainage lines across the alluvial fan, and the lack of defined drainage and presence of ponding areas within the Fortescue Valley (AQ2 2025). The larger drainage lines originating in Chichester (and Hamersley) Range build alluvial fans on reaching the valley. The drainage lines become braided where they flow across their alluvial fans. However, there often appears to be a preferred drainage channel across each fan for flows of smaller, frequent runoff events. This means there are multiple discharge points from these catchments that contribute to a complex wetland mosaic in the Fortescue Valley (AQ2 2025).

Typically, runoff from small rainfall events is retained within the Goodiadarrie Swamp. Water loss from the claypans is dominated by evaporation (80%) and seepage (20%) to the local groundwater regime. The Koodjeepindarranna and Gnalka Gnoona claypans are not connected to the regional groundwater system. Groundwater levels were monitored below the elevation of the claypans from 2018 to 2023 (AQ2 2024a) as shown in **Figure 7-7**. Groundwater levels near the claypans were generally 2 m to 3 m below the lowest ground

surface elevation in the claypans. The groundwater levels are ~400 m AHD compared to the claypan elevation of ~ 402 m AHD, indicating that groundwater does not flow into the claypans. Seasonal groundwater level fluctuation is also relatively low, at around 0.5 m, based on groundwater level data obtained as part of this assessment (refer to **Section 7.3.6.4**).

A portion of the ponded surface water in the claypans seeps into the underlying groundwater system. Groundwater monitoring bores near the claypans show increases in groundwater levels in response to rainfall events and extended periods of elevated groundwater levels coinciding with ponded surface water being contained in the claypans. This groundwater seepage from the claypans also appears to be a controlling factor in increased levels of groundwater salinity through the leaching of residual salts from evaporation. This seepage has given rise to a saline mound observed in the groundwater along the centre of the valley within the Development Envelope.

Figure 7-5: Claypan Hydrological Conceptualisation (AQ2 2025)

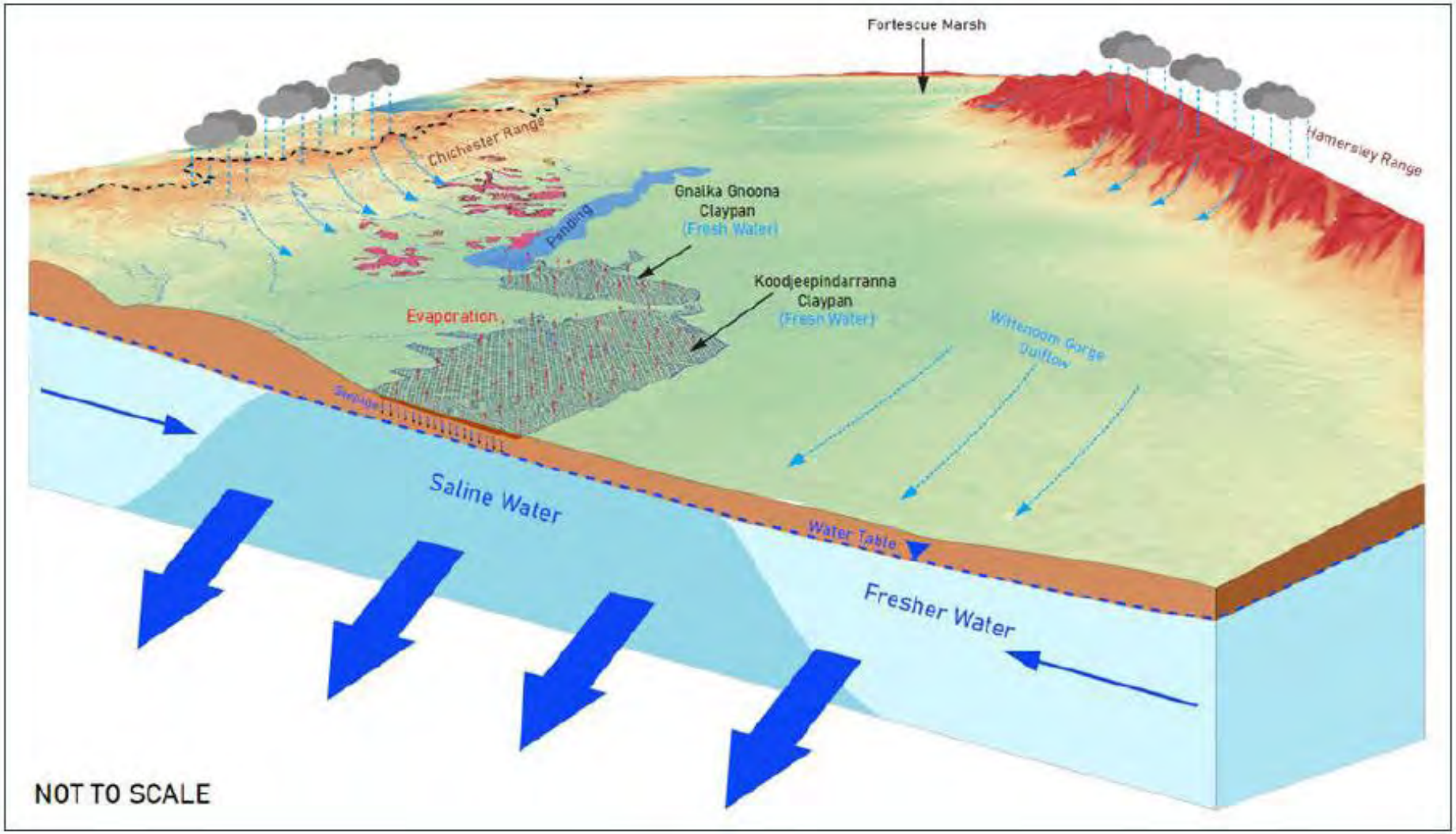

Fortescue Marsh
Chichester Range
Hamersley Range
Gnalka Gnoona
Claypan
(Fresh Water)
Paliling
Koodjeepindarranna
Claypan
(Fresh Water)
Evaporation
Wittenoom Gorge
Outflow
Saline Water
Water Table
Fresher Water
NOT TO SCALE

Figure 7-6: Effective Catchment Areas for the Major Claypans (Mulga East) (AQ2 2025)

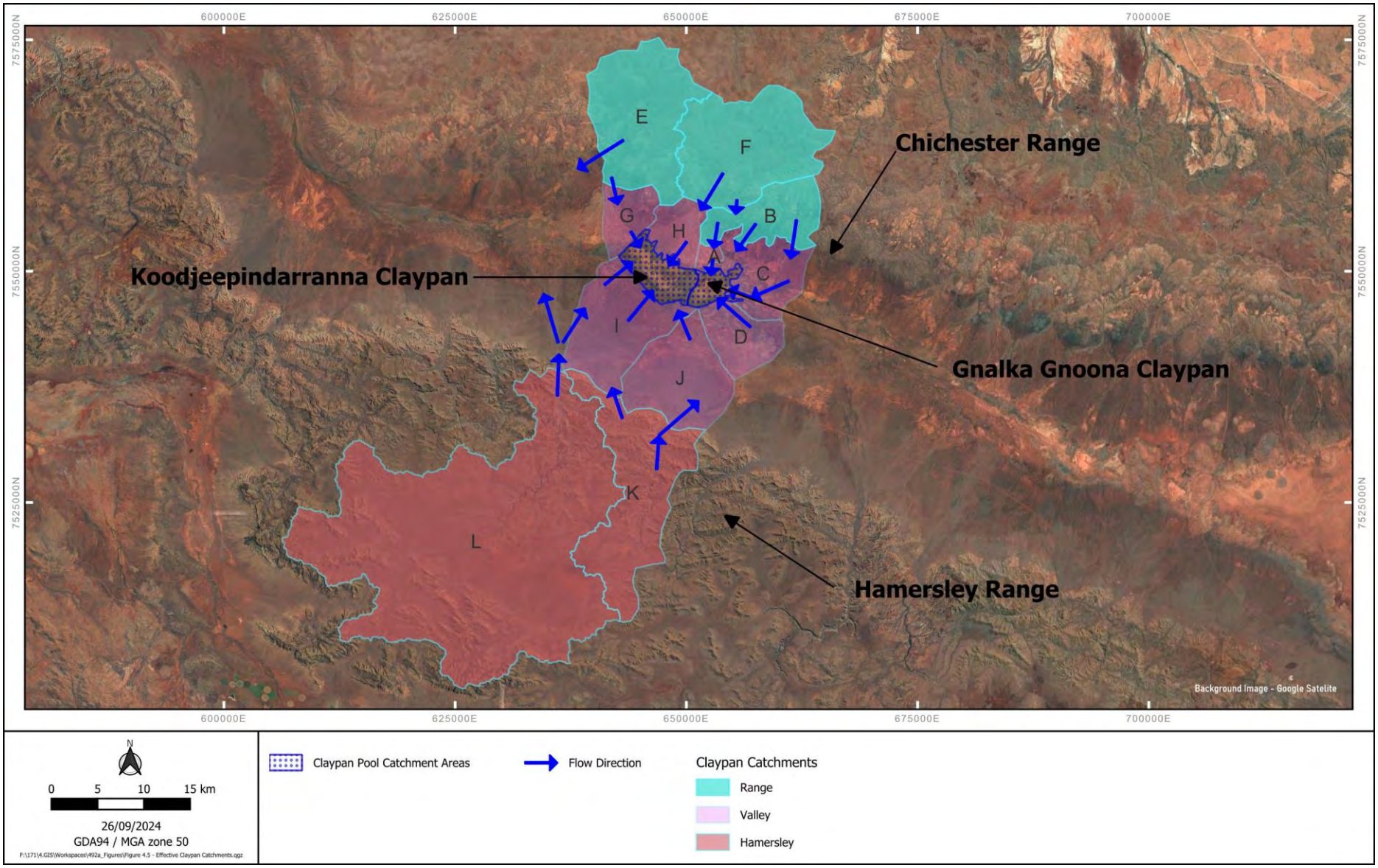

600000E
625000E
650000E
675000E
700000E
7575000N
7550000N
7525000N
E
F
G
H
B
A
C
I
D
J
K
L
Chichester Range
Koodjeepindarranna Claypan
Gnalka Gnoona Claypan
Hamersley Range
Background Image - Google Satelite
N
0 5 10 15 km
26/09/2024
GDA94 / MGA zone 50
F:\171\4.GIS\Workspaces\492a_Figures\Figure 4.5 - Effective Claypan Catchments.qgz
Claypan Pool Catchment Areas
Flow Direction
Claypan Catchments
Range
Valley
Hamersley

Figure 7-7: Groundwater and Surface Water Hydrographs for the Koodjeepindarranna Claypans and Gnalka Gnoona (AQ2 2025)

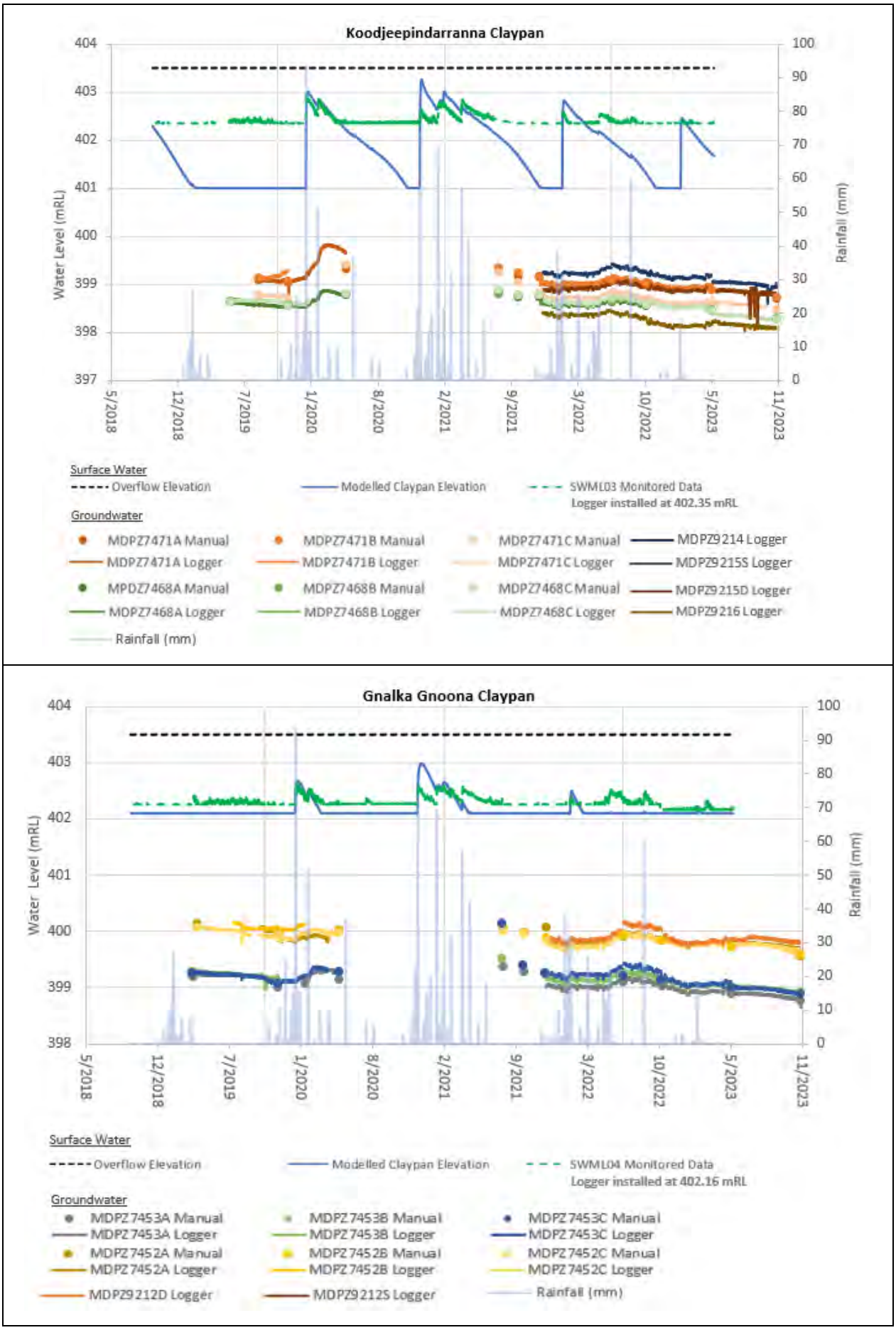


Figure 7.7 Groundwater and Surface Water Hydrographs for the Claypan Areas

7.3.5 Geology

Geology is discussed in **Section 3.9**. Further detail relevant to inland waters is discussed in the following sections.

The Pilbara region occupies the northernmost portion of the ancient Western Shield (Beard 1990). It comprises sedimentary, volcanic and igneous rocks of the Pilbara craton some of which are up to 3.72 billion years (Ga) old (Pepper et al 2013). To the north the Archaean granites and metamorphosed volcanic rocks of the Pilbara Block form the undulating hills and plains observed throughout the Abydos Plain and Yule River and De Grey River catchments. To the south these older rocks are overlain by Archaean and Proterozoic basalts and iron rich sedimentary rocks (Banded Iron Formation – BIF) that comprise the Hamersley Basin (Beard 1990, van Vreeswyk et al 2004, Van Kranendonk et al 2002 in Pepper et al 2013). The Fortescue Valley is part of the larger Hamersley Basin.

The Development Envelope is in the northern part of the Hamersley Basin, a late Archaean to early Proterozoic (2800 Ma - 2400 Ma) depositional basin exposed over most of the southern part of the Pilbara Craton. The Hamersley Basin is occupied by three groups of rocks; the lowermost mafic volcanic dominated Fortescue Group; the Banded Iron Formation (BIF) dominated Hamersley Group; and the uppermost clastic dominated Turee Creek Group (**Figure 7-8** and **Figure 7-9**).

The Development Envelope covers part of the Fortescue Valley and Chichester Ranges. The alluvium represents the Fortescue Valley in Figure 7-8. The Fortescue Valley separates the Hamersley Range to the south from the Chichester Range to the north. The sediments of the Fortescue Group along the Chichester Range are the oldest rocks which cover the Granite-Greenstone Terrain of the Pilbara Craton. The shales and BIFs of the Hamersley Group conformably overlie the Fortescue Group.

The Quaternary and Tertiary sediments (Cainozoic sediments) fill the Fortescue Valley and recent gorges. These sediments include, from youngest to oldest: the alluvium, colluvium, upper calcrete, undifferentiated tertiary (detritals), CID pisolite, basal crete, calcrete of the Oakover Formation. These Quaternary and Tertiary (Cainozoic) sediments overly the older rocks of the Hammersley Group.

The Mulga Downs mineralisation, which is the focus of the Proposal, is hosted by the lower part of the Marra Mamba Iron Formation (MMIF), with secondary mineralisation identified in the transported or detrital materials. The MMIF outcrops as small-rounded hills in the Mulga Downs area, with the hill slopes commonly covered with Cainozoic (Quaternary and Tertiary) sediments such as alluvium, colluvium and/or detritals.

A weathered, hydrated horizon or hard cap is recognised at M 47/1612 with elevated iron to above 50% in places. Localised patches of manganiferous material on outcrops of the MMIF occur at the lower central part of the Mine Area. Manganiferous material is closely associated with hard cap and detritals (Hancock Prospecting, 2015a).

A summary of the stratigraphic sequence in the Development Area is provided in **Table 7-5.** This follows the baseline studies completed by AQ2 (2020, 2024a, 2025) and Mine Earth (2020) for the Proposal.

Figure 7-8: Regional Geology and Geomorphology (Lascelles, 2002)

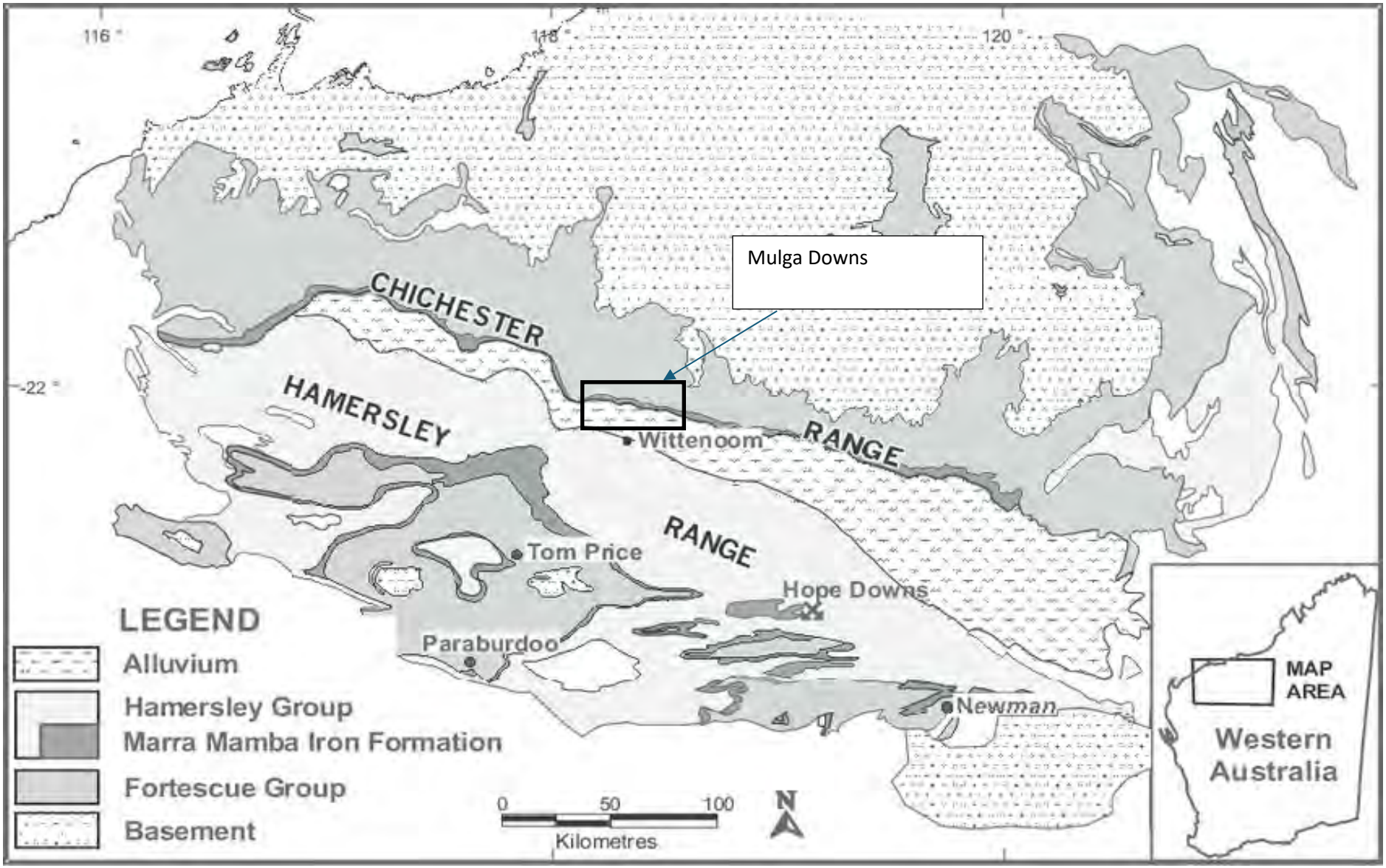

116 °
118 °
120 °
-22 °
Mulga Downs
CHICHESTER
HAMERSLEY
RANGE
Wittenoom
RANGE
Tom Price
Hope Downs
Paraburdoo
Newman
LEGEND
Alluvium
Hamersley Group
Marra Mamba Iron Formation
Fortescue Group
Basement
0
50
100
Kilometres
N
MAP AREA
Western Australia

Figure 7-9: Regional Geology (Kitzig et al 2018)

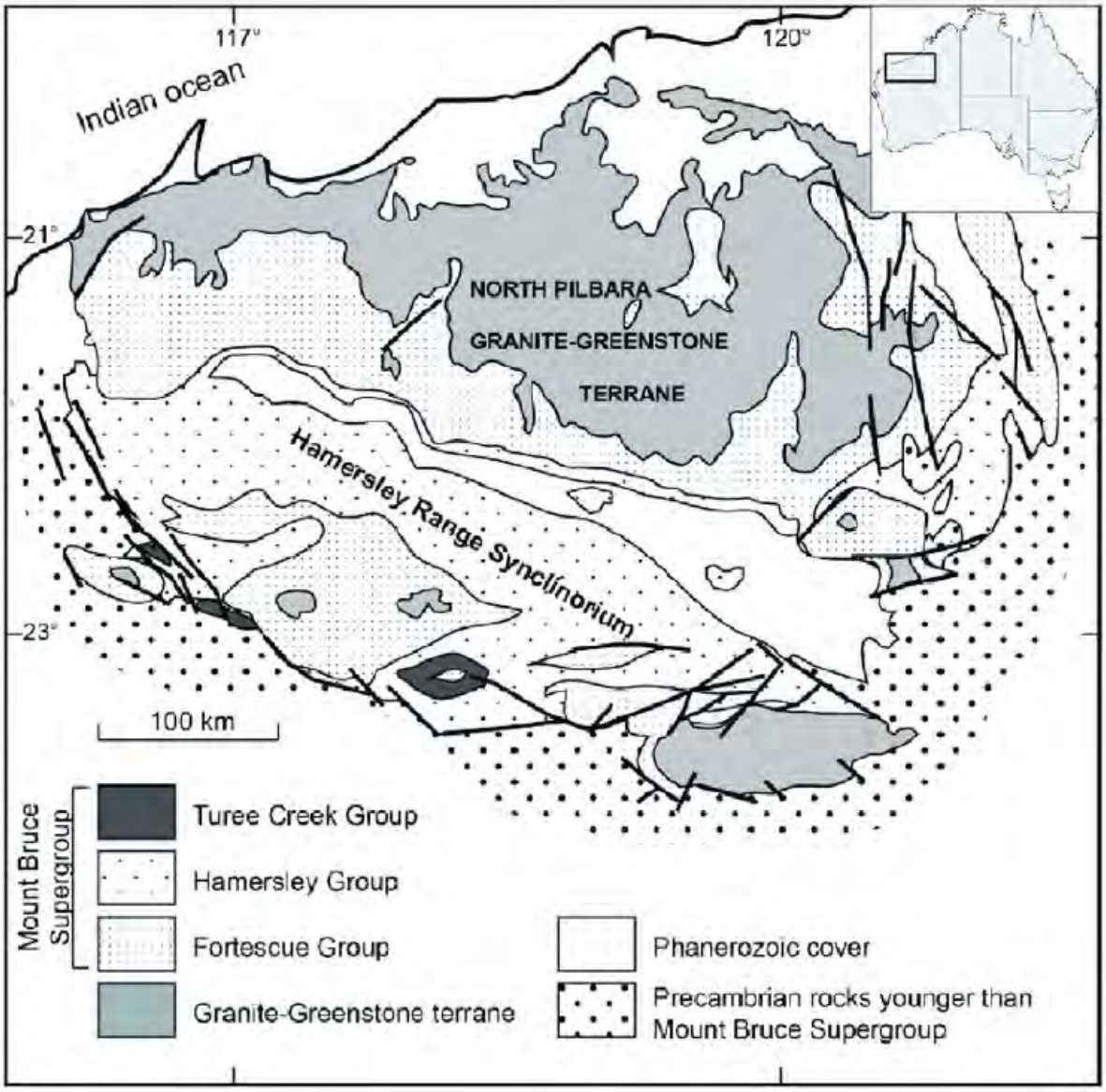

117°
120°
Indian ocean
21°
23°
NORTH PILBARA
GRANITE-GREENSTONE
TERRANE
Hamersley Range Synclinorium
100 km
Mount Bruce Supergroup
Turee Creek Group
Hamersley Group
Fortescue Group
Granite-Greenstone terrane
Phanerozoic cover
Precambrian rocks younger than Mount Bruce Supergroup

Table 7-5: Regional Stratigraphic Sequence within the Development Envelope (Source AQ2 2025, Mine Earth 2020)

Age	Group	Formation	Member	Lithological Description
Quaternary	Alluvium, colluvium			Unconsolidated silts, sand and gravel (claypans).
Tertiary	Detritals	TD3		Red haematitic scree on valley sides. Increasing silt and clay content with distance from slopes and fans. Upper calcrete
		TD2 (Oakover Formation)		Silcrete, calcrete, Channel Iron Deposit (CID) pisolite, basal crete, mottled clay.
	? unknown	? unknown	Pinjan Chert	Siliceous sediment with alternating laminated chert.
Early Proterozoic - Archaean	Hamersley Group	Wittenoom Formation	Bee Gorge Member	Graphitic shale with minor sequences of carbonate, chert, volcaniclastic rock and BIF. (not present in Development Envelope)
			Paraburdoo Member	Dolomite with minor amounts of chert and shale.
			West Angela Member	Dolomite, dolomitic/manganese rich shale, BIF and chert.
		Marra Mamba Iron Formation	Mt Newman Member	BIF with minor shale.
			MacLeod Member	Shale, chert and BIF.
			Nammuldi Member	BIF, chert and shale.
Archaean	Fortescue Group	Jeerinah Formation	Roy Hill Shale Member	Dark grey to black graphitic shale with chert; locally pyritic.
			Warrie Member	Grey dolomitic with inter-bedded chert (locally ferruginous), shale and mudstone.

In stratigraphic order, from oldest to youngest, a summary of the geology for the Development Envelope is provided below (AQ2 2025 and Mine Earth 2020).

7.3.5.1 Fortescue Group

The Fortescue Group is the lowermost unit of the Mount Bruce Supergroup. It unconformably overlies the crystalline East Pilbara Granite-Greenstone basement and is conformably overlain by the Hamersley Group.

7.3.5.2 Jeerinah Formation

The Jeerinah Formation is present in the northern part of the Development Envelope. It conformably overlies the Maddina Formation volcanic rocks and is conformably overlain by the Marra Mamba Iron Formation. The Jeerinah Formation comprises volcanic and interbedded sediments of sandstone, carbonaceous pelite, mudstone, chert and dark grey to black shale. It comprises four members, from oldest to youngest, Woodiana Member, Warrie Member, Nallanaring Member, Roy Hill Member.

The Roy Hill Member of the Jeerinah Formation outcrops along the northern part of the Development Envelope, in the Chichester Range and is characterised by pyritic black shale (Hancock Prospecting, 2015a).

The Jeerinah Formation is a potentially acid forming (PAF) material. Geological assay testing was completed across the Development Envelope from 2010 to 2016 (HPPL 2015) which recorded total sulfur concentrations of 0.3% and above. This indicates these sediments are a possible source of Acid Metalliferous Drainage (AMD) and require careful management throughout the LoM and during closure (Mine Earth 2020a).

7.3.5.3 Hammersley Group

In the Development Envelope the Hammersley Group comprises the Marra Mamba Iron Formation and the Wittenoom Formation.

7.3.5.4 Marra Mamba Iron Formation

The Marra Mamba Iron Formation (MMIF) is the oldest formation of the Hamersley Group. It overlies the Jeerinah Formation and outcrops in the northern part of the Mulga West and Mulga East areas. The MMIF is characterised by sedimentary rocks including BIF, chert and shale. It is host to major iron deposits in the province. It comprises three members, from oldest to youngest; Nammuldi Member, MacLeod Member and Mount Newman Member.

The Nammuldi Member overlies the Jeerinah Formation. It comprises similar carbonaceous black shale at its base and is often logged as Jeerinah Formation given the similarities between the two units (AQ2, 2024a). Stratigraphic analysis of the MMIF within the Chichester Range by HPPL geologists found that all three members of the MMIF occur at Mulga Downs, with a reduced thickness of approximately 105 m compared to a thickness greater than 250 m to the south of the Fortescue Valley (Hurst et al, 2013). In general, the Chichester Range MMIF is composed of interbedded wavy banded to lensoidal chert, BIF and shale units, with the various layers ranging in thickness from 0.5 – 20 cm. At Mulga East the mineralisation starts from the base of the MMIF and rises up through the stratigraphy with increasing distance from where it outcrops.

In the Development Envelope, the MMIF is largely composed of two major rock types; shale and BIF, forming an alternating macroband pattern. The oxide type BIF macrobands consist of two mesoband types, chert and chert-matrix, the latter composed of silicate, carbonate, quartz and magnetite. The intervening thinner shale macrobands consist of varying proportions of ferroan-dolomite and limestone with kaolinitic and ferruginous, shaly intercalations and chert beds referred to as either silicate-carbonate-chert macrobands or more commonly as shales.

The MMIF (Nammuldi Member and MacLeod Member) is considered a PAF material. Geological assay testing was completed across the Development Envelope from 2010 to 2016 (HPPL 2015) which recorded total sulphur contents of 0.3% and above. This indicates these sediments are a possible source of AMD and require careful management throughout the LoM and during closure (Mine Earth 2020).

A brief overview of the members of the MMIF is provided below.

The Nammuldi Member consists of a relatively carbonate rich sequence overlain by silicified cherty carbonate and cherty BIF with interbedded shales. Podded chert units are also present in this Member. Within the Mulga

East tenement, the Nammuldi Member hosts significant hematite mineralisation and has an approximate thickness of 48 m.

The MacLeod Member consists of BIF, cherts and carbonates with numerous interbedded shales and several prominent podded units which are useful markers for field mapping. These podded units can be observed in outcrop. Cherts typified by a granular weathering surface are indicative of a now silicified carbonate parent rock. Within the Mulga East and Murrays Hill tenements, the Macleod Member appears to host significant mineralisation with a thickness ranging 28 to 30m.

The Mount Newman Member is iron-rich and is the uppermost member of the MMIF. The type sections in the Hamersley Range consist of a podded BIF with interbedded carbonates and shales. This member has been identified in various parts of the tenement, commonly occurring undercover south of the range front with a thickness of approximately 46 m and occasionally hosting mineralisation.

7.3.5.5 Wittenoom Formation

The Wittenoom Formation overlies the MMIF (Hancock Prospecting, 2015a). It underlies the Quaternary and Tertiary sediments beneath the Fortescue Valley in the Development Envelope. The Wittenoom Formation consists of calcitic dolomite, interbedded chert and shale and volcanoclastic sandstone. Drilling in the south-western part of the combined tenement group (Malay Well) intersected massive dolomites of the Wittenoom Formation.

The Wittenoom Formation comprises three members, from oldest to youngest: West Angela, Paraburdoo and Bee Gorge. The Paraburdoo and West Angela Members occur within the Development Envelope. The Bee Gorge Member has not been encountered within the Development Envelope and may occur further to the south.

The West Angela Member is the lowermost unit of the Wittenoom Formation. It comprises interbedded BIF, shale, chert and dolomite. It has been observed as being formed of ‘residual’ manganiferous shale and chert with rare dolomite beds (Kepert, 2001).

The Paraburdoo Member comprises dolomite with minor amounts of chert and argillite mostly displaying even, tabular bedding. Most layers of dolomite are a few centimetres to decimetres thick, and less than 1 m. Argillite layers are thinner on average, occurring mostly in the form of sub-millimetre partings to thin beds up to a few centimetres thick separating the dolomite layers. While argillite is present in minor amounts throughout the Paraburdoo Member, chert is restricted to specific horizons of up to 2 m thick that generally contain scattered nodules of grey to black chert.

Tertiary sediments:

The tertiary sediments within the Fortescue Valley in the Development Envelope are collectively known as “detritals” comprising, calcrete (upper and basal), channel iron deposit (CID) pisolitic and clay with local lateritic hardcaps of calcrete and silcrete. Some of these units host secondary ‘detrital’ mineralisation at Mulga East (Hancock Prospecting, 2015a).

Channel iron deposits (CID) are iron-rich fluvial sedimentary deposits of possible Miocene age, occupying paleochannels of the early to middle Tertiary. There is a wide exposure of CID in the central part of Mulga Downs

East tenement. The thickness of the CID in the central part of this paleochannel is typically 8 – 10 m suggesting a shallow braided channel.

The Oakover Formation comprises extensive outcrops of calcrete (upper calcrete) in the Mulga Downs East and Malay Well areas. This unit exhibits massive structure and little evidence of bedding. The calcrete units are covered by white to grey, micritic carbonate fragments and silica rich mudstone.

Quaternary sediments:

The Quaternary sediments were deposited from erosion and transport from the Chichester and Hamersley Ranges. The Quaternary sediments comprise alluvium and colluvium in the Fortescue Valley and overly the Tertiary sediments. The alluvial sediments include the modern creek associated bed load and over-bank deposits of unconsolidated brown and red-brown mud, sand, gravel and conglomerate (Qa). The colluvium covers extensive areas of gently sloping sheetwash plain (Qw), characteristic of the Fortescue valley.

The lithology comprises unconsolidated silt, sand and gravel of the ephemeral creeks and riverbeds and clay and silt of the adjacent flood plains of the Fortescue River. The alluvium is up to around 8 m thick and covers most of the Fortescue Valley (AQ2 2024). Calcrete tertiary sediments generally underly the alluvial deposits (Hancock Prospecting, 2015).

The surface geology (1:1,000,000) within the Development Envelope is illustrated in **Figure 7-10.**

Figure 7-10: Surface Geology within the Mulga Downs Iron Ore Mine

640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000

Aup
Atp
Abfk
Agz
Abfmk
Aep
Agzc
Awftm
Awft
Abfm
GREAT NORTHERN HWY
Awfj
Qa
Achm
Czims
Czl
Qrc
Ashm
Alhw
Lchk
MUNJINA RD

Legend

- Development Envelope
- Indicative Footprint

Surface Geology (DoIR)

- Abfk
- Abfm
- Abfmk
- Achm
- Aep
- Agz
- Agzc
- Alhw
- Ashm
- Atp
- Aup
- Awfj
- Awft
- Awftm
- Czims
- Czl
- Lchk
- Qa
- Qrc

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 64593

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 22-Oct-2024

Drawn By: droberts | Checked By: VC

Scale 1:160,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SURFACE GEOLOGY WITHIN THE MULGA DOWNS IRON ORE MINE

FIGURE 7.10

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

7.3.6 Hydrogeology

The baseline studies (refer to **Section 7.3.1**) have been used to characterise the hydrogeology of the Development Envelope.

7.3.6.1 Hydrostratigraphy

The bedrock within the Development Envelope mainly comprises fractured rock aquifers of the Hamersley Group and the Fortescue Groups youngest formation, the Jeerinah Formation. These are overlain by Tertiary and Quaternary sediments within the Fortescue Valley. The hydrostratigraphy is summarised for the Development Envelope in **Table 7-6** Table 76 and represented in the hydrogeological cross sections in **Figure 7-12** to **Figure 7-16**.

Table 7-6: Generalised Hydrostratigraphy across the Development Envelope

	Unit	Aquifer/Aquitard
Quaternary	Alluvium	Surficial
	Colluvium	Surficial
Tertiary	Upper Calcrete	Aquifer
	Undifferentiated Tertiary	Aquifer
	Pisolite / CID	Aquifer
	Basal Crete	Aquifer
Fractured Rock/Bedrock	West Angela Member	Aquifer
	Wittenoom Formation dolomite (Paraburdoo Member)	Aquitard (with a discontinuous fractured rock aquifer)
	Mineralised Marra Mamba Formation	Aquifer
	Unmineralised Fractured Marra Mamba Fm Fresh Marra Mamba Formation	Aquifer Aquitard
	Jeerinah Formation	Aquitard

The Quaternary / Tertiary sediments form an unconfined, unconsolidated sedimentary aquifer. The alluvium is up to approximately 4 m thick and extends across most of the Fortescue Valley. The alluvium and colluvium are generally unsaturated in the Development Envelope and therefore were not investigated for aquifer properties and not considered further in terms of the hydrogeological characterisation.

The Tertiary sediments form a highly transmissive and continuous aquifer (up to 60 m thick in the central part of the valley) within the Fortescue Valley.

In the vicinity of the MDIOM, the Paraburdoo Member comprises light grey, fresh, crystalline and hard Wittenoom dolomite, which mainly has low permeability. The Wittenoom Formation dolomite (Paraburdoo Member) underlies the Fortescue Valley, in the south of the Malay Well tenement. It is generally considered an aquitard unit in this area, with discontinuous fractures representing localised aquifer units. Elsewhere in the Pilbara the Paraburdoo Member is considered a regional aquifer. Johnson and Wright (2021) identified the dolomite of the Wittenoom and the Jeerinah Formation as major aquifer units. However, investigations undertaken across the Malay Well tenement have generally indicated low permeability. Therefore, this unit is

considered an aquitard in the vicinity of the MDIOM. This interpretation is based on the lithology encountered throughout the drilling investigations. The horizontal hydraulic conductivity of these sediments was not tested as part of the aquifer property assessment, summarised in **Section 11.3, Table 7-7.**

In the Mulga East / Malay Well area , the West Angela Member sub-crops the Tertiary sediments near the claypans and hosts a moderately transmissive and continuous aquifer with highly transmissive, discontinuous aquifers associated with localised mineralisation (as at MDPZ9211, 9212D and 9215D, refer to **Figure 7-11**), weathering and/or fractures/faults (as at MDPZ9212D and MDPB0020, refer to Figure 7-12**.** To the south of the claypan area, the West Angela Member aquifer unit is overlain by the Paraburdoo Member of the Wittenoom Formation. This forms a discontinuous fractured rock aquifer in generally low-permeability basement. The occurrence of faulting may result in the juxtaposition of the West Angela Member aquifer and the Paraburdoo Member aquitard units, potentially resulting in reduced hydraulic connection in these areas.

The Marra Mamba Formation hosts a highly transmissive and continuous aquifer across the Mulga East area. It comprises interbedded BIF, shale, chert and some beds of dolomite, with secondary permeability resulting from mineralisation, fracturing and weathering processes. The Marra Mamba outcrops along the northern flanks of the Fortescue Valley and sub-crops beneath the valley floor. A localised low permeability unit was identified around groundwater monitoring bores MDPZ7451 and MDPZ7464, where the bedrock shale has weathered to a 12 to 26 m thick saprolitic clay. This may also occur in other isolated areas across the Development Envelope.

Based on available data, the Marra Mamba aquifer is believed to be much less extensive in the Mulga West tenement, occurring in localised areas at shallow depths, below the Tertiary overburden. As such, most of the Marra Mamba Formation in the Mulga West tenement is considered a low permeability basement aquitard with minor local fractures (AQ2 2025).

The Marra Mamba Formation is underlain by the Jeerinah Formation, which acts as an aquitard in the Development Envelope, comprising black, pyritic and carbonaceous shale with minor chert beds when fresh and can weather to a pink, brown, white puggy clay. Available data suggest this unit, together with the lowermost unit of the Nammuldi Member (referred to as dolomitic Nammuldi by HPPL), is low permeability and forms a basement aquitard with minor local fractured aquifers.

A summary of hydraulic parameters for each of the identified hydrostratigraphic units in the Development Envelope is presented in **Table 7-7.**

Figure 7-11: Examples of possible inferred geological features from magnetics data (AQ2, 2025). Mine Pits are shown in orange.

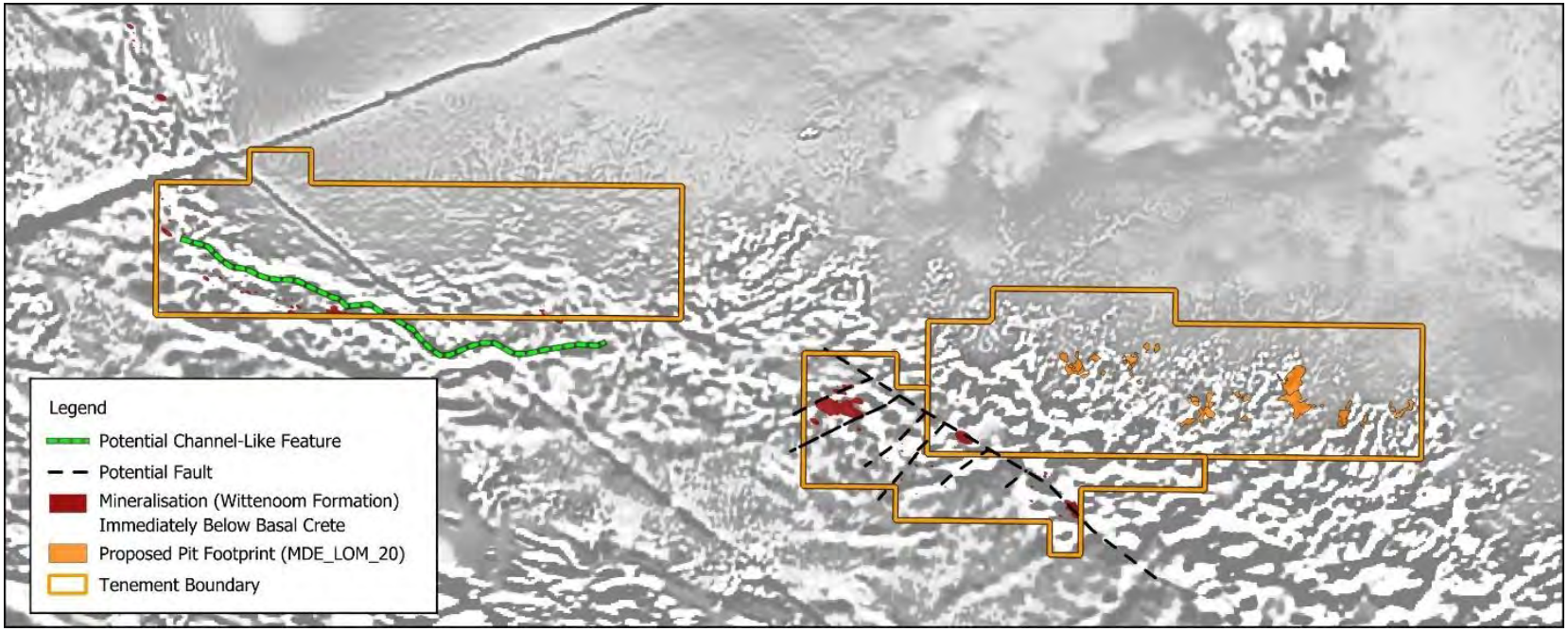

Legend
Potential Channel-Like Feature
Potential Fault
Mineralisation (Wittenoom Formation) Immediately Below Basal Crete
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary

Table 7-7: Summary of Aquifer Parameters (AQ2 2025)

UnitTable		Range in Thickness (m)	Range of Permeability (m/d)	Adopted Permeability[1] (m/d)	No of Aquifer Tests	Confined Storage (unitless)	Specific Yield (%)
Tertiary Cover	Upper Calcrete	0 to 30	2 to 63	10	13	1x10-6	1-5%
	Undifferentiated Tertiary	0 to 45	2 to 365	8	18	1x10-5	5%
	Pisolite / CID	0 to 23	5 to 92	14	10	1x10-5	5%
	Basal Crete	0 to 22	3 to 33	9	8	1x10-6	1-3%
Bedrock	Fresh Dolomite of Wittenoom Formation - Localised Weathering	-	0.001 to 10	0.01	0	1x10-4	1%
	West Angela Member	-	0.01 to 10	2	0	1x10-4	1%
	West Angela Member Hardcap / Ore	-	11 to 131	20	6	1x10-6	1-5%
	Marra Mamba Ore (with mineralised CID)	-	10 to 57	25*	8	1x10-6	3%
	Unmineralised / Fractured Marra Mamba Formation	-	2 to 174	10	12	1x10-3	1%
	Fresh Marra Mamba / Jeerinah Formation – Minor Fractures	-	0.015 to 0.022	0.01	4	1x10-4	1%

*Updated based on model calibration to test pumping (Refer AQ2 2025)

Maximum and minimum values based on 90% confidence limits (assessed using the two-tailed Student's t-test)

Figure 7-12: Location of Hydrogeological Sections – Mulga East (AQ2 2025)

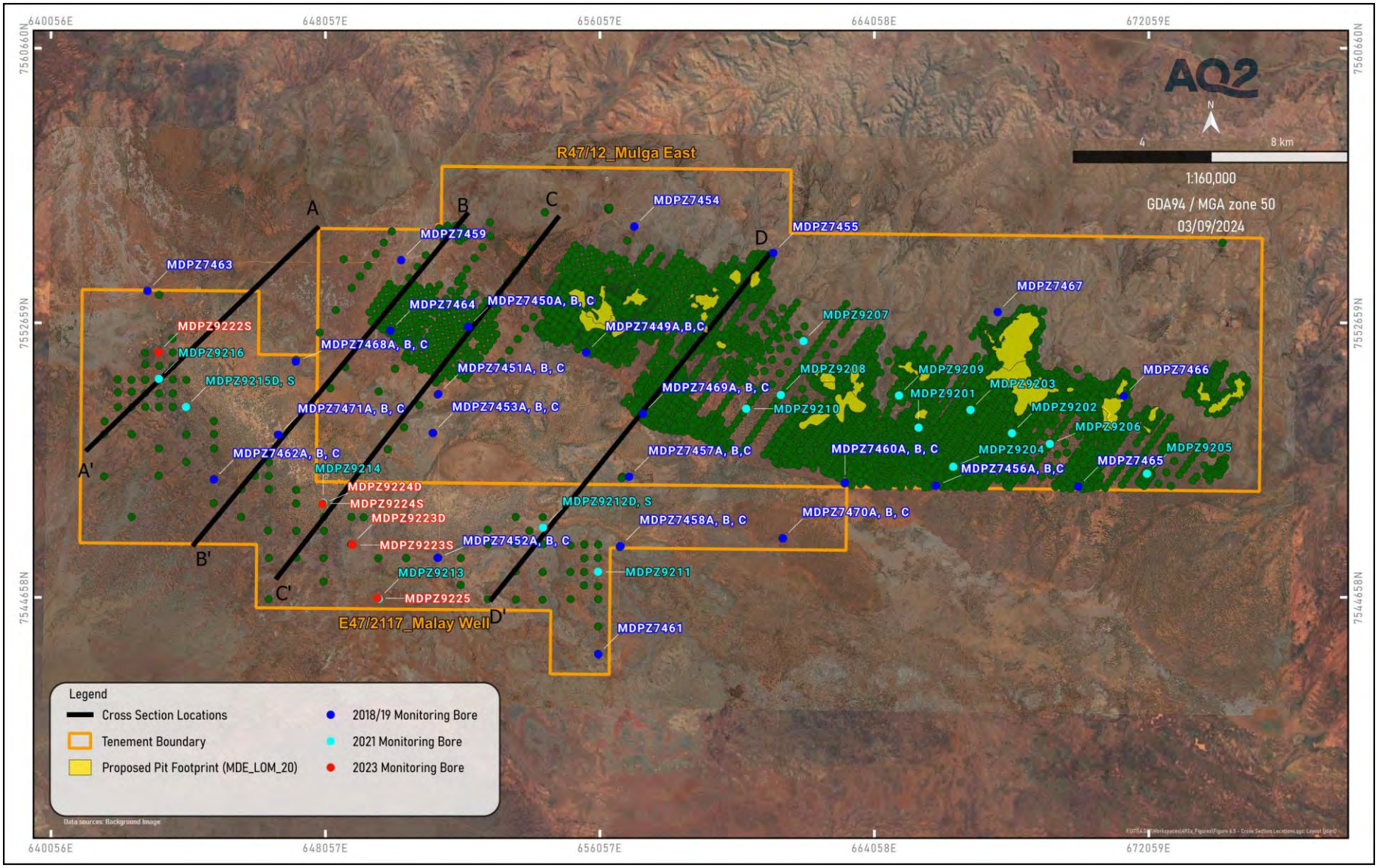

640056E
648057E
656057E
664058E
672059E
7560660N
7552659N
7544658N
AQ2
N
4
8 km
1:160,000
GDA94 / MGA zone 50
03/09/2024
R47/12_Mulga East
E47/2117_Malay Well
A
A'
B
B'
C
C'
D
D'
MDPZ7454
MDPZ7455
MDPZ7459
MDPZ7463
MDPZ7464
MDPZ7450A, B, C
MDPZ7449A,B,C
MDPZ7467
MDPZ9207
MDPZ9222S
MDPZ9216
MDPZ7468A, B, C
MDPZ7451A, B, C
MDPZ9208
MDPZ9209
MDPZ7466
MDPZ9215D, S
MDPZ7469A, B, C
MDPZ9203
MDPZ9201
MDPZ9210
MDPZ9202
MDPZ7471A, B, C
MDPZ7453A, B, C
MDPZ9206
MDPZ7462A, B, C
MDPZ7457A, B,C
MDPZ7460A, B, C
MDPZ9204
MDPZ9205
MDPZ9214
MDPZ7456A, B,C
MDPZ7465
MDPZ9224D
MDPZ9224S
MDPZ9212D, S
MDPZ9223D
MDPZ7458A, B, C
MDPZ7470A, B, C
MDPZ9223S
MDPZ7452A, B, C
MDPZ9213
MDPZ9211
MDPZ9225
MDPZ7461
Legend
Cross Section Locations
Tenement Boundary
Proposed Pit Footprint (MDE_LOM_20)
2018/19 Monitoring Bore
2021 Monitoring Bore
2023 Monitoring Bore
Data sources: Background Image

Figure 7-13: Hydrogeological Cross Section A – Mulga East (AQ2 2025)

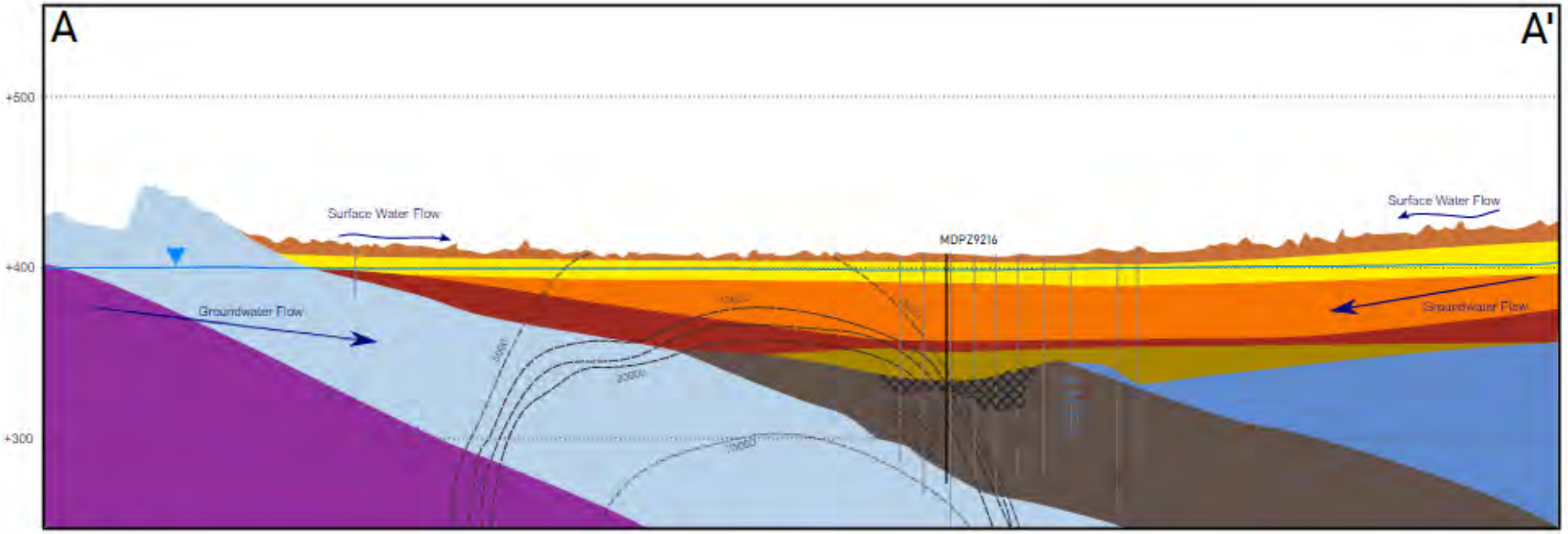

A
A'
+500
+400
+300
Surface Water Flow
Surface Water Flow
MDPZ9216
Groundwater Flow
Groundwater Flow
Legend
Alluvium
Upper Calcrete
Undifferentiated Tertiary
CID Pisolite
Basal Crete
Wittenoom Fm Dolomite
West Angela Mbr
Marra Mamba Fm
Jeerinah Formation
Mineralisation
Hardcap
Dolomite
Groundwater Level
Salinity Contour (uS/cm)

Figure 7-14: Hydrogeological Cross Section B – Mulga East (AQ2 2025)

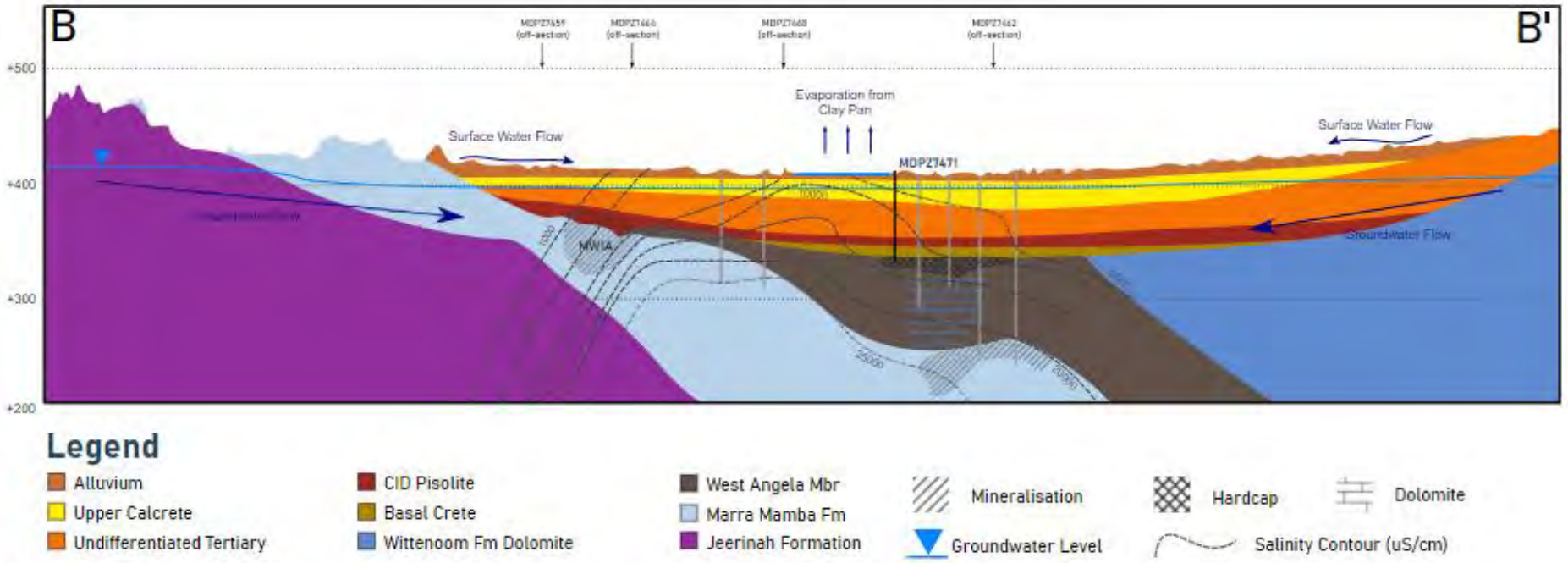
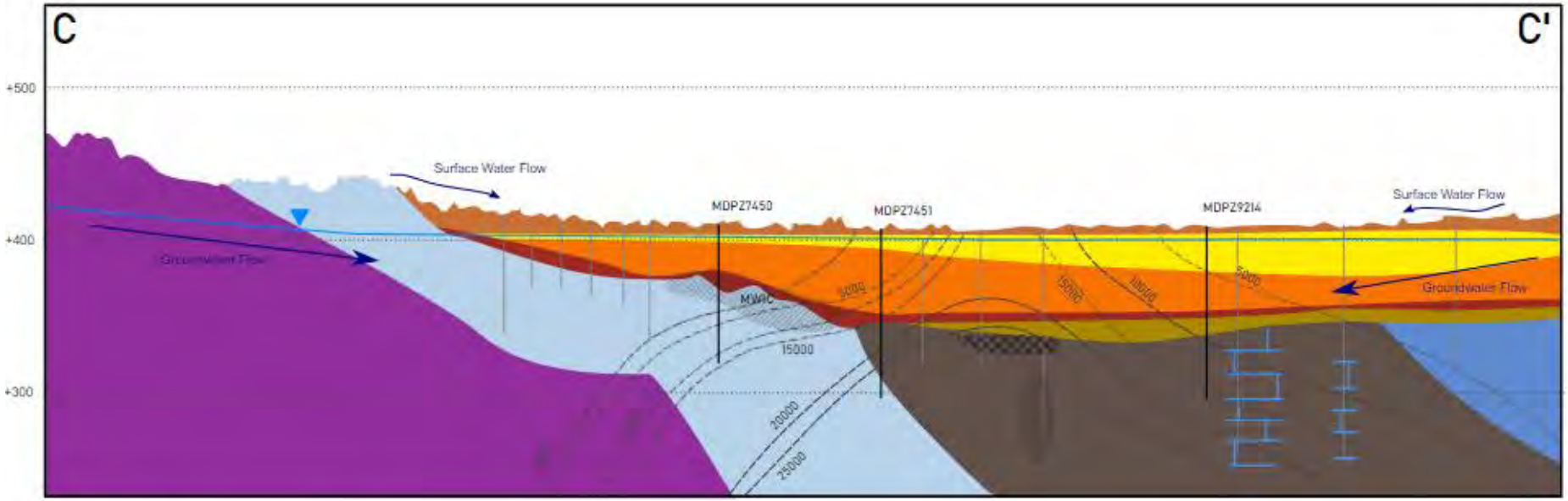

B
B'
MDPZ7659 (off-section)
MDPZ7666 (off-section)
MDPZ7668 (off-section)
MDPZ7662 (off-section)
+500
+400
+300
+200
Evaporation from Clay Pan
Surface Water Flow
Surface Water Flow
MDPZ7471
MW1A
1000
2500
Groundwater Flow
Legend
Alluvium
Upper Calcrete
Undifferentiated Tertiary
CID Pisolite
Basal Crete
Wittenoom Fm Dolomite
West Angela Mbr
Marra Mamba Fm
Jeerinah Formation
Mineralisation
Groundwater Level
Hardcap
Dolomite
Salinity Contour (uS/cm)

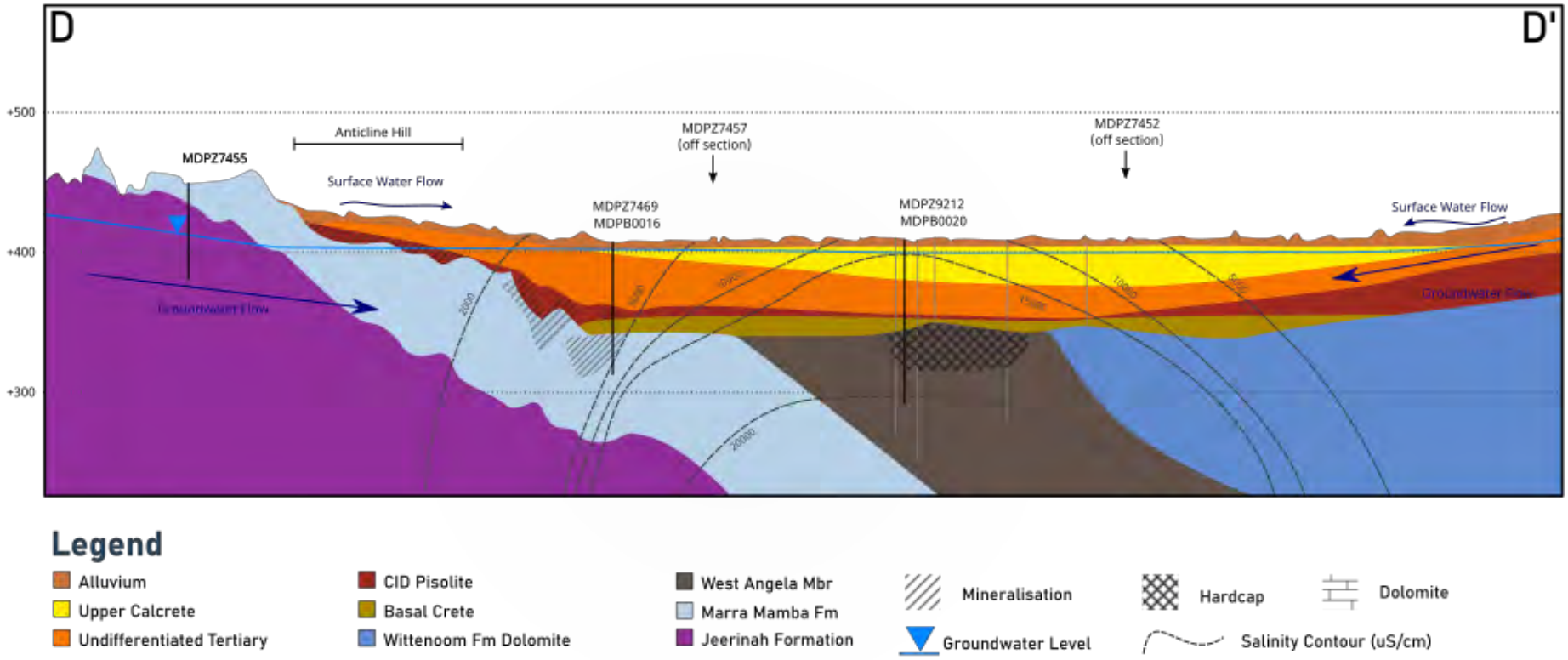
Figure 7-15: Hydrogeological Cross Section C – Mulga East (AQ2 2025)



Legend

- Alluvium
- Upper Calcrete
- Undifferentiated Tertiary
- CID Pisolite
- Basal Crete
- Wittenoom Fm Dolomite
- West Angela Mbr
- Marra Mamba Fm
- Jeerinah Formation
- Mineralisation
- Groundwater Level
- Hardcap
- Dolomite
- Salinity Contour (uS/cm)

Figure 7-16: Hydrogeological Cross Section D – Mulga East (AQ2 2025)



Legend

- Alluvium
- Upper Calcrete
- Undifferentiated Tertiary
- CID Pisolite
- Basal Crete
- Wittenoom Fm Dolomite
- West Angela Mbr
- Marra Mamba Fm
- Jeerinah Formation
- Mineralisation
- Groundwater Level
- Hardcap
- Dolomite
- Salinity Contour (uS/cm)

7.3.6.2 Aquifer connectivity

The hydrogeological conceptualisation of the MDIOM area indicates the Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection, while there are local areas of hydraulic disconnection between aquifers due to the presence of localised low permeable sediments such as clay, shales and saprolitic clay (AQ2 2025). This is based on assessment of lithology, hydraulic heads illustrated in the groundwater contour diagram (**Figure 7-19**), and the analysis of vertical hydraulic gradients at nested bore sites (**Figure 7-20** to **Figure 7-22)** and groundwater salinity.

Vertical gradients (upward or downward flow) were only evident at some nested bore locations where saprolitic clays or thin intervals of clay dominated Tertiary sediments were present, indicative of localised areas of hydraulic disconnection (AQ2 2024a).

Seasonal changes in hydraulic gradients were investigated near the major claypans, where changing gradient direction was observed following wet season recharge events. For example, at two sets of nested bores near the Koodjeepindarranna Claypan and the southern alluvial fan (MDPZ7471 and MDPZ7462 respectively), upward hydraulic gradients were measured during drier periods (November 2019) and downward hydraulic gradients were measured after the 2019/20 wet season (May 2020). This local change in hydraulic gradient was due to wet season recharge (**Figure 7-20**) (AQ2 2025).

7.3.6.3 Groundwater Recharge

The primary source of recharge to the groundwater system is rainfall. Recharge generally occurs on an annual basis during the summer wet season, with cyclonic events resulting in significant rises in water level.

Average annual rainfall for the Development Envelope is low, around 350 – 400 mm / year but is highly variable. Based on the regional groundwater level monitoring program undertaken since 2019, seasonal groundwater level increases have not exceeded 1 m, and generally recorded around 0.3 m – 0.5 m per year. However, longer-term monitoring across the Mulga East tenement, since 2008, indicates a groundwater level rise of up to 1.5 m in response to a cyclonic event in January 2012. The rate and volume of groundwater recharge varies across the area based on depth to groundwater, lithological heterogeneity, seepage from surface water features and/or vertical hydraulic gradients between aquifers. Bores at higher elevations and greater depths to groundwater generally show a muted response to rainfall.

7.3.6.4 Groundwater Levels and Groundwater Flow

Groundwater levels across the Development Envelope range from 398 m AHD to 420 m AHD. A groundwater contour diagram for the Development Envelope is provided in **Figure 7-18** and **Figure 7-19**.

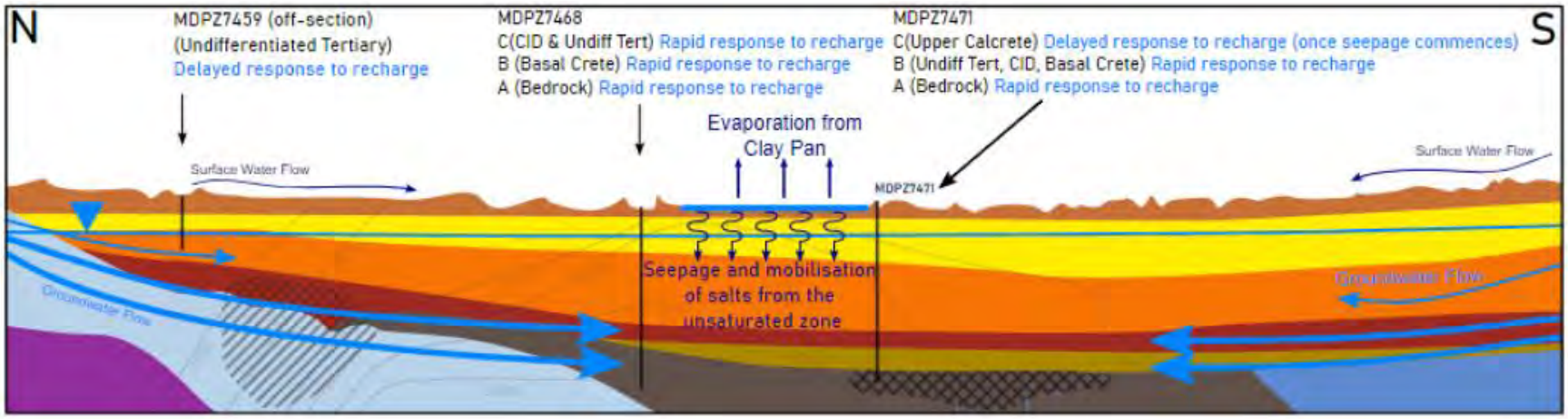
Depths to groundwater vary between around 3 – 5 m below ground level in the Fortescue Valley to around 45 m below ground level in the upper areas of the Chichester Range (bore MDPZ7467).

The groundwater contour diagram in **Figure 7-18** and **Figure 7-19** represents groundwater elevations in the fractured rock aquifers in the Chichester Range and the Quaternary / Tertiary aquifer in the Fortescue Valley.

Groundwater flows from the topographically higher areas into the Fortescue Valley, and then in a north westerly direction along the Fortescue Valley. Groundwater flow lines are presented in **Figure 7.18** and **Figure 7-19.**

In the Mulga East and Malay Well area, the hydraulic gradient is gentle across the lower lying areas, indicative of transmissive aquifers, and steepens along the northern boundary of the Development Envelope, indicative of lower permeable units, consistent with the occurrence of the Jeerinah Formation and fresh Marra Mamba aquitard (AQ2 2025).

Figure 7-17: Hydrogeological cross section highlighting recharge and discharge from claypans in Mulga East (SourceAQ2 2025)



Legend

- Alluvium
- Upper Calcrete
- Undifferentiated Tertiary
- CID Pisolite
- Basal Crete
- Wittenoom Fm Dolomite
- West Angela Mbr
- Marra Mamba Fm
- Jeerinah Formation
- Mineralisation
- Groundwater Level
- Hardcap
- Salinity Contour (uS/cm)
- Dolomite

Figure 7-18: Groundwater Level Contours (AQ2 2025)

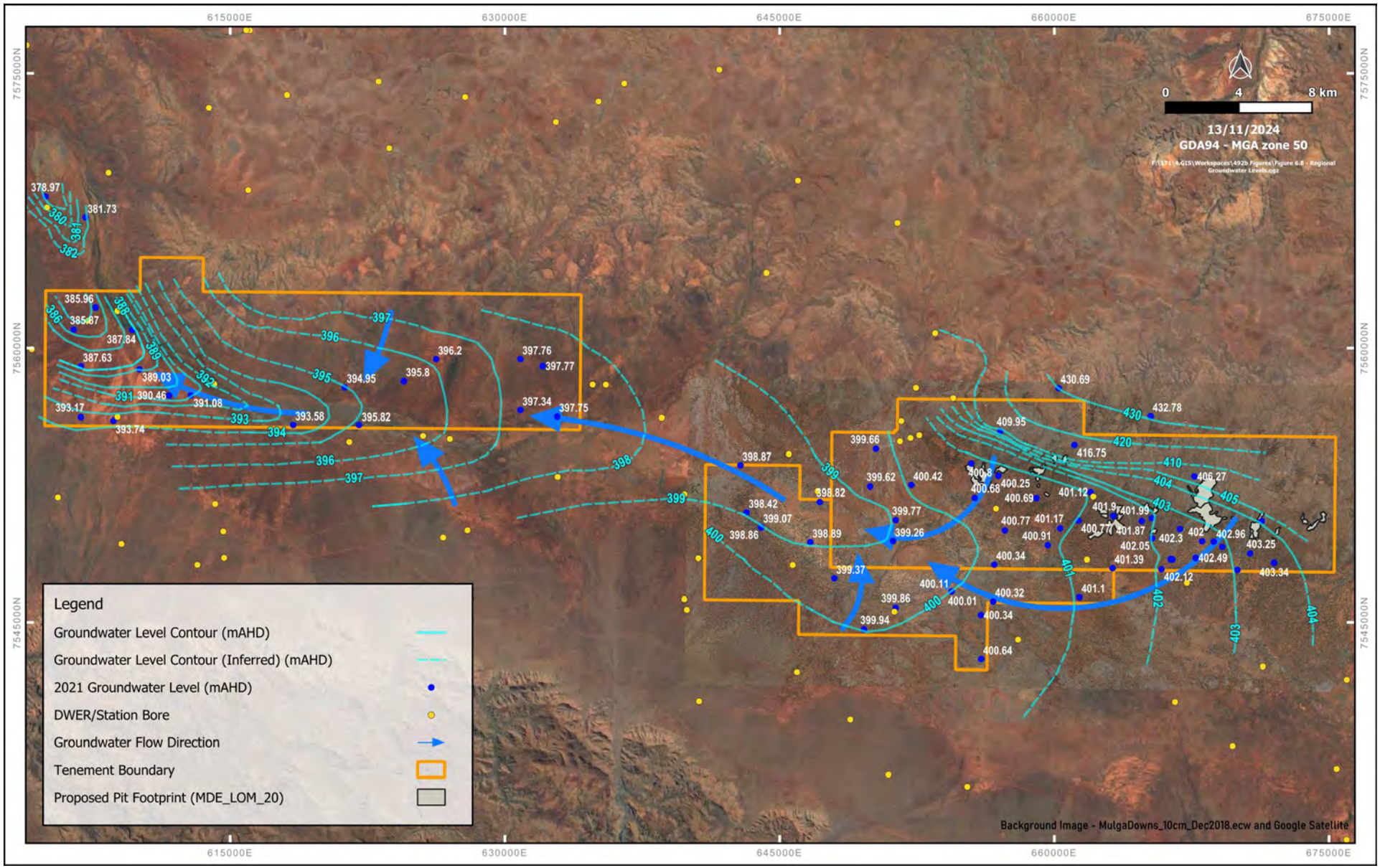
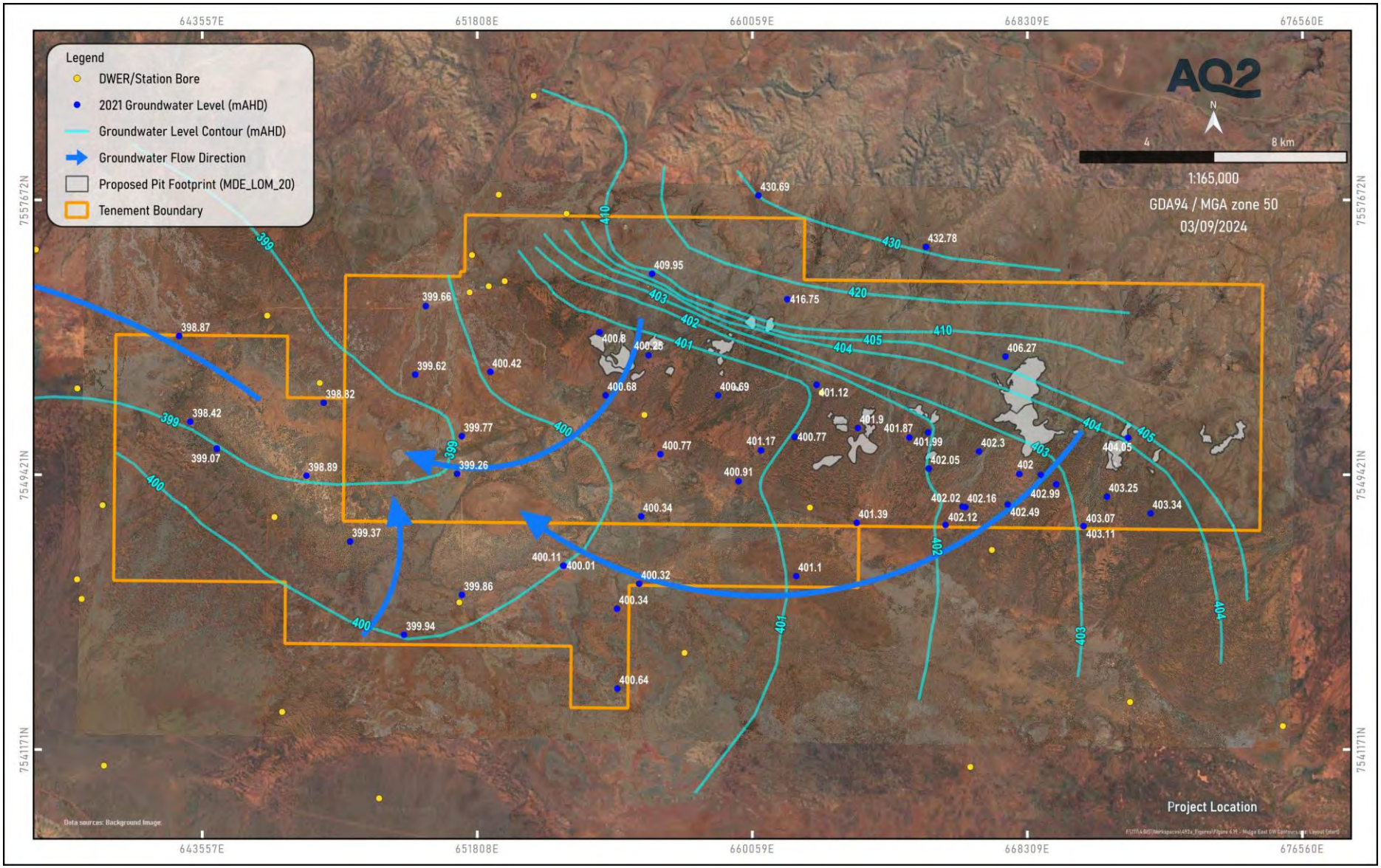


Figure 6.8 Regional Groundwater Level Contours (December 2021)

Figure 7-19: Groundwater Level Contours (AQ2 2025)


643557E
651808E
660059E
668309E
676560E
7557672N
7549421N
7541171N
Legend
DWER/Station Bore
2021 Groundwater Level (mAHD)
Groundwater Level Contour (mAHD)
Groundwater Flow Direction
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
AQ2
N
4
8 km
1:165,000
GDA94 / MGA zone 50
03/09/2024
Project Location
Data sources: Background Image
430.69
432.78
409.95
416.75
399.66
398.87
400.8
400.25
406.27
399.62
400.42
400.68
400.69
401.12
398.82
398.42
399.77
399.07
398.89
399.26
400.77
401.17
400.77
401.9
401.87
401.99
402.3
402.05
402
404.05
400.91
403.25
402.02
402.16
402.99
403.34
400.34
401.39
402.12
402.49
403.07
403.11
399.37
400.11
400.01
400.32
401.1
399.86
400.34
399.94
400.64

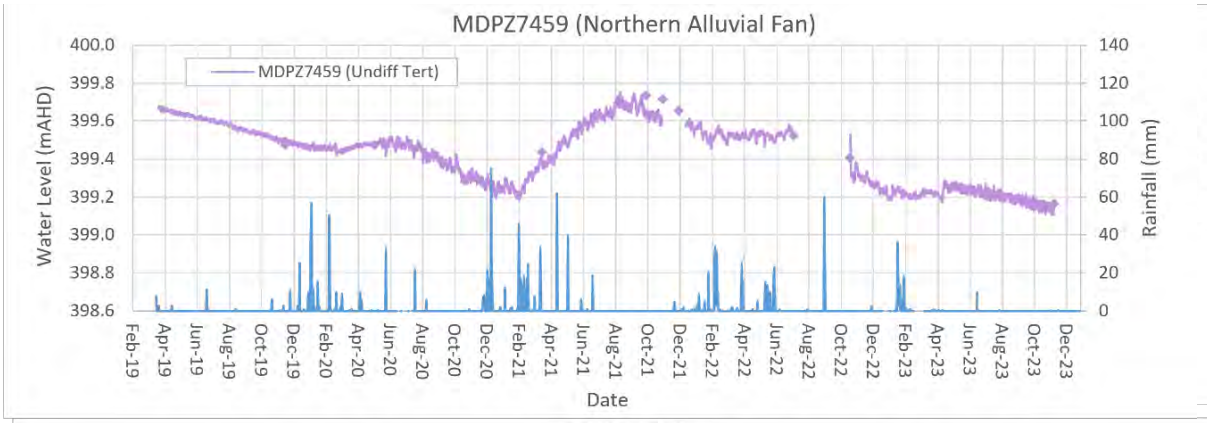
Time-series groundwater levels (hydrographs) for bores installed in 2018/19 are provided for the following areas:

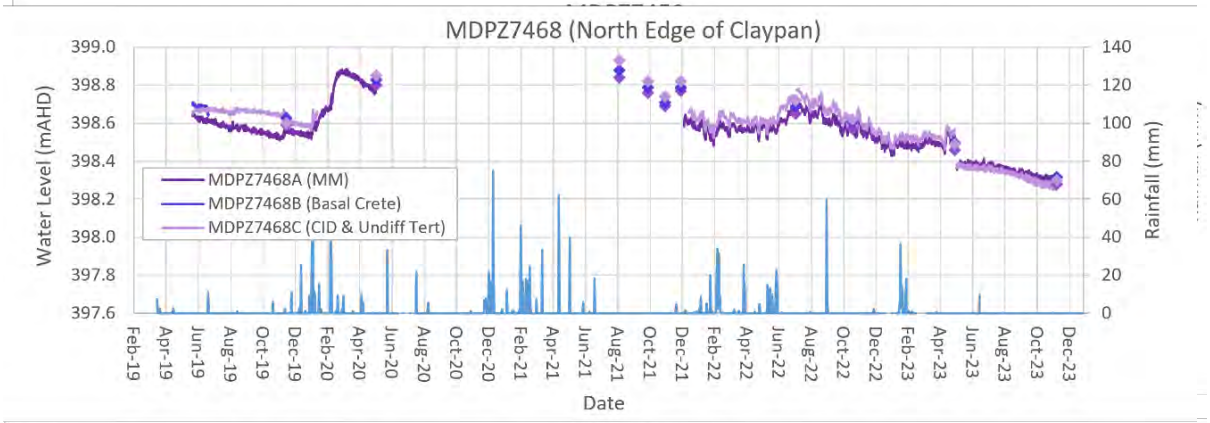
- Hydrogeological Cross Section B (**Figure 7-20**).
- Hydrogeological Cross Section C (**Figure 7-21**).
- Hydrogeological Cross Section D (**Figure 7-22**).
- Koodjeepindarranna Claypan Area (**Figure 7-23**).
- Gnalka Gnoona Claypan Area (**Figure 7-24**).

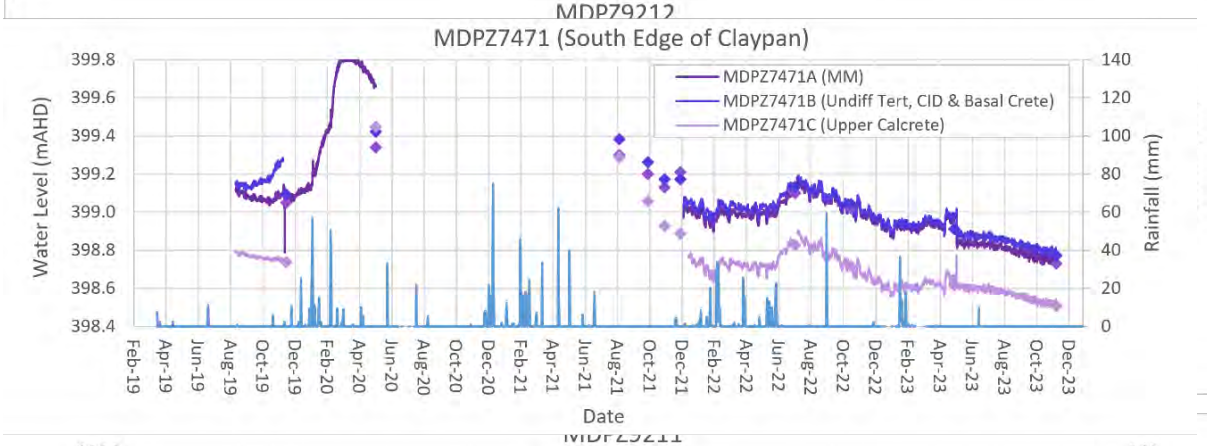
No cyclonic influenced rainfall events have occurred since the installation of the regional / extended monitoring bore network. The data in **Figure 7-20** to **Figure 7-24** therefore does not provide an assessment of groundwater level responses to a cyclonic or monsoonal rainfall event(s).

Bores installed in low permeability lithology record subdued and delayed responses to rainfall. Bore MDPZ7459 (20 m below ground) is installed beneath the northern alluvial fan between the two claypans. Bores MDPZ7454, 7455, 7466 and 7467 (on the upper slopes) are installed in low permeability (fresh) Marra Mamba Formation and / or Jeerinah Formation.

Figure 7-20: Hydrographs for Hydrogeological Cross Section B (AQ2 2025)


MDPZ7459 (Northern Alluvial Fan)
MDPZ7459 (Undiff Tert)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7468 (North Edge of Claypan)
MDPZ7468A (MM)
MDPZ7468B (Basal Crete)
MDPZ7468C (CID & Undiff Tert)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7471 (South Edge of Claypan)
MDPZ7471A (MM)
MDPZ7471B (Undiff Tert, CID & Basal Crete)
MDPZ7471C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

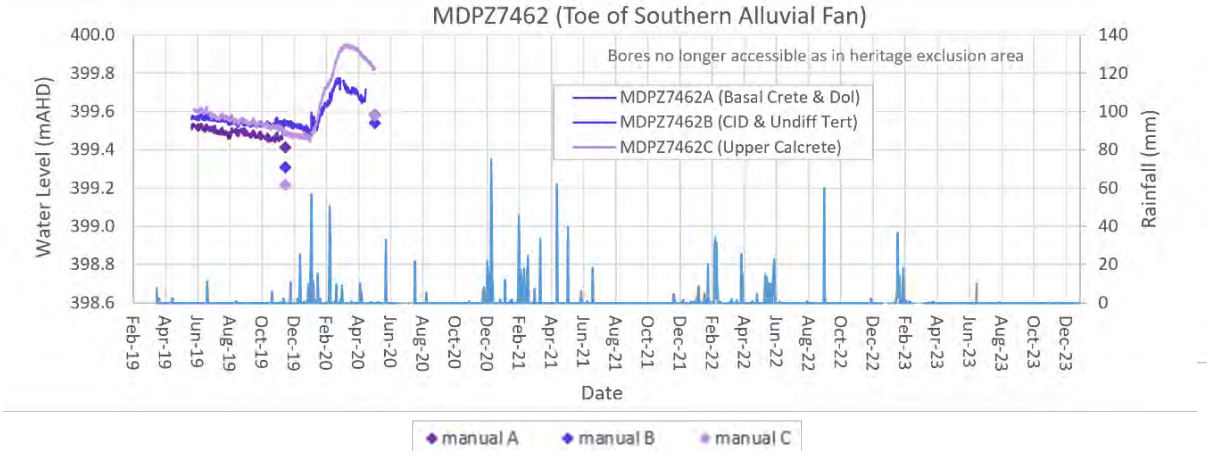
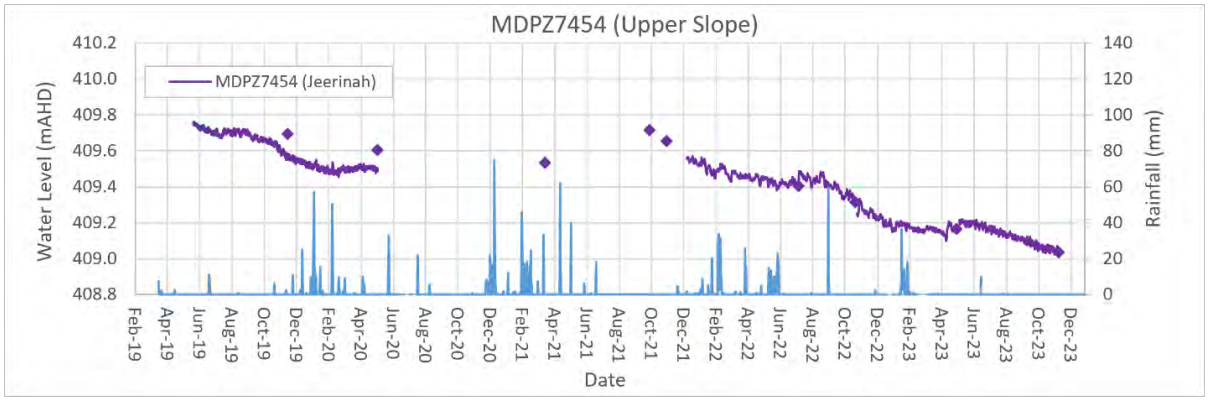
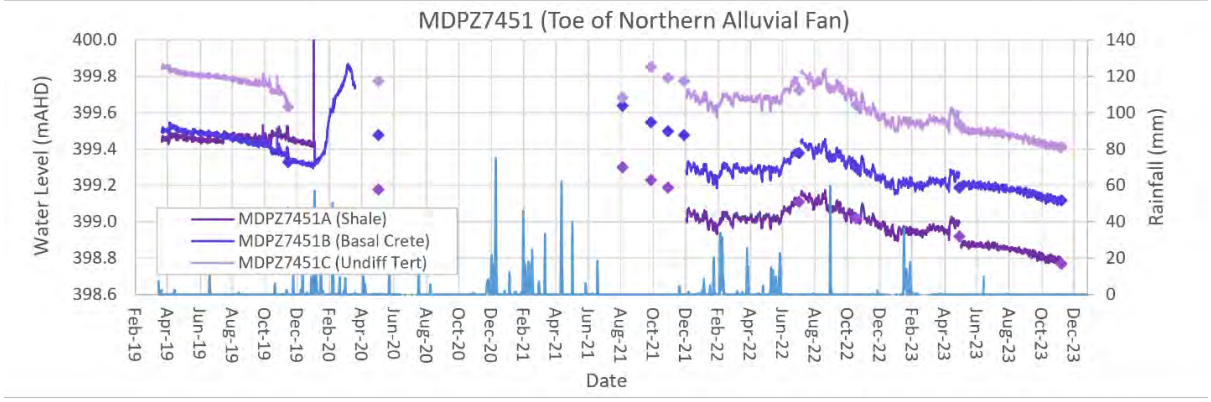
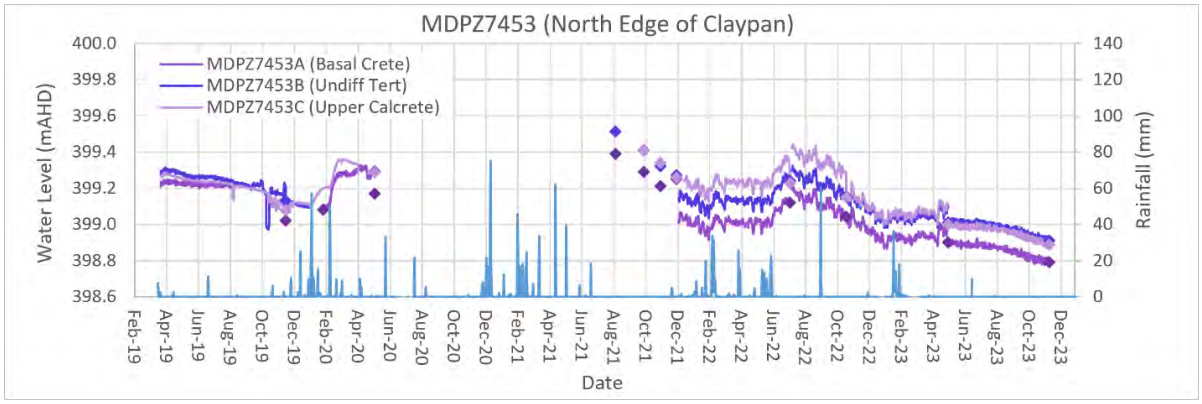

MDPZ7462 (Toe of Southern Alluvial Fan)
Bores no longer accessible as in heritage exclusion area
MDPZ7462A (Basal Crete & Dol)
MDPZ7462B (CID & Undiff Tert)
MDPZ7462C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date
manual A
manual B
manual C

Figure 7-21: Hydrographs for Hydrogeological Cross Section C (AQ2 2025)


MDPZ7454 (Upper Slope)
MDPZ7454 (Jeerinah)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7451 (Toe of Northern Alluvial Fan)
MDPZ7451A (Shale)
MDPZ7451B (Basal Crete)
MDPZ7451C (Undiff Tert)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7453 (North Edge of Claypan)
MDPZ7453A (Basal Crete)
MDPZ7453B (Undiff Tert)
MDPZ7453C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date

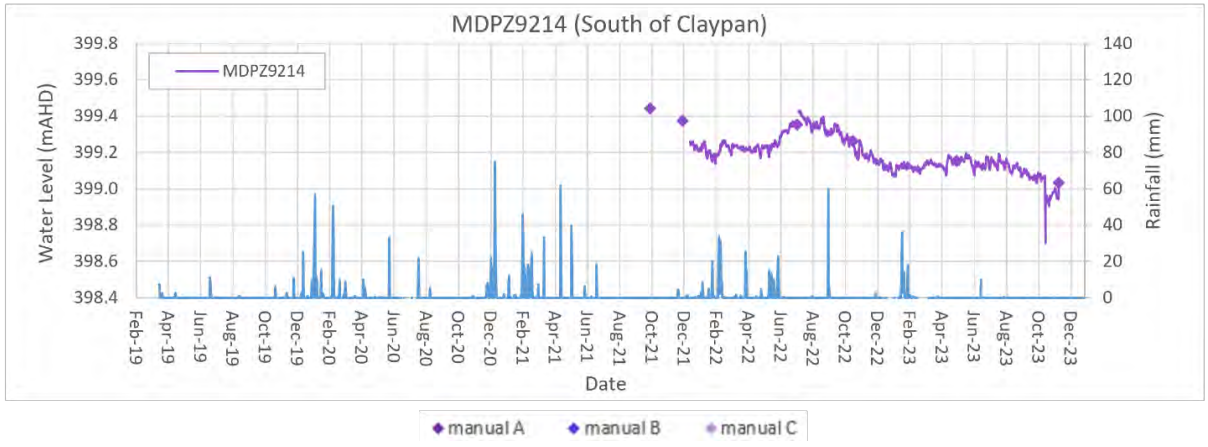
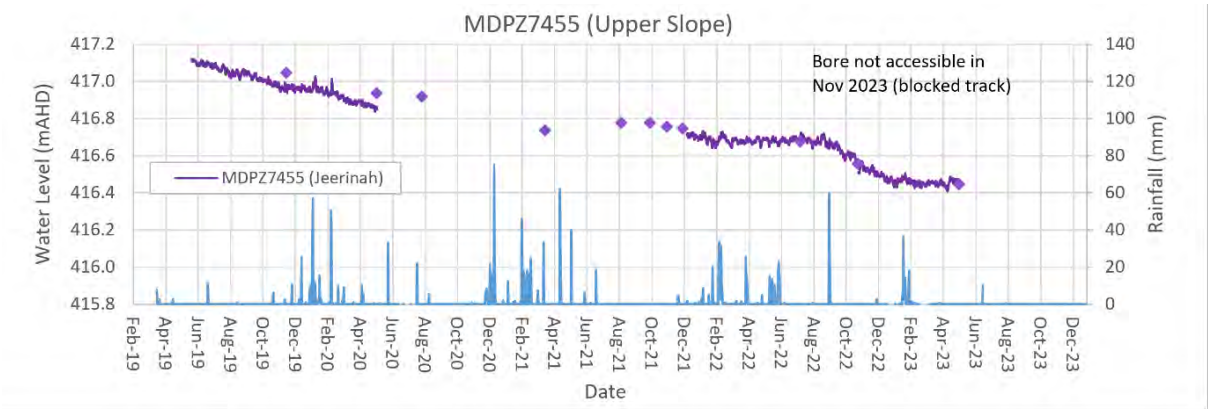
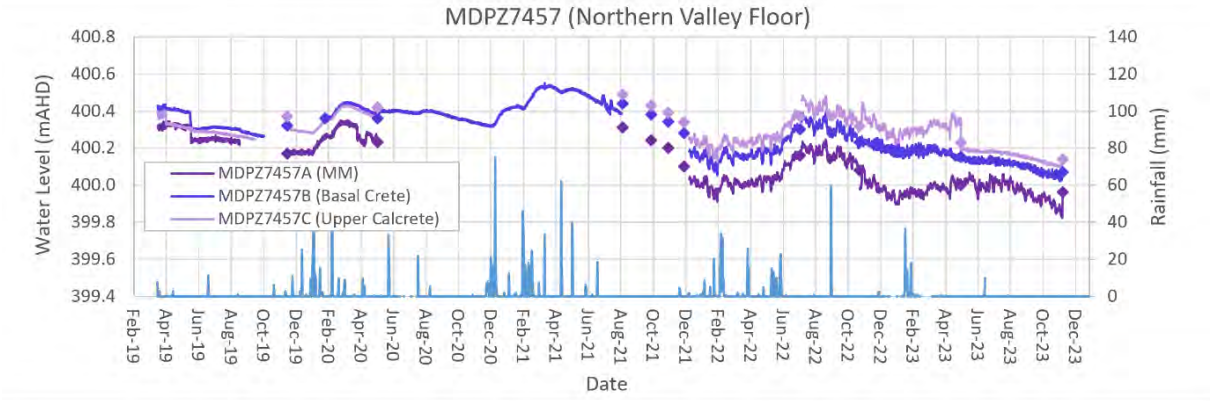
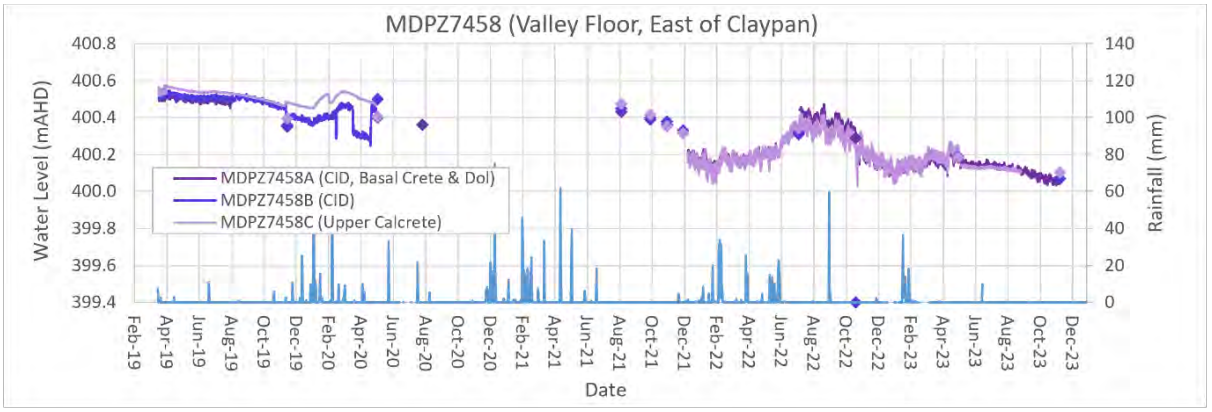
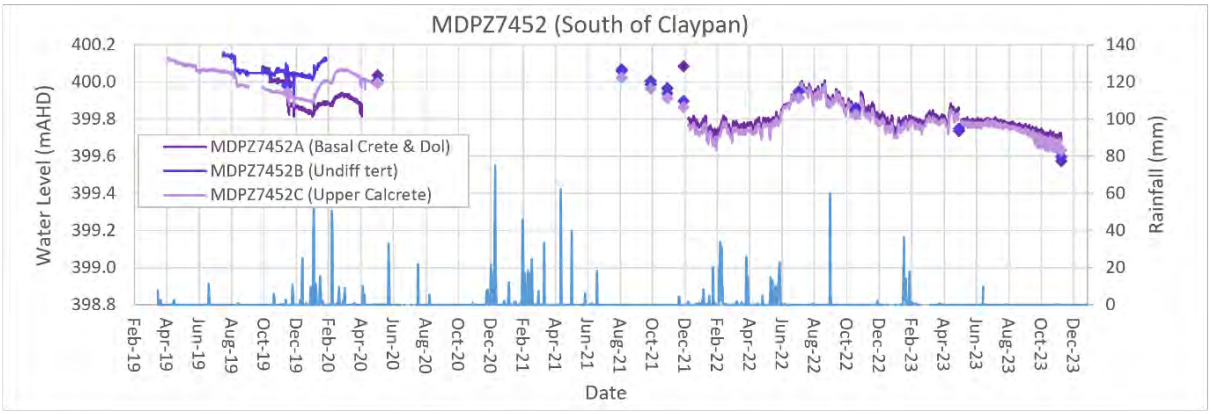

MDPZ9214 (South of Claypan)
MDPZ9214
Water Level (mAHD)
Rainfall (mm)
Date
manual A
manual B
manual C

Figure 7-22: Hydrographs for Hydrogeological Cross Section D (AQ2 2025)



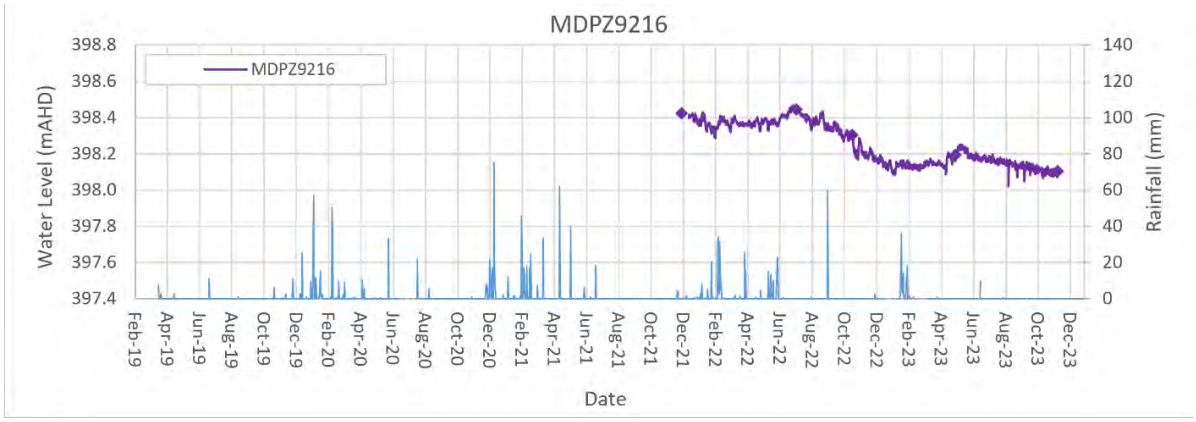


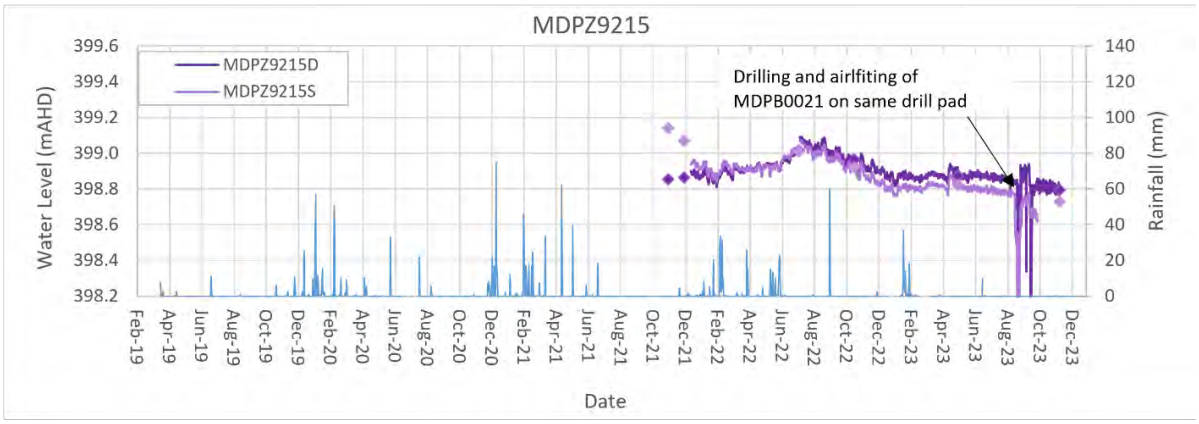


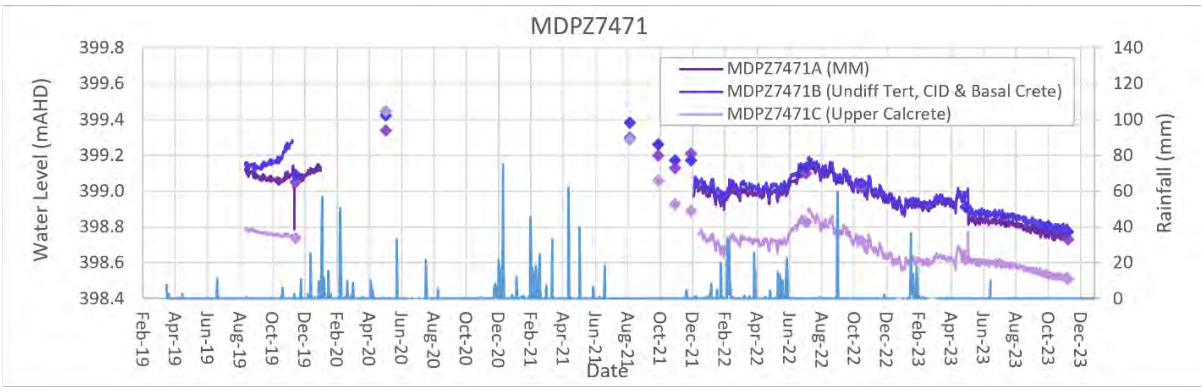


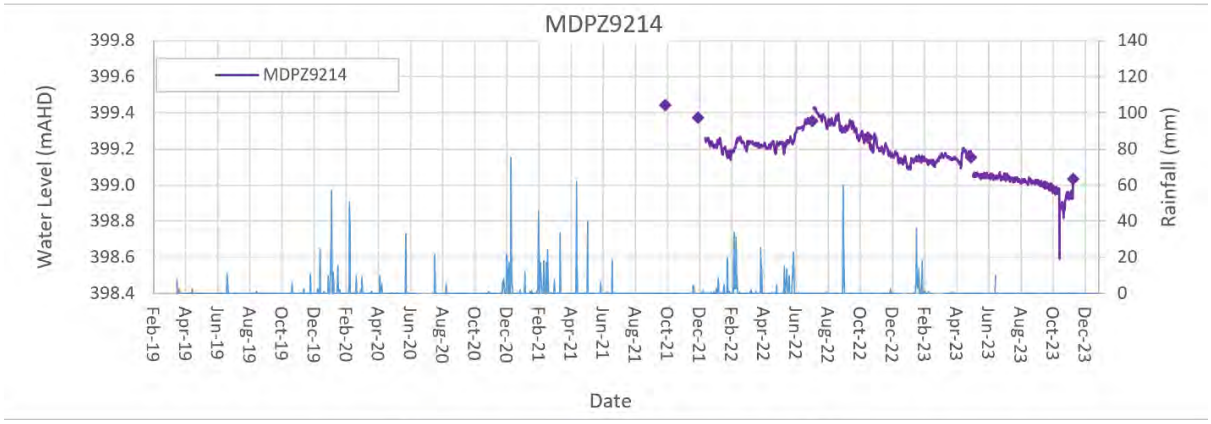
manual A manual B manual C

Figure 7-23: Hydrographs near the Koodjeepindarranna Claypan (AQ2 2025)


MDPZ9216
MDPZ9216
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9215
MDPZ9215D
MDPZ9215S
Drilling and airlfiting of
MDPB0021 on same drill pad
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7471
MDPZ7471A (MM)
MDPZ7471B (Undiff Tert, CID & Basal Crete)
MDPZ7471C (Upper Calcrete)
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9214
MDPZ9214
Water Level (mAHD)
Rainfall (mm)
Date

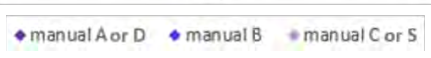
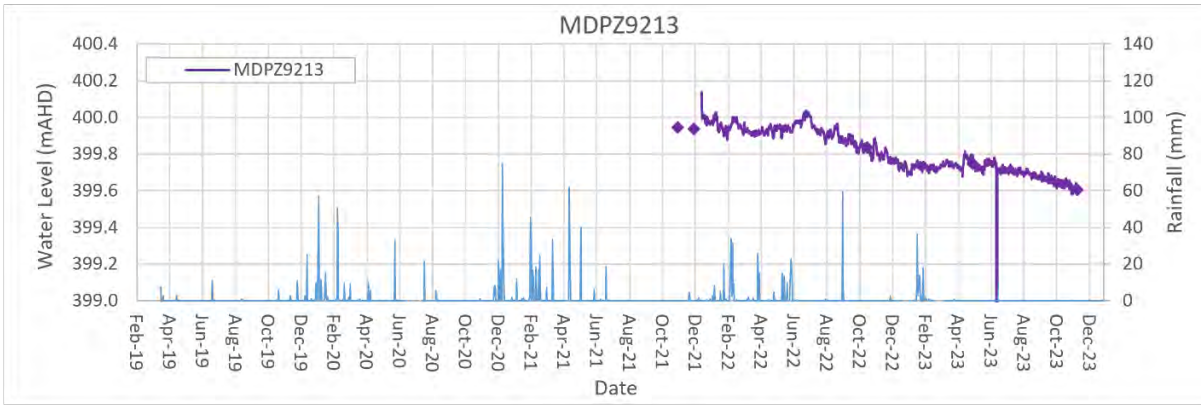
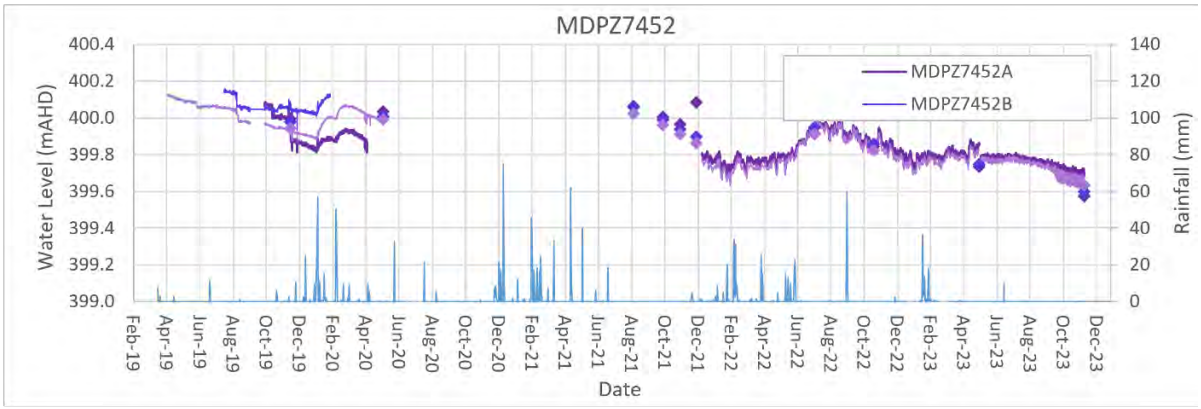
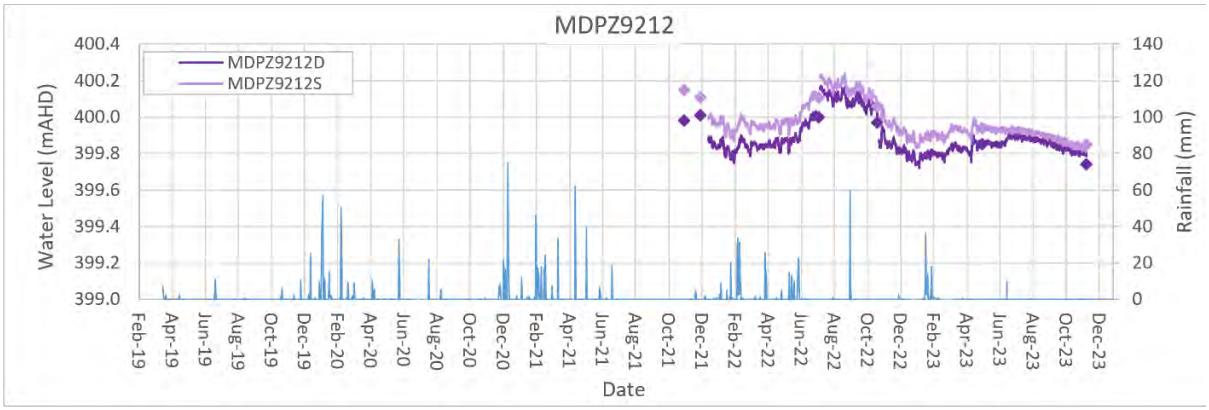
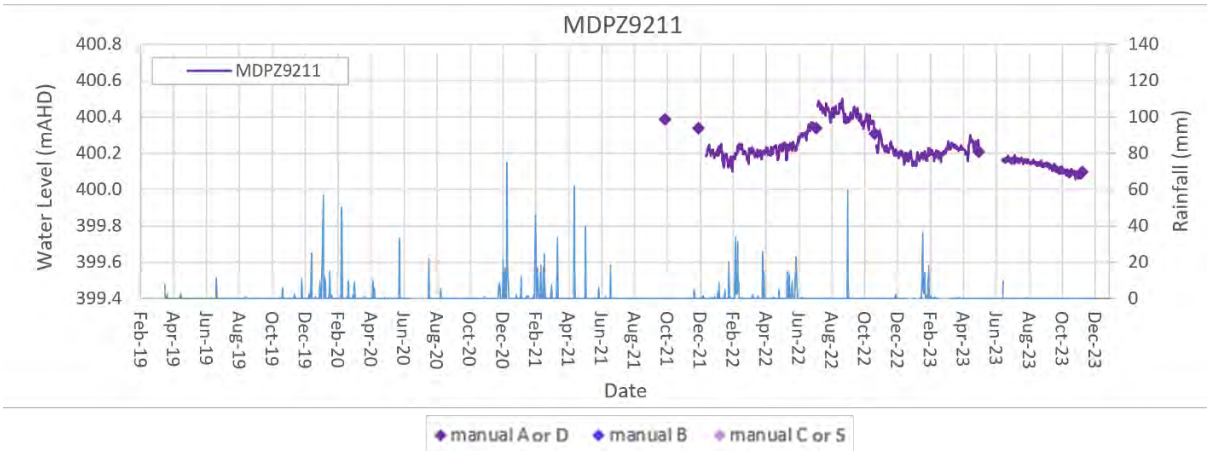

manual A or D
manual B
manual C or S

Figure 7-24: Hydrographs near Gnalka Gnalka Claypan (AQ2 2025)


MDPZ9213
MDPZ9213
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ7452
MDPZ7452A
MDPZ7452B
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9212
MDPZ9212D
MDPZ9212S
Water Level (mAHD)
Rainfall (mm)
Date


MDPZ9211
MDPZ9211
Water Level (mAHD)
Rainfall (mm)
Date
manual A or D
manual B
manual C or S

Longer term, time series, groundwater level data is available for five bores across the orebody area. The locations of these bores are illustrated in Figure 7-25 and the hydrographs of these bores against rainfall, are presented in Figure 7-26. One bore (MDPZ0072) has a monitoring record from 2008 – 2014, while four bores have monitoring records from 2014 – 2022 (**Figure 7-25** and Figure 7-26).

The data shows gradual groundwater level decline with very limited seasonal response (< 1 m) from late 2008 to late 2010 when annual rainfall totals were lower than the long-term average (i.e. 316 mm, 325 mm and 231 mm in 2008, 2009 and 2010 respectively, compared to 395 mm in 2018). Thereafter (2011 to 2021), seasonal responses have ranged between ~0.2 and 1.5 m with the latter in response to a cyclonic event, where 270 mm of rain fell in January 2012. This cyclonic event provided most of the average annual rainfall in one month. This bore however has not been monitored since 2014.

These bores will be replaced before development of the mine pits.

Figure 7-25: Bore Locations for Long-Term Hydrographs (AQ2 2025)

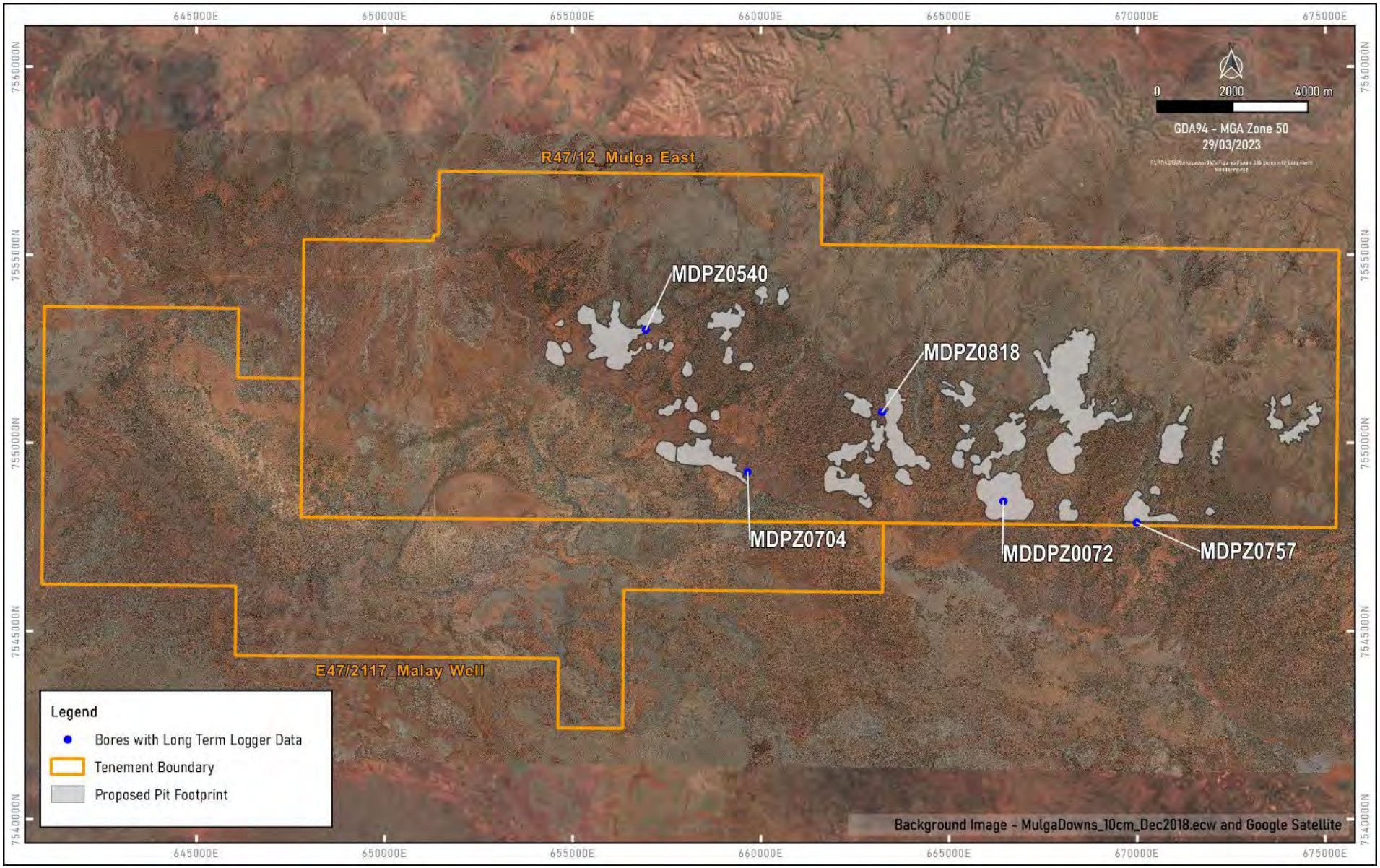
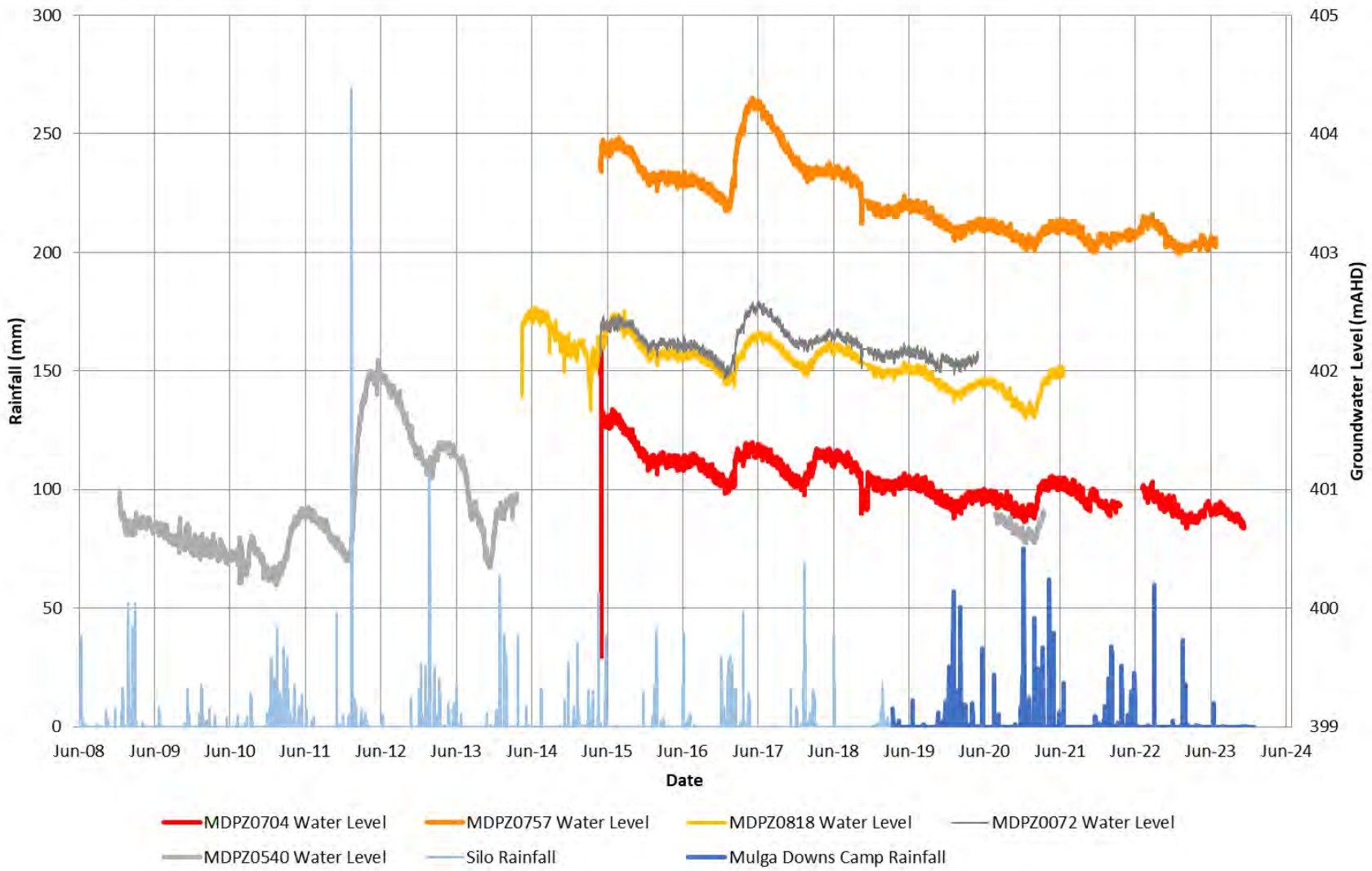

645000E
650000E
655000E
660000E
665000E
670000E
675000E
7560000N
7555000N
7550000N
7545000N
7540000N
0
2000
4000 m
GDA94 - MGA Zone 50
29/03/2023
R47/12_Mulga East
MDPZ0540
MDPZ0818
MDPZ0704
MDDPZ0072
MDPZ0757
E47/2117_Malay Well
Legend
Bores with Long Term Logger Data
Tenement Boundary
Proposed Pit Footprint
Background Image - MulgaDowns_10cm_Dec2018.ecw and Google Satellite

Figure 7-26: Long-Term Groundwater Level Hydrographs (AQ2 2025)


300
250
200
150
100
50
0
Rainfall (mm)
405
404
403
402
401
400
399
Groundwater Level (mAHD)
Jun-08
Jun-09
Jun-10
Jun-11
Jun-12
Jun-13
Jun-14
Jun-15
Jun-16
Jun-17
Jun-18
Jun-19
Jun-20
Jun-21
Jun-22
Jun-23
Jun-24
Date
MDPZ0704 Water Level
MDPZ0757 Water Level
MDPZ0818 Water Level
MDPZ0072 Water Level
MDPZ0540 Water Level
Silo Rainfall
Mulga Downs Camp Rainfall

7.3.6.5 Groundwater Quality

Groundwater salinity across the MDIOM area ranges from fresh (180 mg/L as TDS) to highly saline (18,000 mg/L as TDS). **Table 7-9** salinity groundwater is generally recorded in the upper parts of the system while higher groundwater salinity is associated with the Fortescue Valley, particularly around the claypan areas (AQ2 2025), noting the claypan area falls outside of the MDIOM Development Envelope.

Salinity profiling data shows higher groundwater salinity underlying the claypans. This is due to the evaporative concentration of salts in the claypans during dry periods. Time series salinity data shows the mobilisation of salts through the unsaturated zone beneath the claypans to the underlying groundwater system, during periods of rainfall. This indicates the saline water originates from surface water evaporation in the claypans. This has resulted in a high salinity groundwater mound greater than around 12,000 mg/L as TDS, extending approximately five kilometres along the valley from beneath the claypans. Groundwater salinity generally increases with depth (as would be expected, due to density effects), although further from the valley, the depth of the fresher groundwater increases such that the bores along the northern boundary of the Development Envelope (at higher elevations) show no change in salinity profiles. Some bores on the lower terrain show discrete intervals of increased or reduced salinity which generally correspond to zones of high permeability, indicating potential preferential lateral flow through these units (AQ2 2025).

A groundwater salinity contour diagram at the water table is provided in **Figure 7-27**.

Groundwater quality in the Fortescue Valley area is generally of sodium chloride type. Bicarbonate dominant groundwater, indicative of recharge waters, occurs in the vicinity of the alluvial fan between the two claypans, while groundwater within the Development Envelope have no dominant cations or anions, indicative of the mixing of different groundwater types or the ion exchange / dissolution processes during recharge or aquifer residency (AQ2 2024a). A summary of baseline groundwater quality results is provided **Table 7-8**.

Table 7-8: Summary of Baseline Groundwater Quality Results Compared to Livestock Drinking Water Guidelines (ANZECC & ARMCANZ 2000)

	Preferable Range / Limit (mg/L)	Trigger Range / Value (mg/L)	Maximum in Study Area (mg/L)	Valley Area (mg/L)	Valley Flanks (mg/L)	Upper Slopes (mg/L)	Comment
TDS#	0 to 5,000*	5,000 to 10,000**	18,000	1,200 to 18,000	300 to 16,000	180 to 1,400	Exceedances at many bores in vicinity of the claypans and at depth on the valley flanks
Calcium		1,000	700	42 to 530	22 to 700	7.1 to 170	
Nitrate	400	1,500	51	<0.01 to 33	0.01 to 51	<0.01 to 23	
Nitrite		30	5.3	0.012 to 5.3	<0.005 to 0.16	<0.05	
Sulfate	1,000	2,000	4,200	230 to 4,200	3 to 3,400	13 to 720	Exceedances in many deep and intermediate bores in the valley and flank areas. < 1,000 mg/L at all shallow bores except the following valley area bores: >1,000 mg/L at MDPZ7449C, MDPZ7458C, MDPZ7468C & MDPZ9212S; >2,000 mg/L at MDPZ7452C & MDPZ7453C (max: 2,700 mg/L)
Aluminium		5	9.6	<0.005 to 0.15	<0.005 to 0.31	<0.005 to 9.6	Exceedances at **MDPZ7455 & MDPZ7466** (Upper Slopes) Several bores with Total Aluminium exceeding the trigger value, but only in May 2020.
Arsenic	0.5	5	0.033	<0.001 to 0.025	<0.001 to 0.021	0.015 to 0.033	
Boron		5	5	0.26 to 5	0.19 to 4.4	0.15 to 0.75	Exceedances at MDPZ7451A (valley area)
Cadmium		0.01	0.0021	<0.0001 to 0.0011	<0.001 to 0.0020	0.0001 to 0.0021	
Chromium		1	0.025	<0.001 to 0.025	<0.001 to 0.016	<0.001	
Cobolt		1	0.098	<0.001 to 0.098	<0.001 to 0.014	<0.001 to 0.059	
Copper		1	0.016	<0.001 to 0.002	<0.001 to 0.016	<0.001 to 0.013	
Fluoride		2	11	0.6 to 11	0.2 to 2.8	0.2 to 1.3	Exceedances (2 to 3.5 mg/L) at many bores (predominantly in the valley); those with TDS <5,000 mg/L include: **MDPZ7470B, MDPZ7470C, MDPZ9217** 11 mg/L at MDPZ7458C (one sample)
Lead		0.1	0.005	<0.001 to < 0.005	<0.001 to 0.005	<0.001 to 0.003	

	Preferable Range / Limit (mg/L)	Trigger Range / Value (mg/L)	Maximum in Study Area (mg/L)	Valley Area (mg/L)	Valley Flanks (mg/L)	Upper Slopes (mg/L)	Comment
Mercury		0.002	0.0043	<0.0002 to 0.012	<0.0002 to 0.0043	<0.0001 to <0.002	Exceedances at **MDPZ7451C**, MDPZ7453A (valley area) & **MD6605 Lower** (Mulga West valley flank). 0.002 mg/L at MDPZ7452A & MDPZ7452B (valley area)
Molybdenum		0.15	0.025	<0.001 to 0.025	<0.001 to 0.009	<0.0001 to <0.005	
Nickel		1	0.22	<0.001 to 0.22	<0.001 to 0.04	<0.002 to 0.12	
Zinc		20	0.51	0.006 to 0.24	<0.005 to 0.51	0.034 to 0.51	

Bold indicates bores with groundwater salinity <5,000 mg/L TDS

Recommended TDS Concentrations for Beef Cattle

*TDS of 4,000 to 5,000 mg/L: Animals may have an initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production.

** Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually.

Hydrogeological investigations (AQ2 2025) assessed groundwater recharge through a combination of methods such as groundwater level and groundwater salinity monitoring using high frequency data loggers. AquaTROLL data loggers measure time series groundwater levels and salinity.

Declining groundwater levels were generally evident across all groundwater monitoring bores following the 2020/21 wet season, where rainfall was below average. This can be observed in the hydrographs presented in **Figure 7-20** to **Figure 7-24**. Small rainfall events in November / December 2021 resulted in different groundwater level responses. For example, a rapid increase in groundwater levels was recorded at bores installed in the fractured rock aquifer and the deeper Tertiary units (i.e. Basal Crete or CID), while a delayed response was recorded in the shallower Tertiary units (Upper Calcrete and / or the Undifferentiated Tertiary) (AQ2 2025).

Changes in groundwater salinity can show the impact of groundwater recharge. Short-term increases in groundwater salinity at shallow monitoring bores on the valley floor near the claypans indicate salts are leached from the unsaturated zone into the groundwater system during the “first flush” (i.e. the initial surface water seepage leaches accumulated salts). The reduced salinity recorded from some shallow salinity profiles after a wet season (i.e. in May 2020), show that after the first flush of salts, fresher surface water recharges the groundwater system (i.e. on-going seepage of surface water does not continue to leach high volumes of salt as this was flushed during the early stages) (AQ2 2025). An indicative salinity category guide is provided in **Table 7-9.**

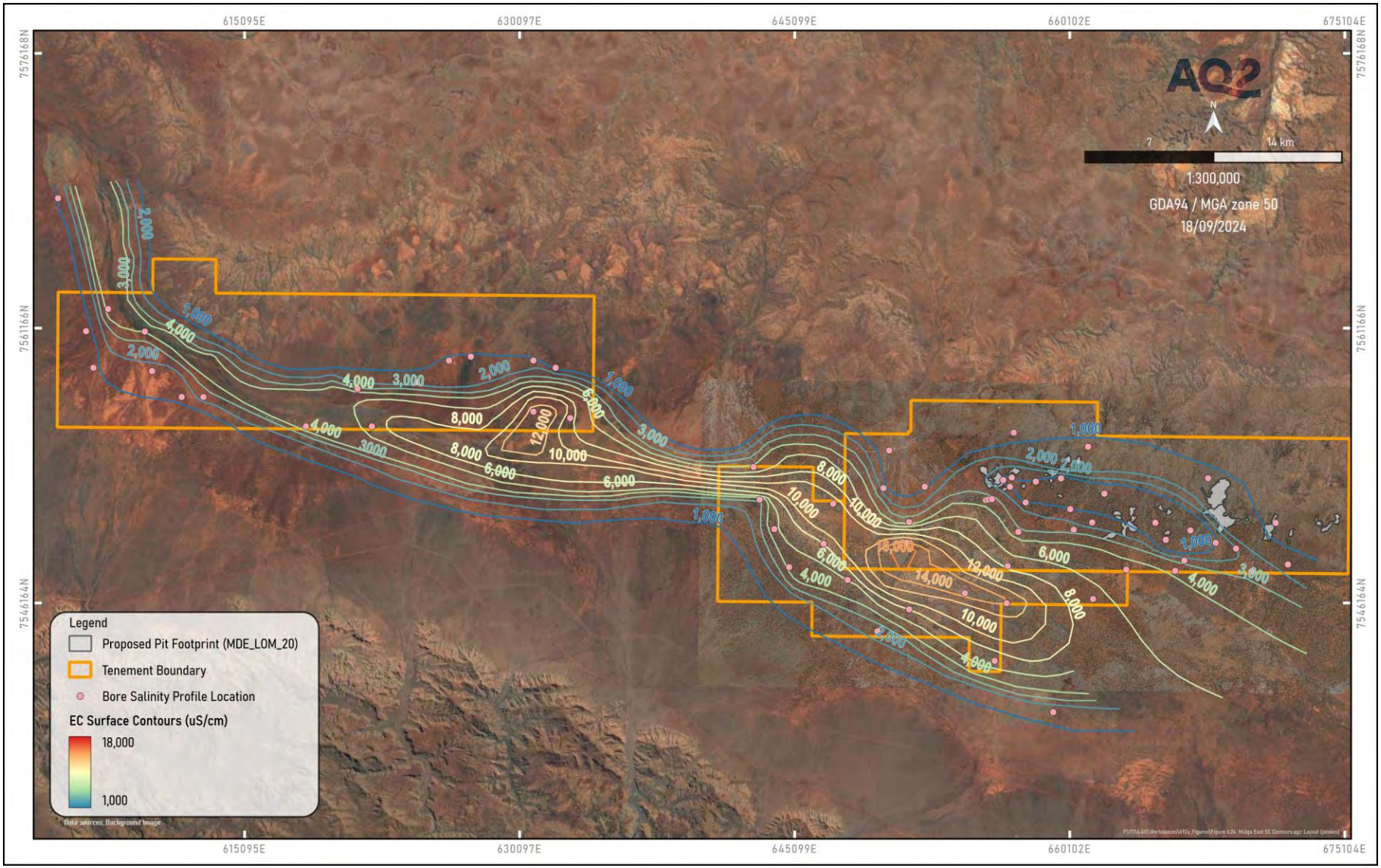
Table 7-9: Salinity threshold categories (Australian Government, 2004; DoW 2009)

Salinity Type	TDS (mg/L)
Fresh	< 500
Marginal	500 - 1000
Brackish	1000 - 2000
Moderately Saline	2000 - 5000
Saline	5000 - 10 000
Highly Saline	10 000 - 35 000
Brine	> 35 000

The pH of the groundwater generally ranges between 5.9 and 7.9 across the MDIOM area, however, in three bores in the most north-eastern section, the groundwater was found to have pH value ranging between 3.6 and 4.4. These low pH values are anticipated to be a result of the oxidation of sulphides in the Jeerinah Formation, with oxygenated groundwater flowing through minor local fractures. This is consistent with observations elsewhere in the Pilbara such as on the Wonnmunna Plateau adjacent to the West Angeles mine (AQ2 2025; Johnson & Wright 2001).

Within the MDIOM area, groundwater is used by pastoral stations for stock (beef cattle) watering. More regionally, groundwater is used for potable supplies at the Wirrilimarra and Youngaleena Communities. Given the predominant use of the land in the vicinity of the Proposal for pastoral activities groundwater quality data may be compared against livestock drinking water guidelines (ANZECC & ARMCANZ 2000). Exceedances of aluminium, fluoride and mercury have been recorded at bores where the groundwater salinity is within the preferable drinking water limits for beef cattle (i.e. < 5,000 mg/l).

Figure 7-27: Groundwater Salinity Contours at Water Table (AQ2 2025)


615095E
630097E
645099E
660102E
675104E
7576168N
7561166N
7546164N
AQ2
N
7
14 km
1:300,000
GDA94 / MGA zone 50
18/09/2024
Legend
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
Bore Salinity Profile Location
EC Surface Contours (uS/cm)
18,000
1,000
Data sources: Background Image

7.3.7 Potential Environmental Receptors

7.3.7.1 Groundwater Dependent Ecosystems

Based on the combination of remote sensing (NDVI), field ecophysiological measurements and ecohydrological water balance modelling studies, no terrestrial groundwater dependent ecosystems were identified in or immediately adjacent to the Development Envelope (AQ2 2025).

A detailed ecohydrological baseline assessment of the Fortescue Valley environs has also been undertaken, involving characterisation of major vegetation types and evaluation of the ecological water requirements of the *E. victrix* woodland communities. The potential groundwater dependence of vegetation in the Fortescue Valley has been evaluated using seven assessment tools outlined in the Australian groundwater-dependent ecosystems toolbox (Richardson et al. 2011). It is concluded that groundwater dependent vegetation does not occur in or immediately adjacent to the Development Envelope, based on the following supporting evidence:

- Groundwater underlying the Fortescue Valley environs is generally brackish/saline and therefore does not constitute a favourable water source for floodplain vegetation.
- Regolith characteristics in the Fortescue Valley environs suggest that vegetation rooting depth is impeded by massive calcrete or dense, low permeability clay layers. Owing to access and ground disturbance constraints due to heritage values in these areas, direct observation of tree roots were limited to several sump pits associated with hydrogeological drilling.
- Across the MDIOM area and surrounds, there are no areas of persistently high greenness as measured by time series NDVI imagery.
- Time series pre-dawn leaf water potentials indicate the tree-root zones are in unsaturated media with widely varying soil matric pressure, that is generally lower (i.e. more negative) than -0.5 MPa. Also taking into consideration the potential influence of brackish groundwater, this precludes the roots being in groundwater or at the capillary fringe.
- Based on water balance modelling supported by on-ground vegetation measurements (i.e. woodland tree size and density), surface water inputs were calculated to be sufficient to support the density of trees occurring in the Fortescue Valley *E. victrix* woodland communities. The more dense woodland stands are associated with better structured soils with relatively higher plant-available water storage capacity.

Approximately 45 km to the west-northwest of the Development Envelope, a surface expression of groundwater was inferred by Pinder et al. (2017) at an unnamed channel pool on Mount Florance Station (GDA94 Lat -21.9848; Long 118.0411) (AQ2, 2025). This contention was supported by the presence of stygofauna taxa in this pool and measured pool water salinity of 6,400 µS/cm on 14 March 2017. The vegetation at this site was not found to be in hydraulic connectivity with groundwater. The vegetation was found to be more representative of halophytic communities of the Fortescue Marsh (AQ2 2024; Pinder et al 2017). Two additional pools further downstream were also sampled on the same date, with pool water salinity of 2,690 µS/cm and 1,290 µS/cm respectively recorded at these pools. These pools occur where channelised flow becomes more defined in lower the Fortescue Valley (AQ2, 2024a). Although no drilling has taken place at the channel pools due to the environmental and cultural heritage significance of these areas, the derived depth to water indicate these features are not groundwater-related (AQ2, 2025).

7.3.7.2 Surface Water Hydrology and Ecohydrology

The following provides a list of potential environmental receptors, relevant to surface water hydrology and ecohydrology, identified within and near the Development Envelope. Their locations are illustrated in **Figure 7-29** (AQ2 2024a).

- The area known as the Fortescue Marsh has been demarcated in the Directory of Important Wetlands in Australia (Environment Australia 2001) as DIWA WA066. This area includes the Fortescue Marsh upstream of Goodiadarrie Hills and includes the section of the Fortescue Valley downgradient of the Development Envelope containing Goodiadarrie Swamp, the claypans and floodplains which is registered as Environmentally Sensitive Area (ESA) DWER-046 (AQ2 2025). The proposed mine pit footprints will avoid the boundary of the ESA area with a buffer of 200 m.
- Koodjeepindarranna and Gnalka Gnoona claypans and surrounding *E. victrix* dominated woodland. These claypans are part of the 'Freshwater claypans of the Fortescue Valley' (Priority 1) Priority Ecological Community (PEC) (AQ2 2025) in the Goodiadarrie Swamp system. These claypans are outside the Development Envelope. When flooded, the claypans are known to provide habitat for waterbirds including migratory species. Across the greater Fortescue Valley, larger claypans and river pools tend to support greater numbers and diversity of waterbirds than smaller shallower wetlands (Pinder et al. 2017).
- The Ebathcalby claypan is a Priority 1 PEC located about 9 km south (and to the east) of the eastern margin of R47/12. The Ebathcalby Claypan is unlikely to be impacted by runoff from the Proposal, as its elevation is approximately 5 m higher than the base of the Fortescue Valley below the Development Envelope.
- Millstream National Park is located more than 100 km west of the Development Envelope, further down the Fortescue Valley. During very large and infrequent cyclonic events, the Koodjeepindarranna Claypan may overtop and contribute to downstream flow into the Lower Fortescue River system towards Millstream.
- Surface water flows from Karijini National Park are towards the Fortescue River, on the opposite side of the Fortescue Valley to the proposal, so there is no mechanism or pathway for modified surface waters as a result of the Proposal to impact the National Park.
- The 'Four plant assemblages of the Wona Land System' Priority 1 PEC is a system of basalt upland gilgai plains comprising vegetation types MTGW and ASL (2) (Priority 1 – Priority 3) with grassland vegetation assemblages. The PEC occurs north of the Goodiadarrie Swamp sub-catchment divide and is therefore ecohydrologically disconnected from the proposed pit areas, however, the proposed haul road crosses through the PEC.
- Several small, surface water fed channel pools that hold water for a period of time following runoff events, in the Fortescue Valley, south of the Development Envelope occur. These pools are considered to have potential local conservation significance. They are within the Goodiadarrie Swamp and within drainage channels reporting to the valley floor, and persist, following runoff events. These pools include (but are not limited to):
    - Channel pool within the Koodjeepindarranna Claypan complex (Pinder et al. 2010).
    - Channel pool at UTM Zone 50 653300E and 7550400N. Identified from aerial photography.
    - Channel pool at UTM Zone 50 661600E and 7547770N. Identified from aerial photography.
    - Gidyea pool south and east of the Development Envelope, near the Ebathcalby Claypan – has significant wetland floor vegetation in contrast with claypans further to the west (Pinder et al. 2017). As discussed above, this pool is not located downstream of the Development Envelope.

- *Acacia stenophylla* is a notable overstorey tree species in the Fortescue Valley floodplain woodlands to the south of the Development Envelope (AQ2 2025). This species is widespread in inland eastern Australia, with the Fortescue Valley population constituting a major outlier from its core distribution (AQ2 2025).

7.3.7.3 Subterranean Fauna

The Development Envelope and surrounding area host a particularly diverse range of subterranean fauna, including stygofauna and troglofauna (BEC 2019; 2021; 2024). Generally, subterranean environments which are highly transmissive, such as that within the Development Envelope and adjacent regional area, have been found to support more substantial assemblages of subterranean fauna, both in terms of abundance and diversity (Gilbert et al, 1994).

On the basis of geological logging, core photos and subterranean fauna survey results, lithological units have been grouped based on the potential to support a troglofauna or stygofauna habitat. The geological units identified as likely habitats for troglofauna and stygofauna are the Upper Calcrete and CID/Pisolite of the Tertiary sequence and Mineralised Marra Mamba (refer to AQ2 2024a **Appendix 9**). For troglofauna, these potential habitat units are restricted to where they occur above the water table. For stygofauna (occurring in the groundwater):

- The likely Upper Calcrete habitat is a continuous unit that occurs to the south of the proposed mining area and extends both across the Fortescue Valley and along the strike of the valley.
- The likely habitats of Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range, with the CID / Pisolite occurring as a continuous unit, extending to the south across the valley and the Mineralised Marra Mamba occurring as discontinuous pods associated with the mineralisation.

These habitats are described in **Section 8** of this document. Refer to **Appendix 9** for 3D habitat assessment by AQ2.

7.3.8 Other Potential Users

Aside from the natural environment, existing groundwater users within and surrounding the Development Envelope include the local and nearby stations (Mulga Downs, Hooley and Mt Florance Stations), for stock watering. Additional, more regional, groundwater users are the Wirrilimarra and Youngaleena Communities and licenced water supplies associated with the operation of the existing FMG (Solomon) railway and Goodiadarrie transport corridor.

Figure 7-28: Conceptual Ecohydrological Model of the *E. victrix* woodland communities (AQ2 2024a)

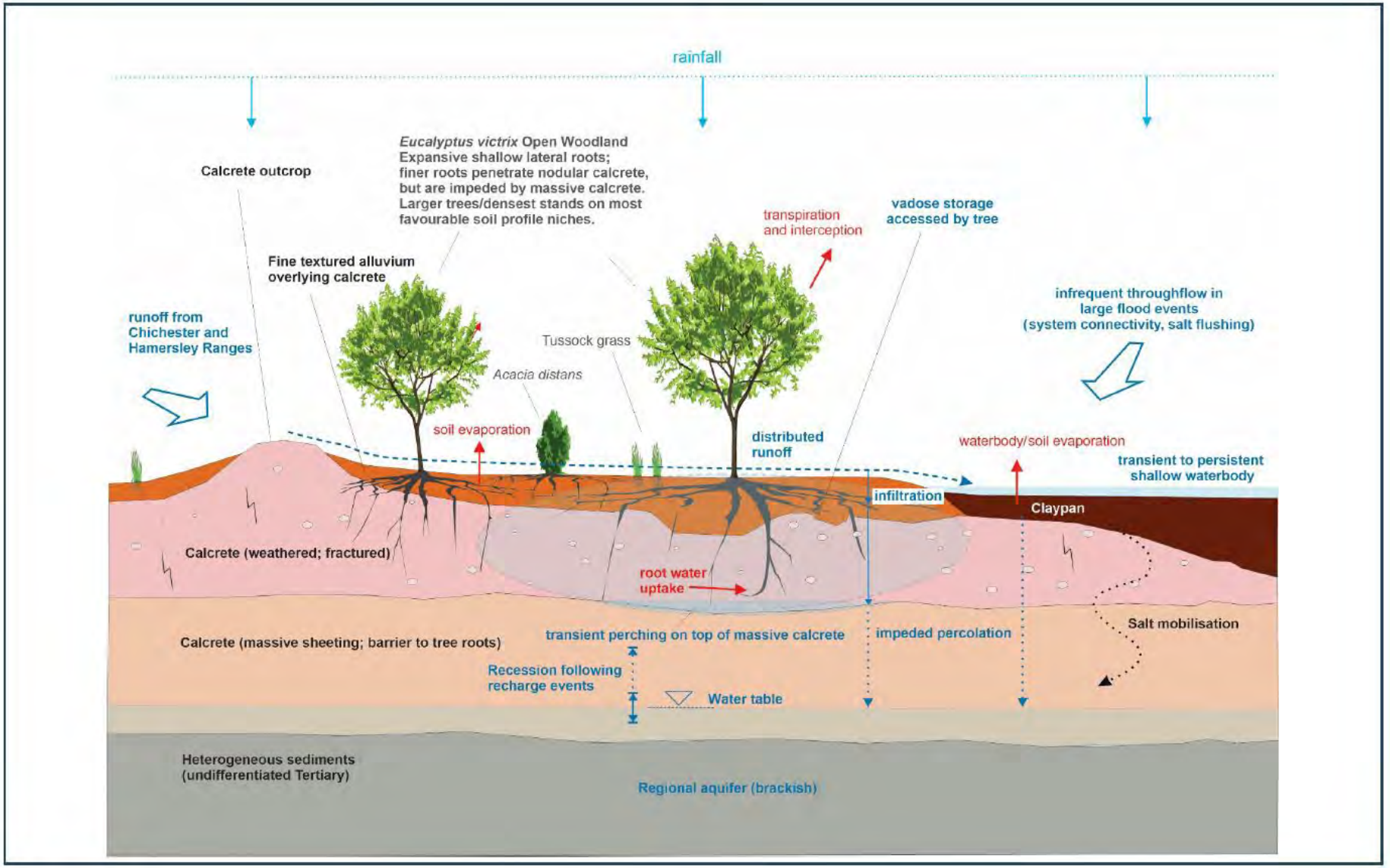
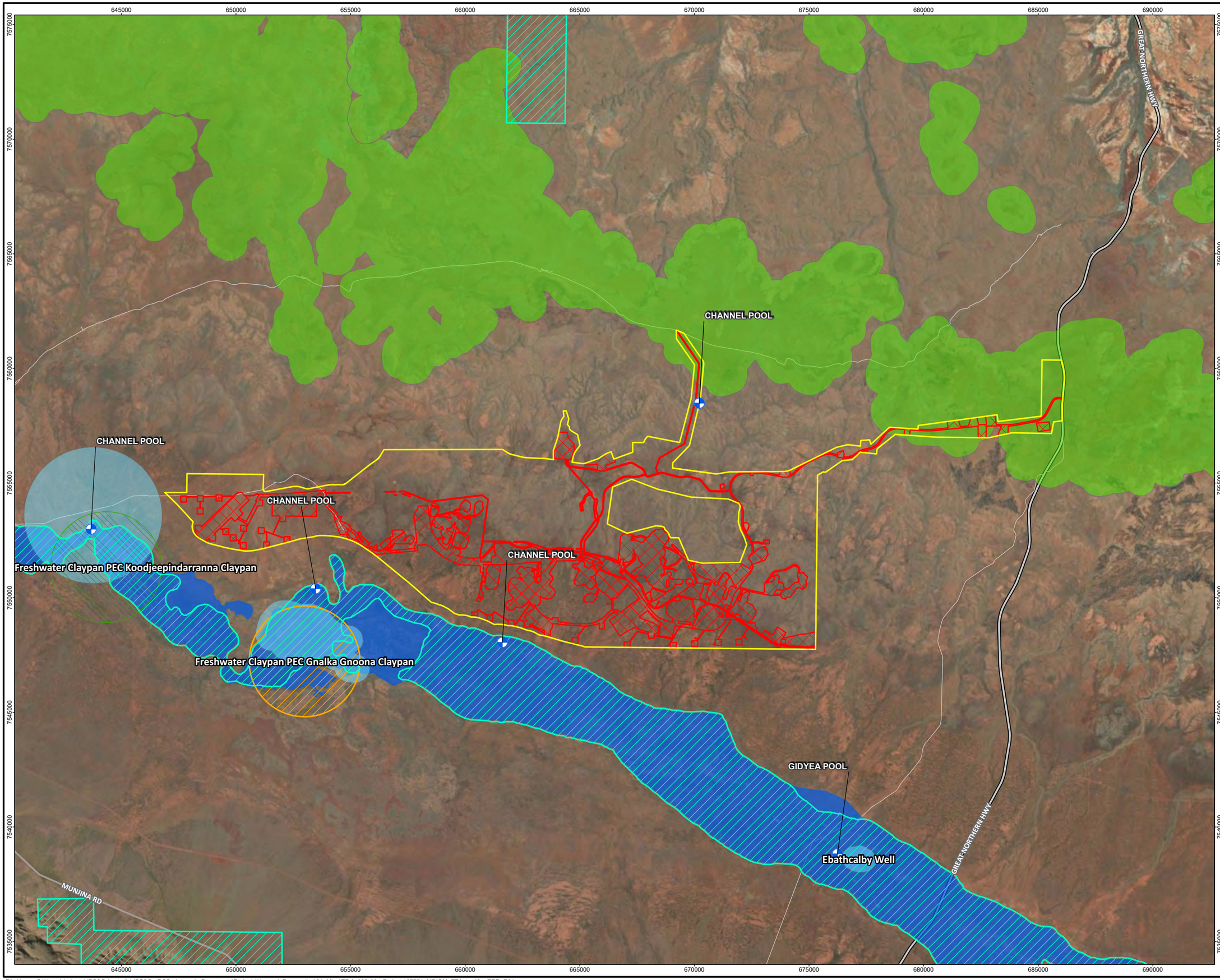

rainfall
Calcrete outcrop
Eucalyptus victrix Open Woodland
Expansive shallow lateral roots;
finer roots penetrate nodular calcrete,
but are impeded by massive calcrete.
Larger trees/densest stands on most
favourable soil profile niches.
transpiration
and interception
vadose storage
accessed by tree
Fine textured alluvium
overlying calcrete
runoff from
Chichester and
Hamersley Ranges
Tussock grass
Acacia distans
infrequent throughflow in
large flood events
(system connectivity, salt flushing)
soil evaporation
distributed
runoff
waterbody/soil evaporation
transient to persistent
shallow waterbody
infiltration
Claypan
Calcrete (weathered; fractured)
root water
uptake
Salt mobilisation
Calcrete (massive sheeting; barrier to tree roots)
transient perching on top of massive calcrete
impeded percolation
Recession following
recharge events
Water table
Heterogeneous sediments
(undifferentiated Tertiary)
Regional aquifer (brackish)

Figure 7-29: Location of Potential Environmental Receptors and other Potential Users



Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA-038)

- Freshwater claypans of the Fortescue Valley PEC buffer (P1)
- Four plant assemblages of the Wona Land System PEC buffer (P1)

Ecohydrology Focus Area (AQ2)

- Focus Area A: Gnalka Gnoona claypan and surround E.victrix woodland
- Focus Area B: The Koodjeepindarranna claypan and surrounding E.victrix woodland
- DIWA Wetland Boundary 066 (Fortescue Marshes) [not the Fortescue Marsh]
- Environmental Sensitive Areas (DWER-046
- Surface Water Channel Pool

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 17-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:150,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF POTENTIAL ENVIRONMENTAL RECEPTORS AND POTENTIAL USERS

FIGURE 7.29

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

7.4 Proposed Water Management Strategy

The location of the proposed pits for the Proposal are shown in **Figure 7-30.** It comprises seven mining domains (from west to east): Murray's Hill, Anticline Hill, Fridge West, Fridge Central, Fridge Hill, Horseshoe West and Horseshoe Hill. Approximately 20 of the pits are proposed to extend (to varying depths) below the groundwater level and will therefore require dewatering. The lowest estimated pit elevation is 388 mRL (i.e. ~12 to 16 m below the groundwater level) (AQ2 2024a).

7.4.1 Dewatering

The preferred approach to dewatering is via ex-pit dewatering bores with in-pit bores only used where additional abstraction is required to achieve required drawdown levels. In-pit sumps may be used towards the end of mining a pit to access the deepest part of the pit (AQ2 2024a).

For pits located closer to the claypan areas (i.e., in the Murray's Hill and Fridge West areas), there is the potential for dewatering discharge to become more saline over time as groundwater is drawn from the higher salinity, valley areas (as shown in **Figure 7-30**). As the proposed pits are only being mined to ~388 mRL and do not have saline water directly beneath them, up-coning of deeper, more saline water is not anticipated with the proposed dewatering abstraction (AQ2 2024a).

The mine plan has been developed to account for the constraints imposed by groundwater management. The adopted mining scenario has mining commencing in January 2027, with a 15.5-year life of mine. Below water table mining commences in 2028 in the west, in the Murray's Hill area, progressing east to Anticline Hill, followed by the mining of Horseshoe West and finally the Fridge West, Fridge Central and Fridge Hill areas. This is summarised and depicted in **Figure 7-31** (AQ2 2024a).

Predicted dewatering commences in April 2028 at ~8,600 kL/d (~3.2 GL/yr). Numerical groundwater modelling predicts peak dewatering rates of between ~30,000 and 31,300 kL/d (~11 to 11.4 GL/yr) during the concurrent dewatering of Murray's Hill, Anticline Hill and Horseshoe West during 2032 and 2033, with similar peaks (~30,200 kL/d) between 2037 and 2041, during the mining of Fridge Hill and Fridge West. Dewatering rates decline rapidly upon the completion of mining Fridge Hill, with rates of ~4,300 kL/d (~1.6 GL/yr) predicted for the final of year of mining Fridge West. The proposed Fridge Central pits (FC02 and FC03) only extend ~2 mbgl and, as such, these pits are dewatered passively by interference effects from the dewatering of neighbouring pits. Predicted dewatering for the adopted mine schedule is shown in **Figure 7-31** (AQ2 2024a).

Dewatering was simulated using 23 dewatering bores. The locations of the modelled bores are presented in **Figure 7-32**. The ex-pit dewatering bores are generally located immediately adjacent to the deepest parts of the pits and where the aquifer is deepest. Dewatering bores are therefore generally located on the down-dip side of the pits to ensure the maximum duration of pumping (with up-dip locations becoming dewatered first). Maximum dewatering rates at the individual bore sites range between 2,600 and 4,300 kL/d (30 and 50 L/s), with yields at some bores declining as the aquifer units are dewatered, particularly the northernmost bores (AQ2 2024a).

A conceptualisation of the potential impact of dewatering on the groundwater system is illustrated in **Figure 7-33**.

Figure 7-30: Simulated pits in the groundwater model (Mulga Downs) (AQ2 2025)

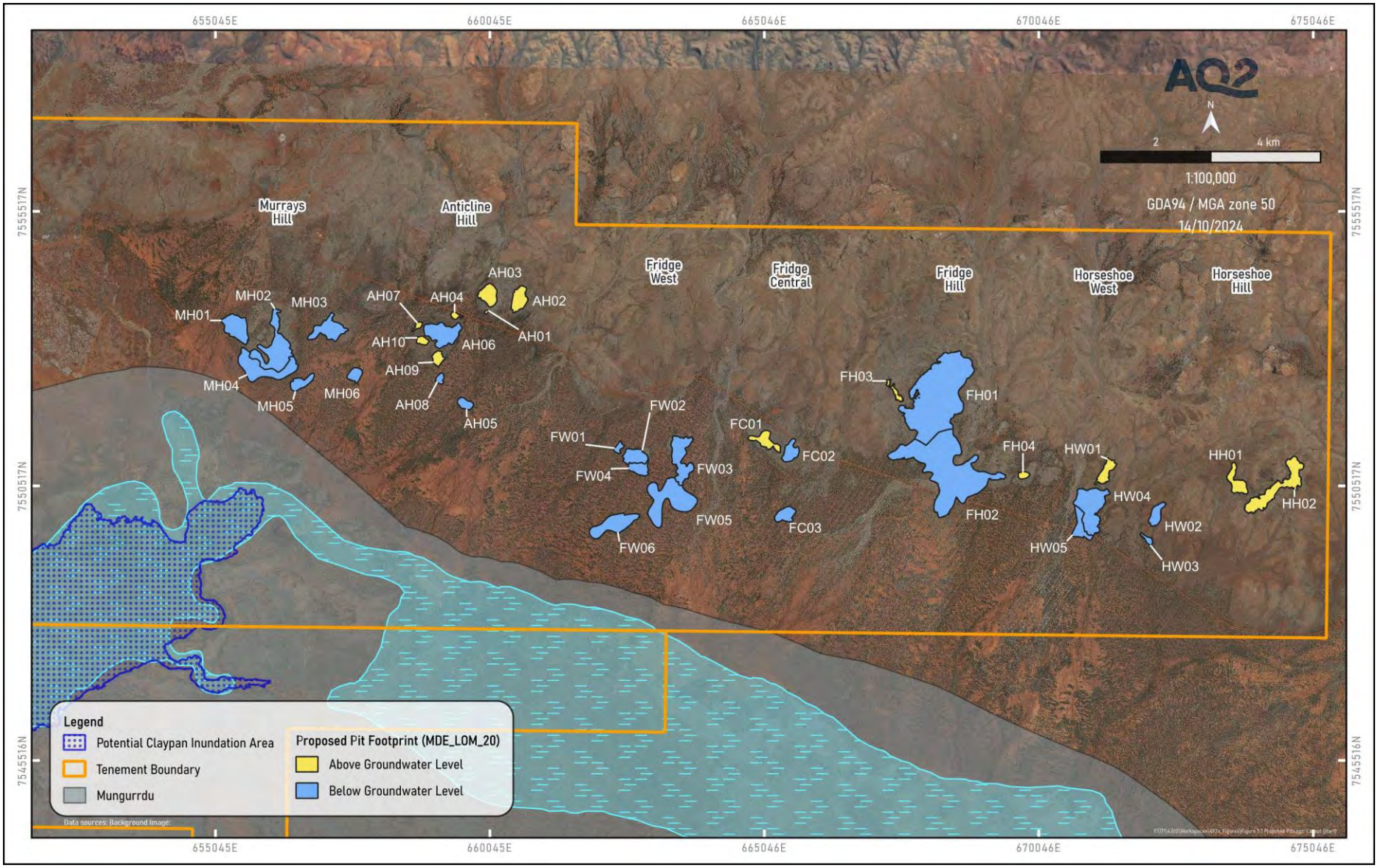
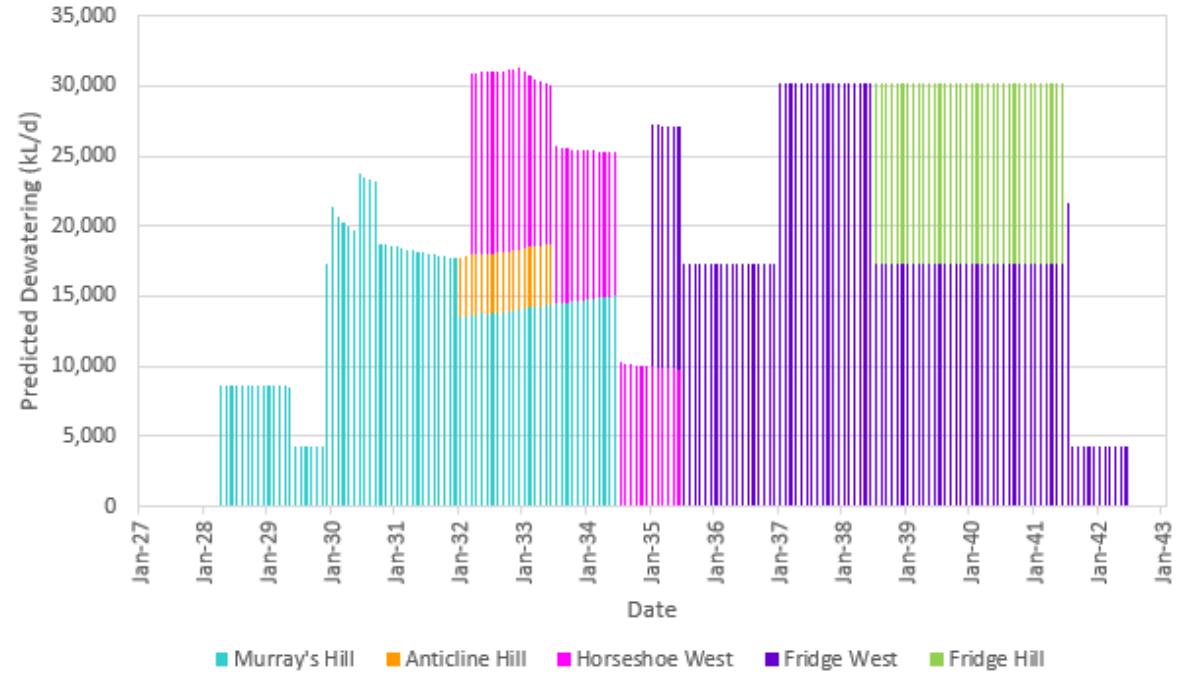

655045E
660045E
665046E
670046E
675046E
7555517N
7550517N
7545516N
AQ2
N
2
4 km
1:100,000
GDA94 / MGA zone 50
14/10/2024
Murrays Hill
Anticline Hill
Fridge West
Fridge Central
Fridge Hill
Horseshoe West
Horseshoe Hill
MH01
MH02
MH03
MH04
MH05
MH06
AH01
AH02
AH03
AH04
AH05
AH06
AH07
AH08
AH09
AH10
FW01
FW02
FW03
FW04
FW05
FW06
FC01
FC02
FC03
FH01
FH02
FH03
FH04
HW01
HW02
HW03
HW04
HW05
HH01
HH02
Legend
Potential Claypan Inundation Area
Tenement Boundary
Mungurrdu
Proposed Pit Footprint (MDE_LOM_20)
Above Groundwater Level
Below Groundwater Level
Data sources: Background Image:

Figure 7-31: Predicted dewatering Schedule (AQ2 2025)


35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Predicted Dewatering (kL/d)
Jan-27
Jan-28
Jan-29
Jan-30
Jan-31
Jan-32
Jan-33
Jan-34
Jan-35
Jan-36
Jan-37
Jan-38
Jan-39
Jan-40
Jan-41
Jan-42
Jan-43
Date
Murray's Hill
Anticline Hill
Horseshoe West
Fridge West
Fridge Hill

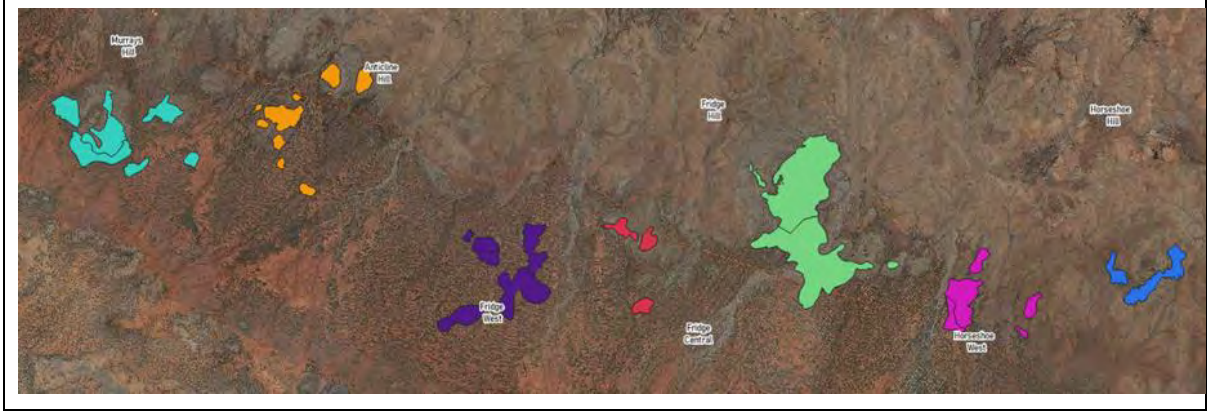
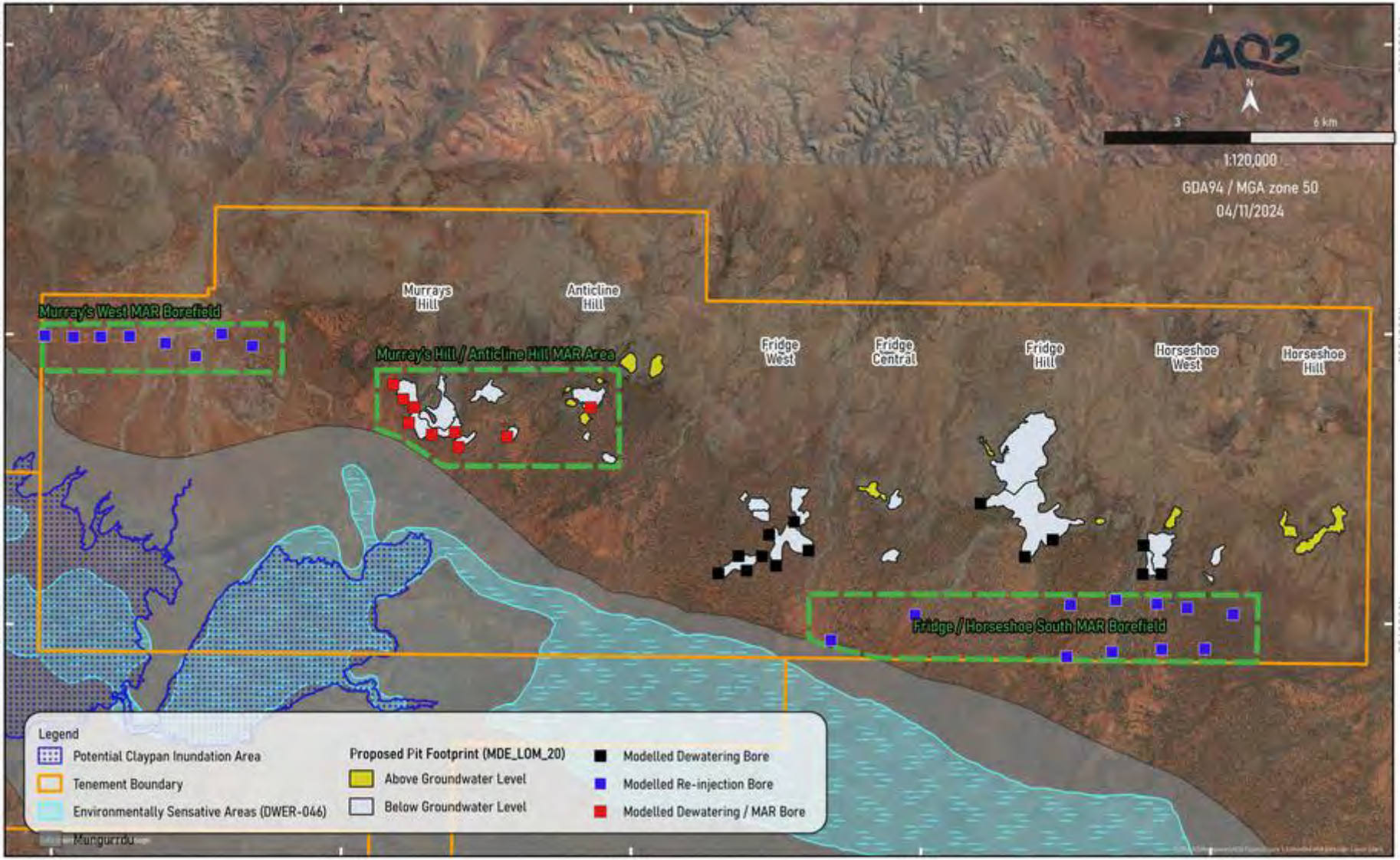

Murrays Hill
Anticline Hill
Fridge Hill
Horseshoe Hill
Fridge West
Fridge Central
Horseshoe West

Figure 7-32: Simulated Dewatering Bores (AQ2 2025).


AQ2
N
3
6 km
1:120,000
GDA94 / MGA zone 50
04/11/2024
Murray's West MAR Borefield
Murrays Hill
Anticline Hill
Murray's Hill / Anticline Hill MAR Area
Fridge West
Fridge Central
Fridge Hill
Horseshoe West
Horseshoe Hill
Fridge / Horseshoe South MAR Borefield
Legend
Potential Claypan Inundation Area
Tenement Boundary
Environmentally Sensative Areas (DWER-046)
Proposed Pit Footprint (MDE_LOM_20)
Above Groundwater Level
Below Groundwater Level
Modelled Dewatering Bore
Modelled Re-injection Bore
Modelled Dewatering / MAR Bore
Mungurrdu

7.4.2 Construction and Operational Water Demand

HPPL estimates an approximate average water demand of 0.75GL/yr (2,000 kL/d) for both the construction period (i.e., a period of 1 to 2 years prior to mining) and throughout the life of mine.

Throughout the mining period water demands will be preferentially met by dewatering volumes and, if required, water treatment will ensure that the water quality criteria are met. It is intended that construction water will be sourced from the mining area and, as such will either provide advance dewatering and / or increased aquifer capacity for the disposal of excess water, dependent on the source area. As such, although the groundwater abstraction has only been modelled to meet dewatering requirements (i.e., commencing in April 2028), early groundwater abstraction for water supply purposes is not not anticipated to have a significant effect on the modelled drawdown / mounding with respect to impact assessment (AQ2 2024a).

7.4.3 Excess Water Disposal

Where dewatering exceeds water demands, excess water will be disposed of by MAR. The generally progressive west to east mining approach (with the exception Horseshoe West mining) allows excess water to be injected and/or infiltrated along strike (i.e., into other mining areas in advance of or after mining in that area) as well as across strike (i.e., to the south of the eastern mining areas) (AQ2 2024a).Initially, MAR is proposed via reinjection bores, with the potential for using repurposed dewatering bores and / or in-pit infiltration, once mining of a pit is complete (AQ2 2024a).

From the field investigations conducted to date, the following are key points relating to the MAR potential for this area (AQ2 2024a):

- The Altered Marra Mamba unit is an extensive and continuous aquifer, as is the Tertiary overburden.
- Although weathered shale and / or clay dominant intervals within the Tertiary overburden exist, no continuous, extensive confining layer to allow pressurised MAR has been identified by investigations completed to date.
- The generally unconfined nature of the identified Tertiary and bedrock aquifers means that MAR will be limited by the available freeboard (i.e., the unsaturated aquifer above the current groundwater level and below the ground surface / root zones). However, with regional groundwater levels being drawn down by the dewatering of the pit areas, the freeboard is likely to increase.
- The increased depth to groundwater in the eastern areas provides greater freeboard, however, these areas have inherently fresher groundwater, being further from the claypan areas, therefore potential changes to water quality will need to be assessed and managed.
- The MAR will reduce the extent of drawdown, however, the proximity of the proposed MAR areas to the pits is anticipated to result in re-circulation of the re-injected water back to the pits.
- With respect to the beneficial use of the groundwater in the Development Envelope: Although the groundwater salinity is naturally elevated near the claypans, the salinity reduces with increased distance from the claypans due to the lateral flow of fresher groundwater from the valley slopes; with preferential flow evident through the lower units of the Tertiary sequence (i.e., the CID / Pisolite and Basal Crete) and upper bedrock units. Station bores for livestock drinking water are installed in the Tertiary aquifer units.

Three MAR areas have been simulated, as shown in Figure 5.8 of **Appendix 5**. The simulated groundwater level rise at each modelled MAR bore was restricted to 2.5 mbgl, i.e, below the vegetation root zone, which is

constrained by largely impenetrable subsoil/regolith materials (e.g. calcrete). Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl (AQ2 2024a).

The modelling indicates that all excess water can be disposed of by MAR. **Figure 7-31** presents the simulated MAR rates by area, in comparison to the dewatering by area. It can be seen that variable bores of the Fridge / Horseshoe South MAR Borefield are used throughout the LoM, with the exception of approximately two years (mid-2033 to mid-2035), during the mining of Horseshoe West. With the influence of dewatering creating additional freeboard across the area, maximum predicted re-injection rates reach ~28,000 kL/d (~10 GL/yr) for the Fridge / Horseshoe South Borefield, 23,000 kL/d (~8.5 GL/yr) for the Murray's West Borefield pit areas and ~25,000 kL/d (~9 GL/yr) for the Murray's Hill / Anticline Hill pit areas.

7.4.4 Surface Water

Storm water runoff across the Development Envelope (including the mining area and associated ancillary infrastructure) will be managed to limit environmental impacts of the Proposal on the surface water regime and downstream environment.

The general management objectives for the Proposal relating to surface water are as follows (AQ2 2024a):

- Maintain the existing hydrological regime as much as is practicable.
- Mitigate impacts on surface water quality from construction and operations by containing and treating impacted water on-site prior to release to the downstream environment.
- Reduce the risk of surface water having a significant impact on mining operations.

Additionally, HPPL's Environmental Compliance Standard (HanRoy 2023) sets an objective to "*Maintain, to the extent practicable, the quantity and quality of surface water to minimize environmental impacts on the existing downstream environment.*" The following targets sit under this objective:

- No minimized release of any pollutant to surface water.
- No significant impact on Riparian or Mulga vegetation health because of altered hydrology.

Proposed surface water management measures to meet the above objectives have been based on the following design philosophies (AQ2 2024a, HanRoy 2023):

- Clean water should be diverted around mining areas to the downstream environment to prevent contamination of runoff from clean water catchments.
- Flood mitigation measures are required to prevent flood ingress to open pits and mine infrastructure areas.
- Surface water management infrastructure must incorporate measures to avoid excessive scour, erosion and sediment transport, and should be designed to prevent prolonged ponding following rainfall events.
- Surface water will be allowed to infiltrate waste rock dumps and/or runoff from waste rock dumps will be contained and diverted through sediment basins prior to release downstream following treatment.

7.5 Potential Environmental Impacts

An assessment of the potential direct, indirect and cumulative impacts of the Proposal to inland water values in consideration of the EPA objectives is provided below.

The potential impacts from mining are conceptualised in **Figure 7-33.**

7.5.1 Direct impacts

7.5.1.1 Surface Water

The identification of potential impacts from the Proposal on the hydrological environment was completed by comparing the proposed infrastructure layout to the existing catchments and baseline flood modelling results.

Direct impacts to the hydrological environment fall into the following categories (AQ2 2024a):

- Modification of the existing hydrological regime, by increasing or reducing water availability within the downstream environment. This can have impacts both immediately downstream of disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Project are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools.
- Modification of the physical water quality (i.e., suspended sediments) in the downstream environment, which may be due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste rock dumps (among others). The environmental impacts from this would be increased sediment loads to the Fortescue Valley (including claypans and pools).
- Modification of the chemical water quality (for example hydrocarbon pollution) resulting in contamination of local waterways and the Fortescue Valley.

Modification of the existing hydrological regime

Modification of the existing hydrological regime can have impacts both immediately downstream of disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. The receptors which may potentially be impacted by the Proposal are local vegetation and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools. Proposed surface water diversions for the MDIOM are shown in **Figure 7-34.**

The mine development will cause a reduction in surface water flows to the environment on the downstream side of the Proposal, particularly in the central section, due to a reduction in contributing catchment areas. This particularly applies to the development of the pit footprints which will capture rainfall. Runoff from other mine disturbance areas (such as waste rock dumps and stockpiles) will be diverted through sediment basins prior to the release of water downstream. As a conservative approach to the assessment of potential impact of the Project on the surface water regime, it is assumed that no runoff from within Surface Water Containment Areas (refer **Figure 7-34**) will report downstream. A reduction in surface water flows to the environment on the downstream side of linear infrastructure (such as road and pipeline installations) and ponding on the upstream side may occur due to the interruption of surface flow paths.

Diversion of surface water flows around development areas and into different drainage lines, and areas of the Fortescue Valley, also have the potential to impact the surface water regimes. Where diversions increase flow rates in local areas, there is the potential for an increase in erosion and water ponding to occur.

Across the 17 catchment areas, as identified in **Table 7-10**, the catchments to the west and east of the mine disturbance areas (1 to 3 and 11 to 16) experience small changes as a result of the disturbance footprints. The central catchments that experience the greatest reductions are impacted either by the mine development reducing the catchment area contributing to downstream surface water flows, or by the proposed surface water diversions transferring water into an adjacent catchment that delivers flows to an alternative location downstream. Catchment 6 is almost completely developed upon, whereas Catchment 9 is partly developed and mostly diverted into Catchment 10 (AQ2 2024a).

Table 7-10: Proposal Catchment Area Changes (AQ2 2024a)

Catchment	Baseline Area (km^2)	Life-of-Mine Area (km^2)	Change in Area
1	23.1	22.0	-5%
2	164.4	164.3	0%
3	39.8	35.5	-11%
4	28.4	22.5	-21%
5	33.8	30.3	-10%
6	13.5	2.8	-79%
7	29.0	29.9	3%
8	11.9	2.6	-78%
9	43.3	13.2	-69%
10	53.9	73.7	37%
11	65.5	60.3	-8%
12	1.7	1.6	-4%
13	6.3	6.0	-5%
14	2.1	1.6	-22%
15	4.5	4.2	-8%
16	7.3	7.1	-3%

Figure 7-33: Conceptual cross section showing potential impact of mining (AQ2 2025)

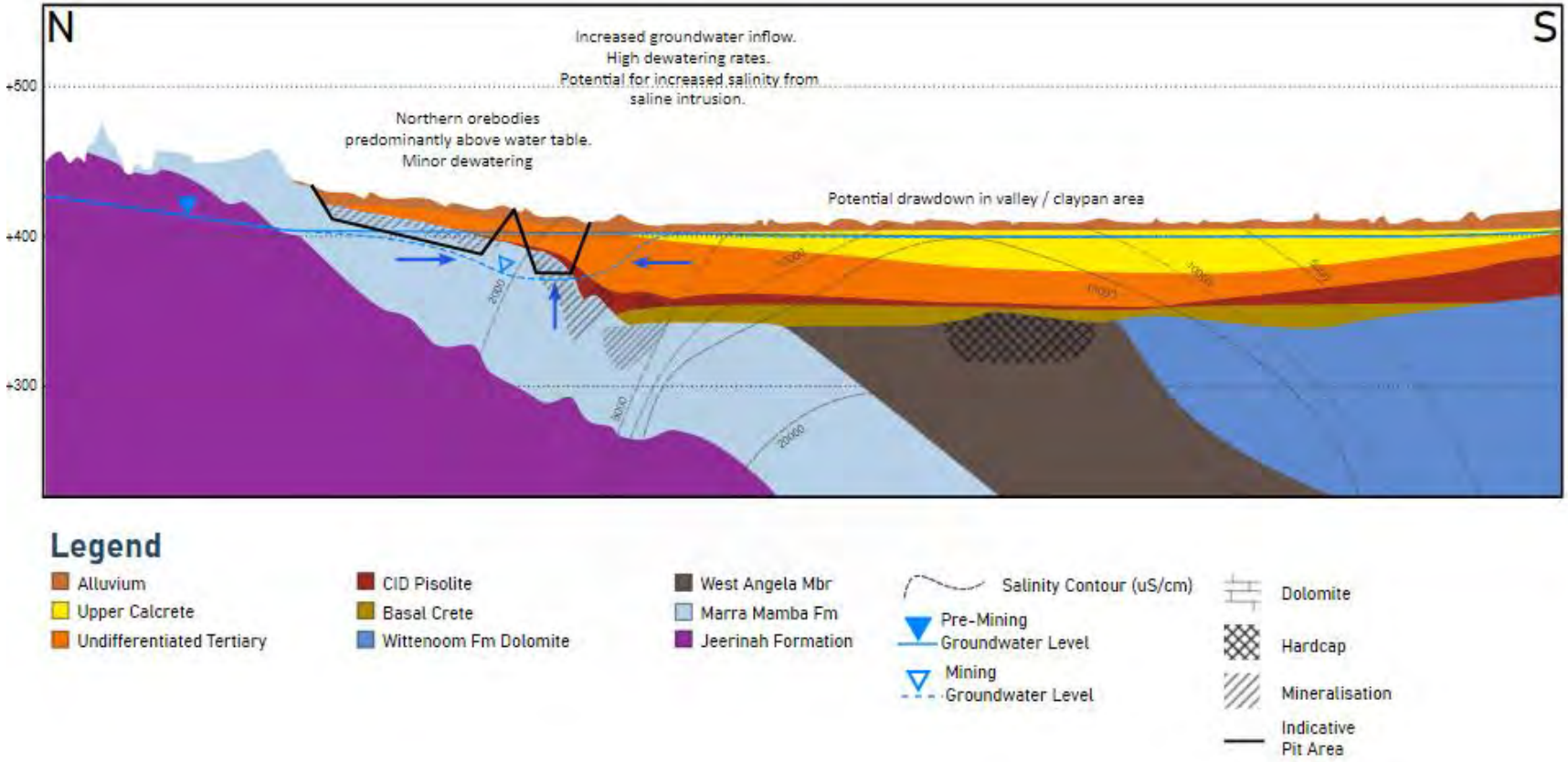
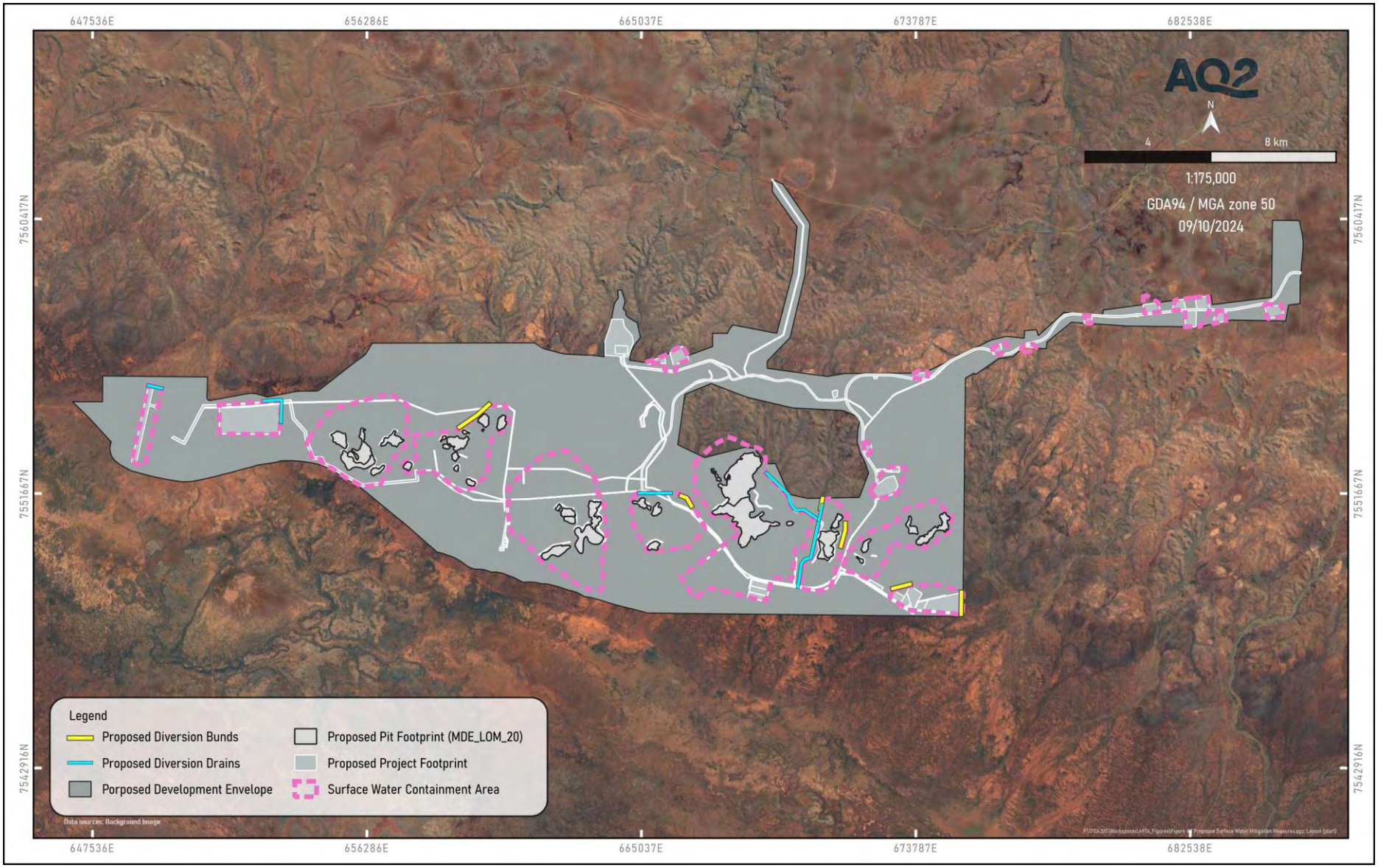

N
S
Increased groundwater inflow.
High dewatering rates.
Potential for increased salinity from saline intrusion.
Northern orebodies predominantly above water table.
Minor dewatering
Potential drawdown in valley / claypan area
+500
+400
+300
2000
3000
10000
Legend
Alluvium
Upper Calcrete
Undifferentiated Tertiary
CID Pisolite
Basal Crete
Wittenoom Fm Dolomite
West Angela Mbr
Marra Mamba Fm
Jeerinah Formation
Salinity Contour (uS/cm)
Pre-Mining Groundwater Level
Mining Groundwater Level
Dolomite
Hardcap
Mineralisation
Indicative Pit Area

Figure 7-34: Proposed Surface Water Diversions (AQ2 2024a)


647536E
656286E
665037E
673787E
682538E
7560417N
7551667N
7542916N
AQ2
N
4
8 km
1:175,000
GDA94 / MGA zone 50
09/10/2024
Legend
Proposed Diversion Bunds
Proposed Diversion Drains
Porposed Development Envelope
Proposed Pit Footprint (MDE_LOM_20)
Proposed Project Footprint
Surface Water Containment Area
Data sources: Background Image

Modification of the physical water quality

Diversion of surface water flows around development areas and into different drainage lines, and areas of the Fortescue Valley, also add an additional risk to the downstream environment. The positioning of the pits, waste dumps, and stockpiles, will cause the diversion of several surface water flow paths towards alternative areas of the Valley. There is the potential for this to increase erosion.

Modification of the physical water quality (i.e. suspended sediments) may occur in the downstream environment due to erosion of disturbed areas relating to construction, stockpiles, laydowns and waste dumps (among others). The resulting environmental impacts include increased sediment loads to the Fortescue Valley (including claypans and pools).

The inherent risks to physical water quality from the Proposal have been identified as:

- Erosion from cleared areas for pits, infrastructure and along waste dump toes leading to sediment reporting to the Fortescue Valley and claypans.
- Ongoing sediment release to the downstream environment from frequent rainfall events leading to increased sediment loads to the Fortescue Valley and claypans.

7.5.1.2 Groundwater

Direct impacts that are anticipated to groundwater include:

- Changes in groundwater levels (groundwater drawdown and groundwater mounding).
- Changes to groundwater salinity.

Changes in groundwater levels

Predicted changes in groundwater levels resulting from the modelled dewatering and MAR have been plotted as drawdown / mounding contours at the end of selected periods of dewatering / MAR and for the end of mining (June 2042). These are presented in **Figure 7-35** to **Figure 7-37**.The maximum extents of the predicted 1 m mounding and 2 m drawdown contours, throughout the LOM, are shown in **Figure 7-38**.

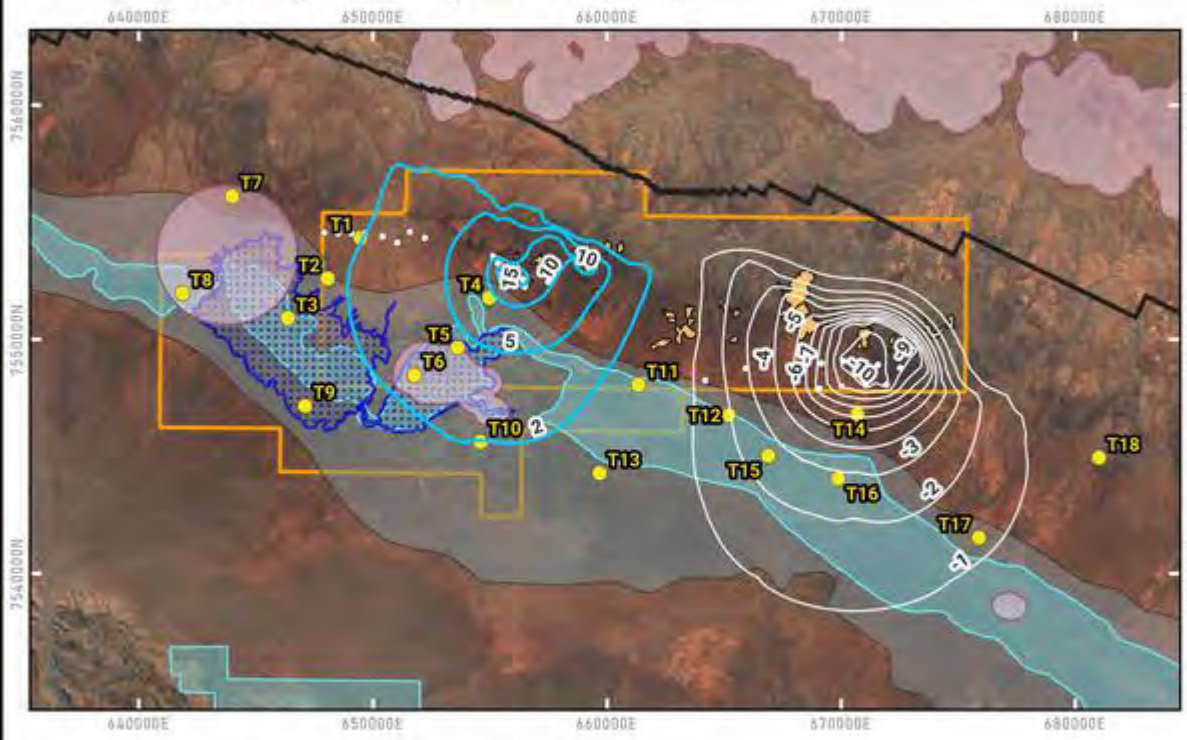
The following observations are made regarding the predicted groundwater level changes (AQ2 2024a):

- Maximum drawdowns are predicted in the active mining areas, with maximum drawdown depths of up to 25 m (i.e., in excess of the maximum proposed depths of mining below the groundwater level).
- Drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along the strike of the valley is curtailed by MAR in both the east and the west of the Mulga East tenement for various periods through the LoM.
- The maximum extent of the predicted 2 m drawdown contour across the valley occurs between July 2038 and the end of mining July 2042, extending ~8 km south-southwest of Fridge West. The drawdown is not predicted to reach the Hamersley Range (nor the model boundary).
- The maximum extent of the predicted 2 m drawdown contour in the vicinity of the claypans occurs in October 2032, extending ~7.5 km south-southwest of the Murray's Hill mining area, across the Gnalka Gnoona Claypan area.

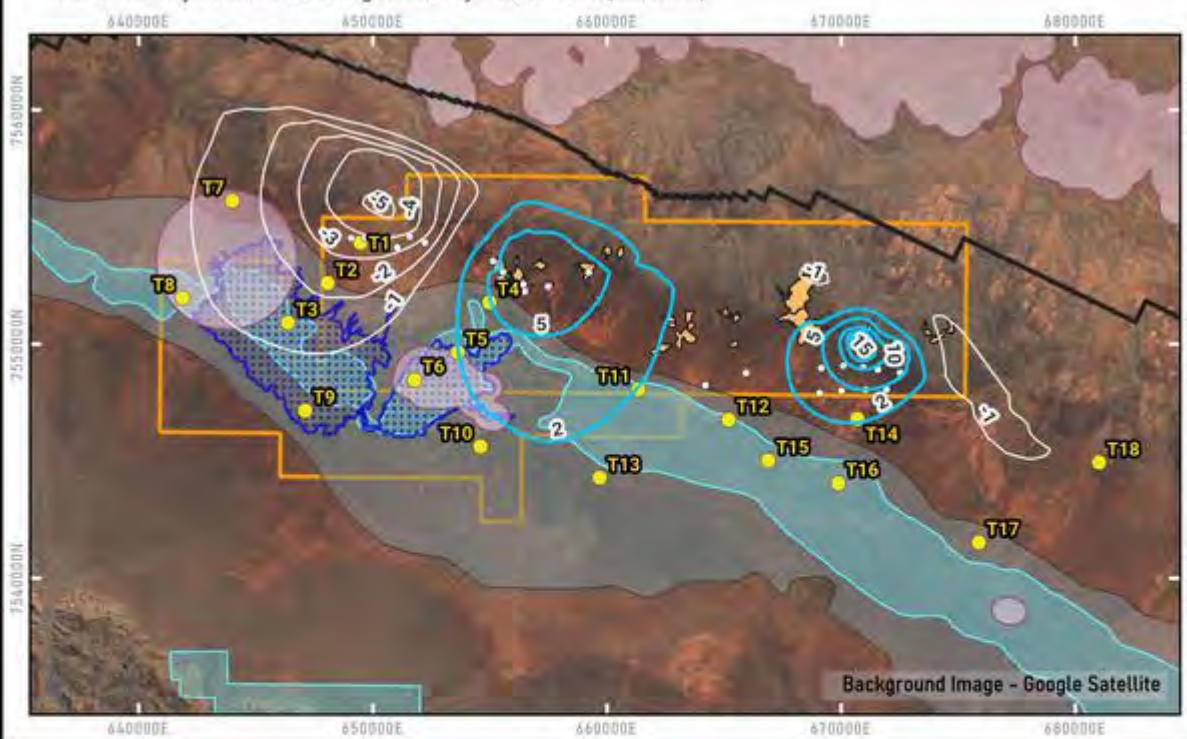
- The maximum western extent of the predicted 2 m drawdown contour occurs in January 2032, during the mining of Murry's Hill and prior to the commencement of MAR in the Murray's West Borefield; it extends ~6 km along strike to the west of the Murry's Hill mining area.
- The maximum eastern extent of the predicted 2 m drawdown contour occurs in July 2035, extending ~3.5 km to the east of the main Horseshoe West pit (HW05).
- Maximum peaks in groundwater mounding of ~11 to 12 m are predicted in the Fridge / Horseshoe South MAR Borefield area in January 2032 and through the latter half of 2038, with predicted hydrographs for the down-gradient observation points (T14 and T16) showing more subdued mounding responses over these periods (refer **Figure 7-36)**.
- The maximum extent of the 1 m mounding contour associated with the Fridge / Horseshoe South MAR Borefield is predicted to occur between January 2032 and July 2033, extending ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary in a southeasterly direction.
- Maximum peaks in groundwater mounding associated with the Murray's West MAR Borefield and Murray's Hill / Anticline Hill MAR area are predicted to be ~4 to 6 m occurring in 2033 to 2034 and July 2035 respectively (refer **Figure 7-35** observation points T1 and T4).
- The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to occur in July 2034, extending ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koodjeepindarranna Claypan.
- Predicted groundwater level hydrographs in the vicinity of the claypans (refer **Figure 7-35** and **Figure 7-36** observation points T3 and T6), show only subdued responses to dewatering and MAR, with predicted groundwater levels remaining below the maximum mounding criterion of 2.5 mbgl.

Figure 7-35: Predicted drawdown and mounding for January 2032 and July 2034 (AQ2 2024a)

Murray's Hill Dewatering Before Murray's West MAR (Jan 2032)



End of Murray's Hill Dewatering & Murray's West MAR (Jul 2034)



N

0 5 10 km

GDA94 / MGA zone 50

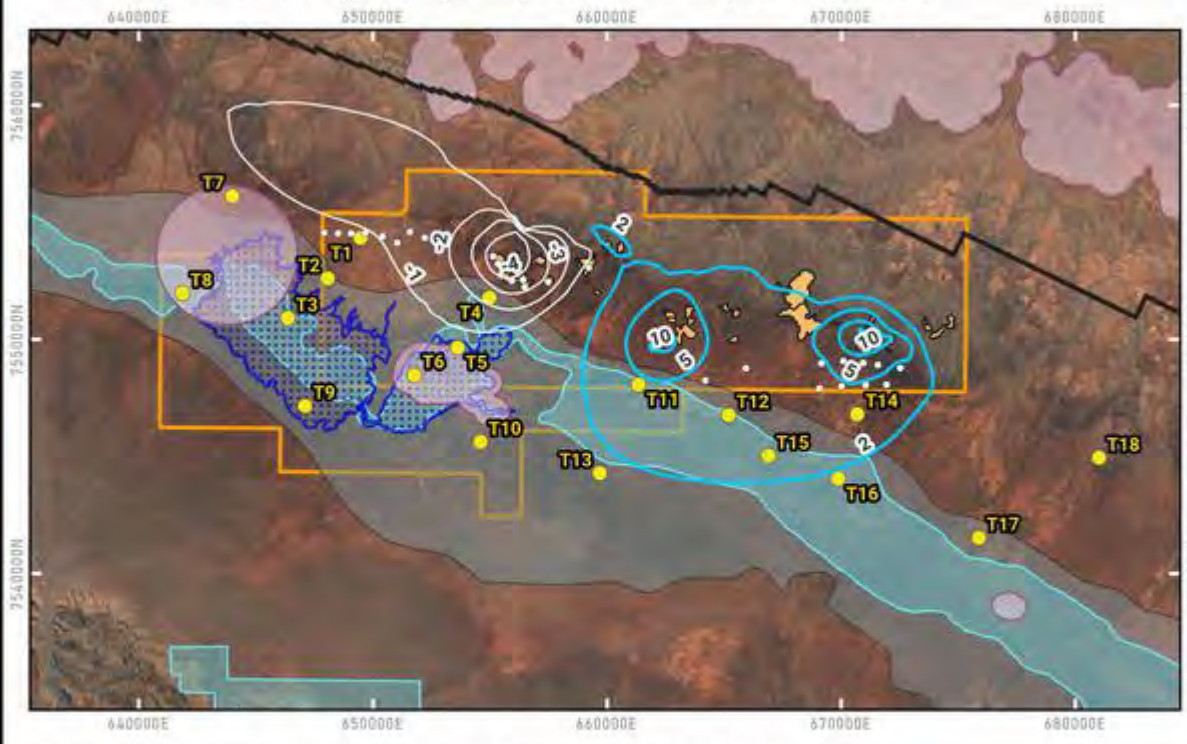
10/11/2024

Legend

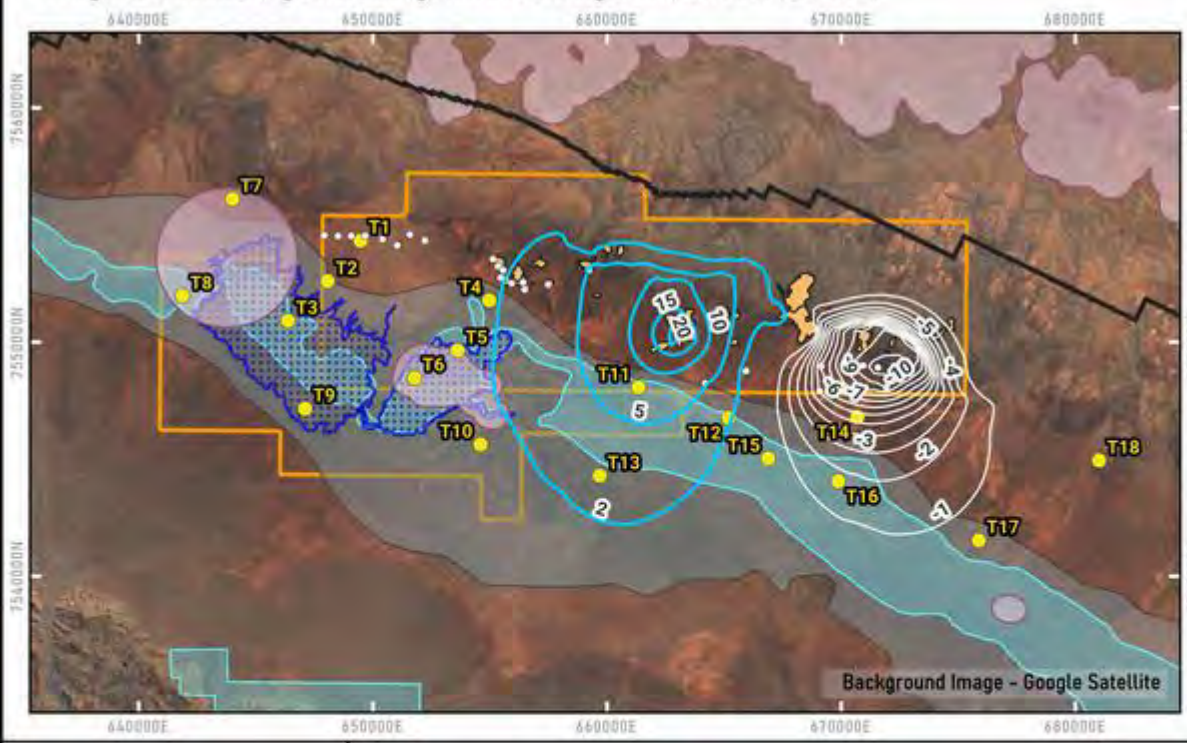
- Proposed Pit Footprint (MDE_LOM_20)
- Environmentally Sensitive Areas (DWER-046)
- Priority Ecological Community (PEC) Boundary
- Potential Claypan Inundation Area
- Simulated MAR Bore
- Model Boundary
- Drawdown (m)
- Mounding (m)
- Simulated Observation Points
- Mungurrdu

Figure 7-36: Predicted drawdown and mounding for July 2035 and July 2038 (AQ2 2024a)

End of Horseshoe Dewatering & Murray's Hill (MH) / Anticline Hill (AH) MAR (Jul 2035)



Fridge West Dewatering Before Fridge Hill Dewatering & MH / AH MAR (Jul 2038)



N

0 5 10 km

GDA94 / MGA zone 50

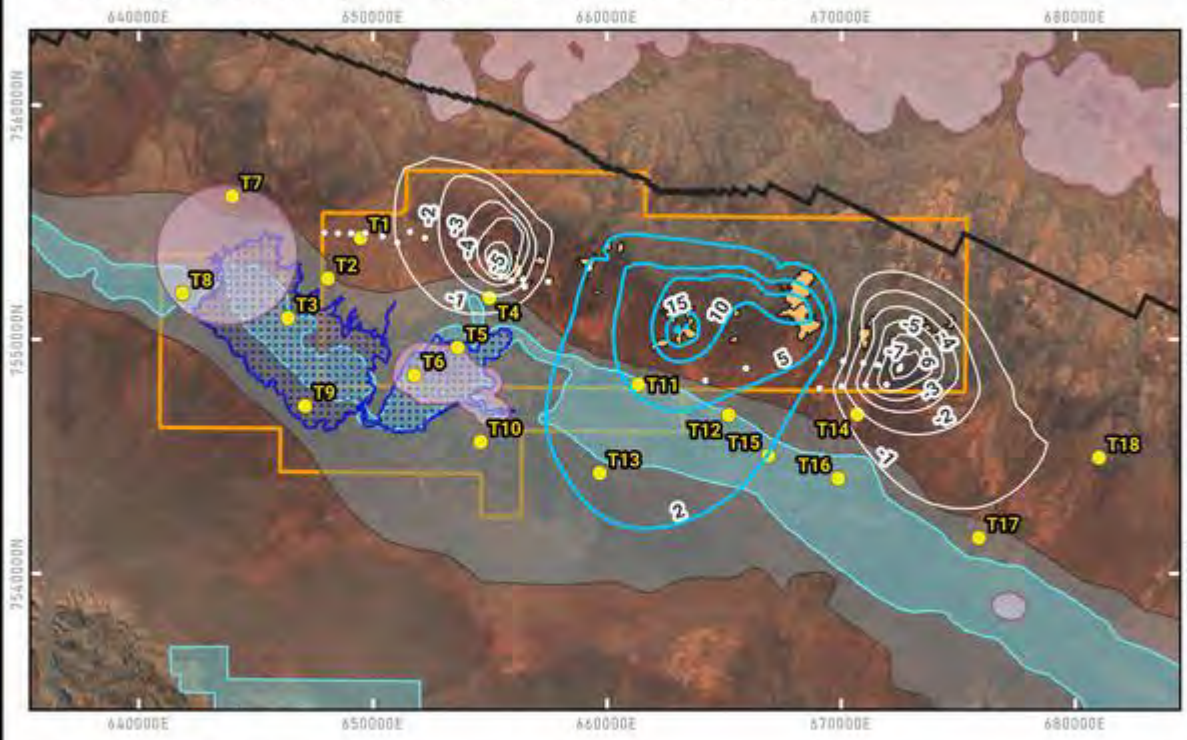
10/11/2024

Legend

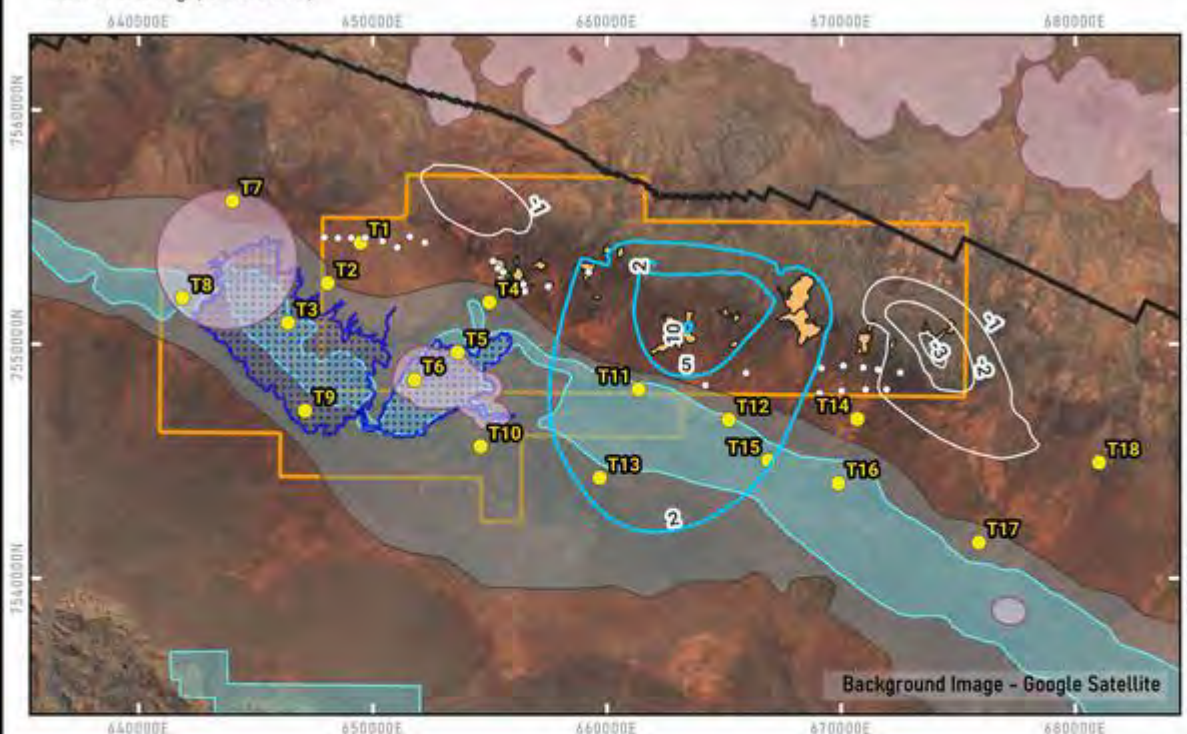
- Proposed Pit Footprint (MDE_LOM_20)
- Environmentally Sensitive Areas (DWER-046)
- Priority Ecological Community (PEC) Boundary
- Potential Claypan Inundation Area
- Simulated MAR Bore
- Model Boundary
- Drawdown (m)
- Mounding (m)
- Simulated Observation Points
- Mungurrdu

Figure 7-37: Predicted groundwater drawdown and mounding for July 2041 and July 2042 (AQ2 2024a)

End of Fridge Hill Dewatering & Murray's Hill / Anticline Hill MAR (Jul 2041)



End of Mining (June 2042)



N

0 5 10 km

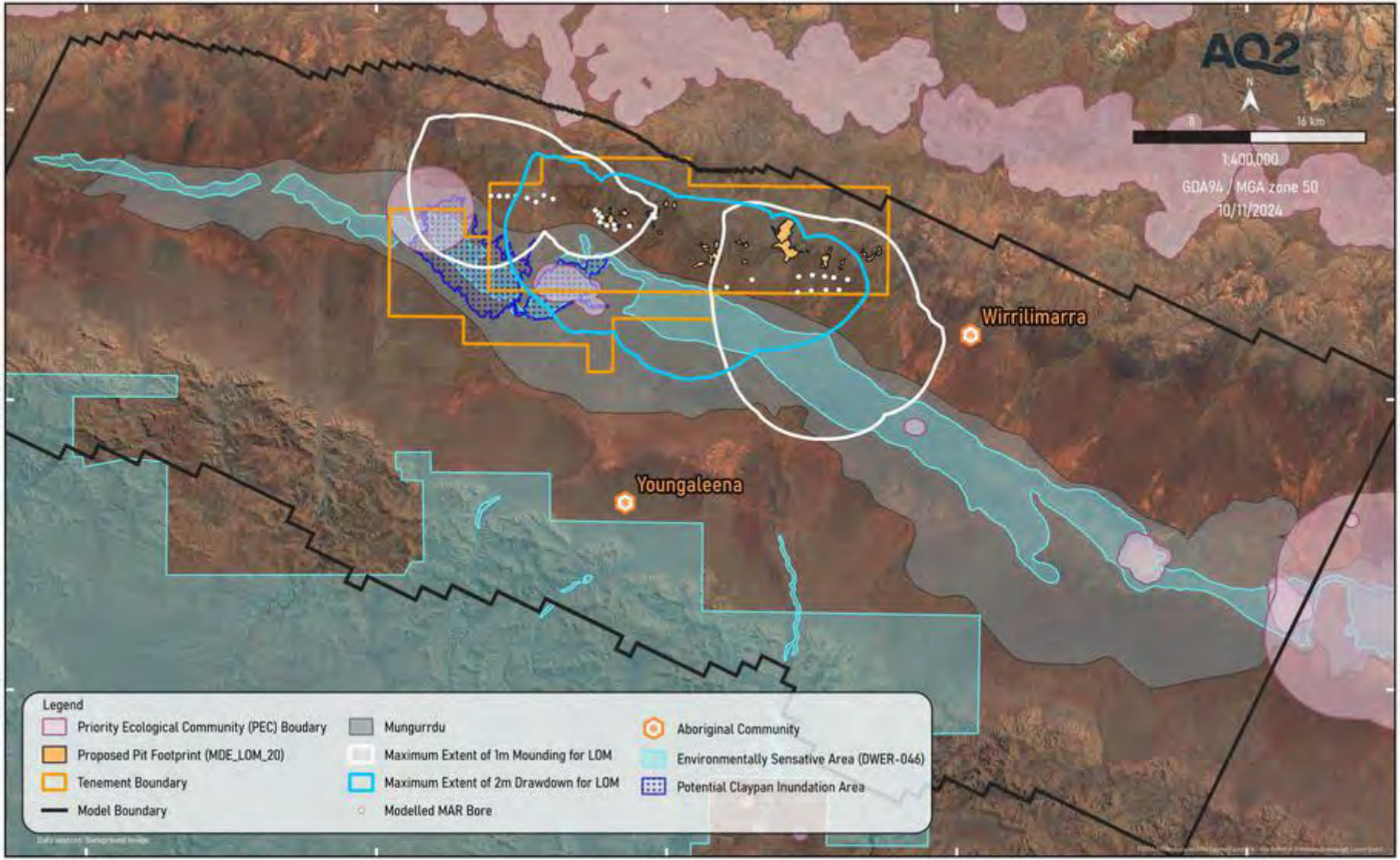
GDA94 / MGA zone 50

10/11/2024

Legend

- Proposed Pit Footprint (MDE_LOM_20)
- Environmentally Sensitive Areas (DWER-046)
- Priority Ecological Community (PEC) Boundary
- Potential Claypan Inundation Area
- Simulated MAR Bore
- Model Boundary
- Drawdown (m)
- Mounding (m)
- Simulated Observation Points
- Mungurrdu

Figure 7-38: Maximum extent of predicted drawdown and mounding throughout LOM (AQ2 2024a)


620040E
640042E
660043E
680044E
700045E
7560491N
7540489N
7520488N
AQ2
N
0
16 km
1:400,000
GDA94 / MGA zone 50
10/11/2024
Wirrilimarra
Youngaleena
Legend
Priority Ecological Community (PEC) Boudary
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
Model Boundary
Mungurrdu
Maximum Extent of 1m Mounding for LOM
Maximum Extent of 2m Drawdown for LOM
Modelled MAR Bore
Aboriginal Community
Environmentally Sensative Area (DWER-046)
Potential Claypan Inundation Area

Changes to Groundwater Salinity

Groundwater across the Development Envelope and the surrounding area ranges from fresh (180 mg/L TDS) in the upper reaches of the groundwater system, to saline (18,000 mg/L TDS) across the valley area, with salinity profiling data confirming saline groundwater originating from the claypans and extending along the valley as well as beneath the orebodies closest to the claypans (although the mining of these orebodies is not part of the proposed mine plan).

The numerical model was used to simulate changes in groundwater salinity resulting from dewatering and MAR. The predicted TDS of the combined dewatering discharge for all dewatering bores over the LoM varies between 1,700 and 4,200 mg/L. This represents the TDS concentrations that were then assigned to all MAR bores over the LoM. It is assumed that there will be no increase in the salinity of the re-injected water resulting from evapoconcentration as, for the rates being considered, only limited storage (i.e., less than a week) would be feasible based on the required dewatering rates (AQ2 2024a).

7.5.2 Indirect impacts

7.5.2.1 Surface Water

Potential indirect impacts to surface water include changes to physical and chemical water quality through:

- Leaks or spills from mine operations including vehicles, stored fuels, chemicals and hydrocarbons;
- Acid mine drainage (AMD) leachate seepage from the WRD and to a lesser extent the RoM; and
- Saline water runoff (dust suppression), saline pipeline leaks/failure.

Modification of the chemical water quality (for example hydrocarbon pollution, seepage from WRDs) may result in contamination of local waterways and the Fortescue Valley.

Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur.

Use of saline water for the suppression of dust during construction and operations of the mine can result in increased surface water salinity entering into the receiving environment (creeklines, claypans, pools and floodplain). There is also the potential for pipeline failure resulting in release of saline water into receiving environment, including vegetation.

7.5.2.2 Groundwater

Potential indirect impacts to groundwater include:

- Contamination through:
  - Spills and accidental discharges of stored materials (oils, fuels etc);
  - Leaching contaminants or acid mine drainage from WRDs or RoM and/or onsite landfill.
- Impacts on other groundwater users through reduction in quantity or quality of groundwater available.

Contamination of groundwater

During construction and operation, the Proposal has the potential to contaminate groundwater due to storage and handling of hazardous materials and hydrocarbons and WRDs which may result in leaching of acidic or soluble metals or salts into groundwater.

Other Groundwater Users

Existing groundwater users in the vicinity of the Proposal include the Mulga Downs Station, Hooley Station and Mt Florance Station (for stock water). The key groundwater quality criterion for maintaining the current beneficial use is based on the drinking water requirements for livestock (beef cattle).

More regionally, other groundwater users in the vicinity of the Proposal include the Wirrilimarra and Youngaleena Aboriginal Communities.

From ecohydrological studies conducted to date in the vicinity of the claypans, the vegetation in that area is not considered to be groundwater dependent (AQ2 2025).

In addition, water is a key aspect to be considered in terms of traditional cultural heritage and assessment of impacts on social surroundings in **Section 14.**

7.5.2.3 Other Environmental Values

Impacts on inland waters from changes in hydrological and hydrological regimes and water quality can have indirect impacts on other environmental values including:

- Surface water dependent vegetation (i.e., sheetflow), riparian vegetation, and associated fauna habitat (**Section 8** and **10**), and
- Subterranean fauna: troglofauna and stygofauna (discussed in **Section 8**).

7.5.3 Cumulative Impacts

The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:

- Changes in surface hydrological regimes.
- Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR).

Cumulative impacts are discussed in **Section 17**.

7.6 Mitigation

The hierarchy of impact management has been adopted and implemented for the Proposal by HPPL in relation to this environmental factor as outlined in **Table 7-11.**

Table 7-11: Mitigation Measures for Inland waters

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts			
Modifications to the existing hydrological regime	Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal.	• The Water Management Plan will be implemented (**Appendix 6**) • Surface water management during construction, mining and closure will be designed to minimise adverse impacts on the natural function and environmental value of watercourses, water quality and sheet flow downstream of the mine area. • Adherence to permit requirements under the RiWI Act.	• Implement the monitoring as outlined in the Water Management Plan (**Appendix 6**) • Implement the approved Mine Closure Plan. Temporary infrastructure will be removed and natural flow paths, and catchments, reestablished in these areas.
Modification of surface water quality	Divert surface water flows away from mining areas to avoid the potential for contamination. Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal	• The Water Management Plan will be implemented (**Appendix 6**)	• Implement the monitoring as outlined in the Water Management Plan (**Appendix 6**) • Implement the approved Mine Closure Plan.
Changes to groundwater levels	Mining will be scheduled so that operational water demand can be supplied from mine dewatering; avoiding the need for a non-potable water supply borefield Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal	• Implement the Water Management Plan (**Appendix 6**) • Pit optimisation and mine planning to reduce dewatering and MAR required. • Maximise use of abstracted water for mine processes prior to MAR. • Adherence to permit requirements under the RiWI Act.	• Monitoring of groundwater water levels in accordance with the Water Management Plan **(Appendix 6)** • Implement the approved Mine Closure Plan.

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Changes in groundwater salinity	Complete avoidance is not possible for this Proposal with minimisation then being the key measure.	• The Water Management Plan will be implemented (**Appendix 6**)	• Monitoring of groundwater quality in accordance with the Water Management Plan **(Appendix 6).** • Implement the approved Mine Closure Plan.
Indirect Impacts			
Contamination of surface water	Avoidance is not possible for this Proposal with minimisation then being the key measure.	• Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Spills and leaks will be cleaned up in accordance with HPPL procedures. • The Water Management Plan will be implemented (**Appendix 6**) • If encountered during mining, encapsulate PAF materials within the larger WRL structures. • Construct WRD with appropriate seepage and leachate control structures. • Separate contaminated water runoff (from mine areas).	• Monitoring of surface water quality in accordance with the WMP. • Waste dumps and TSFs at closure will be rehabilitated to ensure they are stable, revegetated and non-polluting, in accordance with relevant approvals obtained under the EP Act Part V, Part IV, Mining Act and EPBC Act. • Remove infrastructure on closure.
Contamination of groundwater	Avoidance of mining the JER and NAM geological units which contain higher sulphur levels.	• Implement management actions in accordance with the Water Management Plan **(Appendix 6)**. • Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Spills and leaks will be cleaned up in accordance with HPPL procedures. • If encountered during mining, encapsulate PAF materials within the larger WRL structures.	• Monitoring of groundwater quality in accordance with the Water Management Plan. • Waste dumps and TSFs at closure will be rehabilitated to ensure they are stable and revegetated and non-polluting, in accordance with relevant approvals obtained under the EP Act Part V, Part IV, Mining Act and EPBC Act.’

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
		• Construct WRD with appropriate seepage and leachate control structures. • Storage, handling, and disposal of hazardous substances in accordance with internal procedures.	
Impacts on other groundwater users	Minimisation is considered to be the key measure to minimise impacts to other groundwater users.	• Implement management actions in accordance with the Water Management Plan **(Appendix 6)** • Ongoing consultation with other groundwater users.	• Monitoring of groundwater levels and groundwater quality in accordance with the Water Management Plan **(Appendix 6)**

7.7 Assessment and Significance of Residual Impacts

An assessment of the significance of residual impacts to Inland Waters as a result of the Proposal is addressed in this section. The assessment of potential impacts from mining operations, dewatering and MAR on other factors is also addressed under the relevant factor, e.g. impacts on riparian vegetation in flora and vegetation (**Section 8**), impacts to social surroundings (**Section 14**) and impacts on subterranean fauna habitat (**Section 8**).

7.7.1 Direct Impacts

7.7.1.1 Surface Water

Modification of Existing Hydrological Regimes

The residual risks of the Proposal to the hydrological environment were assessed taking into account the proposed mitigation measures and the results of the flood modelling and claypan water balance modelling. The residual risks were generally considered to be low.

A Water Management Plan (**Appendix 6**) has been prepared and provides additional information on the surface water management measures proposed, including proposed management infrastructure. The proposed management infrastructure and resulting surface water flow are shown in **Figure 7-34**.

The potential footprints of the Surface Water Containment Areas (covering the pits, waste rock dumps, ore handling plants, borrow pits, and stockpiles) extend across approximately 20 km^2 within the claypan catchments. To prevent the impact of potentially sediment laden runoff from these areas impacting the downstream environment, any rainfall across these footprints will be initially contained and be prevented from contributing flows to the downstream environment. These footprints represent approximately 10% of the assumed total catchment area estimated for the Gnalka Gnoona claypan and 2% of the combined Gnalka Gnoona and Koodjeepindarranna claypan catchment area (1,033 km^2 total catchment area (AQ2 2024a)). Water balance model predictions of the claypan water levels indicate that the potential reduction in claypan catchment areas result in only a negligible reduction on the hydroperiod (in the order of days) and water levels of the claypans (between nil to 0.022 m) (AQ2 2024a).

Although the surface water diversions aim to return the water back to the downstream surface water drainage line, the diversions do change the distribution of surface water flows in the Fortescue Valley, particularly in the area immediately to the south of Fridge pits, Murray's Hill and Horseshoe West pits. Difference mapping of Baseline and LoM maximum water depth model predictions are shown in AQ2 2024; Appendix D) for the design rainfall events. In terms of potential impact to vegetation communities, the changes to the more frequent event flood depths (such as the 63% and 50% AEP events) are more important than the changes to the 1% AEP event given the distribution of vegetation is correlated to the inundation patterns in smaller, more regular runoff events.

The 50% AEP flood difference map indicates that a reduction in maximum flood depths of up to 0.2 m is predicted to occur in the valley ponding areas which are located south of the Fridge pits, which is related to the diversion of a large catchment to the west of Fridge Hill Pit. The most extensive area of water level reduction is located to the south of Fridge West. Some larger reduction in flood depths is predicted in localised areas within the model which represent drainage lines that have had flow diverted around them due to the proposed mine

development. Conversely, the diversion of runoff around the disturbance footprints is predicted to cause an increase in water depths along the diversions and in the Fortescue Valley immediately downstream of the diversion. Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. The most extensive area of increased ponding within the Fortescue Valley is caused by the diversion between Fridge Hill and Horseshoe West areas.

Water shadowing downstream of linear infrastructure (e.g. roads) is minimal due to the preliminary locations selected for the proposed culverts as captured in the model, which allow flows to continue downstream of the infrastructure. The modelling predicts only localised impacts on surface water inundation depths upstream and downstream of roads, with the largest impact at locations where culverts haven't been considered to date (AQ2 2024a). The predicted impacts to key environmental assets as identified in AQ2 as a result of changes to hydrological regimes is as follows:

- The claypan water balance quantified impacts to the claypans during a small, medium and a large inundation event. The impacts are considered negligible and are summarised as follows:
    - Reductions in claypan water level were predicted to range between nil to 0.022 m. Note that the water levels in the Koodjeepindarranna Claypan were only impacted if the water level in the Gnalka Gnoona Claypan exceeded the height of the divide between the two claypans (402.9 mRL)
    - Inundation duration was predicted to decrease in the order of days for large and medium events, with negligible change in inundation duration predicted for the small events.
    - Only a marginal change in TDS between the model scenarios.
    - The Ebathcalby claypan, as it is located about 9 km south of the eastern margin of R47/12. It is unlikely to be impacted by runoff from the Proposal, as its elevation is approximately 5 m higher than the base of the Fortescue Valley below the Development Envelope (AQ2 2024a).
- Millstream National Park is located more than 100 km west of the Development Envelope and will not be impacted.
- As shown in Figure 2.14, surface water flows from Karijini National Park are towards the Fortescue River so there is no mechanism or pathway for modified surface waters as a result of the Proposal to impact the National Park.

Modification of the Physical Water Quality

Surface water runoff in the region naturally has a high sediment load given the high velocity of runoff from intense storms or cyclonic activity. Disturbed material resulting from construction and/or mining activities and areas where vegetation cover has been removed may increase the volume of sediment available to be mobilised during these events. Where practicable, natural runoff will be diverted around operating areas, thereby limiting the volume of water required to be treated before being released to the natural environment. Where diversion of larger drainage channels is required, the design will aim to incorporate geomorphic design principles such that the natural sediment transport through the channel is maintained and the structure itself does not become a sediment source. Surface water management measures will be undertaken to capture and minimise sediment runoff to undisturbed areas and drainage lines where practicable, such as using bunding and other drainage features such as silt traps and sediment basins.

The residual risks to the physical quality of surface water have been rated Low AQ2 2024). The Water Management Plan (**Appendix 6**) outlines the management measures to manage sediment transport, with the key management measurements summarised in the preceding section of this report.

The surface water mitigation measures as outlined in the Water Management Plan (**Appendix 6**) are anticipated to reduce all of the surface water risks identified for the Proposal to Low (AQ2 2024a).

7.7.1.2 Groundwater

Change in Groundwater Levels

Without management practices in place, there is the potential for detrimental environmental impacts resulting from changes to groundwater levels and / or quality because of the mining activities (in particular dewatering and MAR). The overarching groundwater management strategy is therefore to:

- Minimise impact to the current beneficial use of the groundwater.
- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e. subterranean fauna); this includes minimising the extent of groundwater level changes.
- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

From the numerical modelling conducted to date, the groundwater drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along strike (i.e., in a northwest – southeast direction) is curtailed by MAR. Due to the progressive approach to the mining , the maximum extent of the 2 m drawdown occurs in different directions at different times. The maximum extent of the predicted 2 m drawdown contour, from the mining areas, extends ~6 km to the west, ~3.5 km to the east and ~8 km to the south across the majority of the valley's width; however, it is not predicted to reach the Hamersley Range or Karijini National Park.

The maximum extent of the predicted 1 m mounding contour associated with the Fridge / Horseshoe South MAR Borefield extends ~10 km to the south (across the valley) and ~5 km beyond the Mulga East tenement boundary, in a southeasterly direction. The maximum extent of the 1 m mounding contour associated with the Murray's West MAR Borefield is predicted to extend ~7 km to the northwest (along strike) and ~5 to 5.5 km to the south and southwest (across the valley), in the vicinity of the Koodjeepindarranna Claypan.

As ecohydrological studies to date have found that the vegetation is disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. A lowered water table would increase the thickness of unsaturated sediments, which may slightly reduce the responsiveness of the aquifer to recharge events. However, these sediments are not considered to be accessible to plant root systems.

Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl. If water levels rise above this threshold for prolonged periods, vegetation stress is predicted. Although the predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LOM, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at

the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time. Impacts to flora and vegetation are further discussed in **Section 8**. Upon the reduction / cessation of dewatering and MAR, groundwater level recovery will occur. Modelling indicates that he majority of groundwater level recovery occurs during the LoM, as the maximum depths of mining are reached prior to the end of mining. In particular, the western areas of Murray's Hill and Anticline Hill, which are mined (and dewatered) first and subsequently used for MAR have predicted water levels near to pre-mining water levels at the end of the LoM (i.e., at mine closure). The modelling indicates a rapid recovery of groundwater levels post-mining. Groundwater levels are predicted to recover to within 0.1 m of pre-mining level within 10 years after the cessation of mining, at all mining areas, MAR areas and regional simulated observation points (AQ2 2024a).

The groundwater modelling and assessment was subject to peer review in 2023. The review concluded that the modelling and assessment has been conducted competently and justifiably consistent with best practice methods (HydroGeoLogic 2023**; Appendix 7b**).

Groundwater drawdown and mounding will affect subterranean fauna and this is discussed further in **Section 7.**

Ongoing monitoring of groundwater levels will be undertaken as outlined in the Water Management Plan (**Appendix 6**).

Changes to Groundwater Quality

Groundwater salinity across the Development Envelope and surrounds ranges from fresh (180 mg/L as TDS) to saline (18,000 mg/L as TDS). Higher groundwater salinity is associated with groundwater beneath the claypans in the Fortescue Valley, while lower groundwater salinity is associated with the fractured rock aquifers on the Chichester Range, around the proposed mine pit areas. Groundwater salinity contours are also illustrated in the hydrogeological cross sections (**Figure 7-13** to **Figure 7-16**).

Groundwater salinity will change as a result of dewatering and MAR activities. The predicted TDS of the combined dewatering discharge for all dewatering bores over the LoM is varies between 1,700 and 4,200 mg/L. This represents the TDS concentrations that were then assigned to all simulated MAR bores over the LoM. It is assumed that there will be no increase in the salinity of the re-injected water resulting from evapoconcentration, as for the rates being considered, only limited storage (i.e., less than a week) would be feasible based on the required dewatering rates.

The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). This is demonstrated by both the simulated groundwater flow paths for the LoM and predicted salinity changes at the simulated observation points. Model predictions indicate that the key driver for groundwater salinity change is the proposed dewatering at Murray's Hill. This is predicted to result in increases to the dewatering discharge salinity as more saline water is drawn in from the valley areas. The subsequent re-injection of this more saline dewatering discharge into the Murray's West and Fridge / Horseshoe South MAR Borefields results in localised areas of increased groundwater salinity as well as subsequent increases to the combined dewatering discharge, as the re-injected water in the east is recirculated towards the Fridge West and Fridge Hill mining areas later in the LoM.

Taking into account the uncertainty associated with aquifer porosity, the greatest changes in salinity outside of the mining areas are predicted in three areas:

- In the Murray's West MAR Borefield area, the TDS is predicted to increase from ~1,200 mg/L to between ~3,600 and 4,700 mg/L (for high and low porosity scenarios), recovering to between ~2,700 and 3,500 mg/L, upon the cessation of MAR in this area and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.
- Down-slope from the Murray's Hill mining / MAR area, the TDS is predicted to increase from ~3,600 mg/L to between 4,400 and 5,600 mg/L (for high and low porosity scenarios), potentially exceeding the tolerance limit for cattle (i.e., 5000 mg/L). However, when the Murray's Hill / Anticline area is used for MAR, the TDS is predicted to reduce, reaching between ~3,300 and 4,300 mg/L by the end of mining.
- Down-slope from the Fridge / Horseshoe South MAR Borefield, the TDS is predicted to increase from ~2,300 mg/L to between 2,400 and 3,900 mg/L (for high and low porosity scenarios), with TDS at the end of mining predicted to range between 2,300 and 3,700 mg/L.Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM.

The excavation and exposure of PAF materials in the pit walls is not anticipated and groundwater contamination from other potential sources such as waste rock dumps or spills is anticipated to be low risk, being managed by on-going monitoring and adaptive management. Furthermore, the risk of re-injection water becoming acidic or contaminated is low as this water will be sourced predominantly from ex-pit dewatering bores on the southern, down-dip side of the pits, rather than in-pit sump pumping.

HPPL will back fill the pit voids to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided which eliminates any post-mining increases in groundwater salinity caused by evaporation from the pit lake surfaces. No modelling of post-mining groundwater quality has been conducted to date; however, it is anticipated that the return of the groundwater salinity distribution to pre-mining conditions will take considerably longer (i.e., geological times scales) to achieve than the recovery of groundwater levels (AQ2 2024a).

Surveys and assessments undertaken to identify the subterranean fauna values across the Proposal (Bennelongia, 2024) indicate stygofauna are present in areas of both fresh and saline groundwater (up to ~18,000 µS/cm EC). **Section 8** provides further information on the predicted salinity ranges and tolerances of subterranean fauna taxa found within the Development Envelope.

7.7.2 Indirect Impacts

7.7.2.1 Surface Water

Contamination of surface water

During construction and operation, the Proposal has the potential to contaminate surface water due to storage and handling of hazardous materials, hydrocarbons, and waste. Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur. Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate the risk of contamination from these sources.

To mitigate the risk of AMD impacts to soil, surface water and groundwater, HPPL has purposely designed the mining pits to exclude basal Nammuldi Member subunits and Roy Hill Shale. Waste material characterisation conducted to date shows elevated sulfur material at depth within these units, posing the highest AMD

generation risk. Excluding these material types notably lowers the risk of AMD from waste rock dumps, in-pit backfill, exposed mine pit walls, ore on RoM pads and low-grade ore stockpiles.

The majority of waste material 95% is classified as non acid forming (NAF) with less than 1% being classified as potentially acid forming (PAF) by a very conservative measure. Any probability that significantly acid generating material will occur in waste material stored in landforms or backfilled below water table has been almost completely avoided. Waste management of any PAF encountered during mining will consider the placement of the material into discrete cells that can be isolated within waste rock to limit acid generation. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low. This is an established approach to effectively manage PAF and prevent acid mine drainage. Leachate pH is a primary control on contaminant solubility. Under the neutral pH conditions expected for most of the waste rock, leaching is expected be limited and the risk of metalliferous drainage is low.

Pipelines transferring saline water will be routinely inspected for operability and maintenance. Saline pipelines will also be bunded or equipped with telemetry or pressure sensors to identify leaks or pipeline failures to allow for immediate response. Indirect impacts can be managed by application of the Water Management Plan (**Appendix 6**) and through conditions of the Mining Proposal under the *Mining Act 1978*.

7.7.2.2 Groundwater

Contamination of groundwater

Groundwater contamination from potential sources such as the WRD landforms or spills will be considered and managed. HPPL has purposely designed the mining pits to exclude basal Nammuldi Member subunits and Roy Hill Shale. Waste material characterisation conducted to date shows elevated sulfur material at depth within these units, posing the highest AMD generation risk. Excluding these material types notably lowers the risk of AMD from waste rock dumps, in-pit backfill, exposed mine pit walls, ore on RoM pads and low-grade ore stockpiles.

Waste rock generated by the Proposal will be stored in waste dumps and used to backfill pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process. From the studies undertaken, PAF classed material was found to be a very low proportion - approximately 1% of the waste material to be managed. If PAF is encountered during mining, waste management will consider the placement of PAF material into discrete PAF cells that can be isolated within waste rock to limit acid generation. This will allow for the control of acid mobilisation and solute release from these materials into groundwater (SRK 2024).

Mitigation of potential groundwater related impacts are proposed through the Water Management Plan (**Appendix 6**), which includes trigger and threshold levels.

Upstream and downstream groundwater quality triggers and thresholds have been proposed to assess impacts to groundwater attributed to the proposed WRD landforms. These facilities will be constructed such that they are stable, non-polluting landforms in accordance with relevant approvals obtained under the EP Act, Mining Act and EPBC Act.

Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate any associated risk of contamination.

Impacts on other groundwater users

Other groundwater users in the vicinity of the Proposal include pastoral stations as well as the Wirrilimarra and Youngaleena Communities.

The potable water supply bores for the Wirrilimarra and Youngaleena Communities are located outside of the predicted maximum extent of the 1 m draw-up and 2 m drawdown contours and the predicted injection zones. It is therefore not anticipated that either the quantity or quality of the Community water supplies will be affected by the proposed dewatering and MAR activities (AQ2 2024a). However, should the water supplies be unduly impacted, an alternative supply will be provided.

Throughout the planning of the Proposal HPPL have been actively engaged in stakeholder consultation. As part of engagement the draft Water Management Plan has been provided to the Native Title holders as part of the referral package for review. The Water Management Plan has been developed to management any potential impacts and ensure no significant impacts to sites of cultural significance (**Appendix 6**).

The potential for indirect impacts to groundwater in use by the pastoral stations of Mt Florance, Hooley and Mulga Downs for stock drinking water has been considered. The groundwater within the predicted area of impact is only used for stock water and the key groundwater quality criterion for maintaining the current beneficial use is based on the drinking water requirements for livestock (cattle). Drinking water guidelines for beef cattle indicate a tolerance limit of 5,000 mg/L TDS (ANZECC & ARMCANZ, 2000), therefore where shallow groundwater is currently within this limit, the intent is to minimise the impact on this zone. The groundwater quality in the vicinity of the pastoral bores will be monitored and basic groundwater will be measured against the ANZEEC & ARMCANZ (2000) Livestock Drinking Water Guidelines (**Appendix 6**). Should the livestock water supplies be unduly impacted by changes to groundwater quality and / or groundwater levels, an alternative supply will be provided.

A detailed discussion of the proposed management measures is provided in the Water Management Plan (**Appendix 6**), with key management measures summarised below:

- Surplus water managed via MAR (i.e. via re-injection bores, repurposed dewatering bores and / or in-pit infiltration) to:
    - Limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater).
    - Limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.
- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes.

- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

7.8 Significant Residual Impact

The residual impacts of the Proposal to Inland Waters are not considered significant. HPPL therefore considers the Proposal can be managed to meet the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

7.9 Environmental Outcomes

Based on the studies and investigations undertaken to date, the potential direct, indirect and cumulative impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objective (**Section 7.1**) and guidance (**Section 7.2**) for inland waters as outlined in **Table 7-12.**

Table 7-12: Environmental Outcomes for Inland Waters

Potential impact	Environmental Outcome
Direct impacts	
Modifications to hydrological processes	A) Water depth increases of up to 0.3 m are predicted in some areas of valley floor ponding. Water depth reductions of up to 0.2 m are predicted in some areas of valley floor ponding. B) No significant impacts to key environmental assets (including the claypans) are predicted. C) Groundwater drawdown and catchment area modifications are not predicted to materially impact on the key ecohydrological receptors. D) The potential indirect impacts on claypans within the vicinity of the Development Envelope are not considered significant.
Changes to surface water quality	• The residual risks to the physical quality of surface water have been rated Low. • Potential changes to surface water quality will be managed in accordance with the Water Management Plan.
Change to groundwater levels	• Potential changes to groundwater levels will be managed to ensure that mounding is maintained beneath root zones of vegetation. • Managed in accordance with the Water Management Plan.
Changes to groundwater salinity	1. Changes (and extent of changes) to groundwater salinity resulting from dewatering and MAR are predicted to be minor with respect to beneficial use.
Indirect impacts	
Contamination of surface water	2. Potential contamination of surface water will be managed in accordance with the MCP and Water Management Plan.
Contamination of groundwater	3. Potential contamination of groundwater will be managed in accordance with the Mine Closure Plan and Water Management Plan.

8 Subterranean Fauna

8.1 EPA Objective

The EPA's objective for the environmental factor Subterranean Fauna is:

"To protect subterranean fauna so that biological diversity and ecological integrity are maintained" (EPA 2016a).

Subterranean fauna are fauna which live in underground environments. This includes fauna which inhabit the terrestrial realm (hypogean) and are referred to as troglofauna, and fauna which inhabit the groundwater and are referred to as stygofauna. The subterranean communities are composite and encompass species which are at different stages adapted to underground environments. They can be classified as stygoxene or trogloxenes (temporary inhabitants), stygophile or troglophile (strong hypogean affinities) or stygobites and troglobite (obligatory hypogean) (Gibert and Deharveng 2002).

For the purposes of EIA, subterranean fauna is defined as fauna that live their entire lives (obligate) below the surface of the earth (EPA 2016; 2021a).

8.2 Policy and Guidance

In addition to the policy and guidance outlined in Section 4.1, specific policy and guidance relevant to the key environmental factor Subterranean Fauna which have informed the planning for the Proposal are listed in Table 8-1.

HPPL has specifically considered these guidance documents in the following ways:

Surveys and analyses undertaken to describe the receiving environment and its significance;

Identification of activities which may lead to impacts to Subterranean Fauna; and

Application of the mitigation hierarchy in elements of Proposal design.

Table 8-1: Subterranean Fauna Policy and Guidance

Reference	Title	How Policy and Guidance have been considered
EPA 2016a	Environmental Factor Guideline: Subterranean Fauna	Documents were applied when planning and undertaking the subterranean fauna surveys for this Proposal. This document also provided guidance on the identification of activities which may lead to impacts to subterranean fauna.
EPA 2021i	Technical Guidance – Subterranean Fauna Surveys for Environmental Impact Assessment	
EPA 2012	A review of subterranean fauna assessment in Western Australia. Discussion Paper.	This document provides guidance on the current state of knowledge on subterranean fauna for the purpose of EIA. It presents different approaches and direction for future assessment.
Government of Western Australia (GoWA) 2011	WA Environmental Offsets Policy	The offset policy and guidelines have been considered in relation to the definition of significant residual impacts and the proposed offset strategy.
GoWA 2014	WA Environmental Offsets Guidelines	

Specific additional work required for assessment of the Proposal, relating to Subterranean Fauna, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in Table ES 4) are considered in this section.

8.3 Receiving environment

The following sections describe the key features of the receiving environment in relation to Subterranean Fauna, including details of the surveys and studies undertaken to support the Proposal.

8.3.1 Relevant Studies

A summary of the subterranean fauna studies undertaken for the Proposal and surrounding area is provided in (Table 8-2). The assessment of potential impacts on subterranean fauna resulting from implementation of the Proposal draws on the information from these studies.

Table 8-2: Subterranean fauna studies undertaken to inform the Proposal

Reference	Title	Survey/Study Type and Area	Guidance
Strategen-JBS&G 2021	Subterranean Fauna – Preliminary Impact Assessment.	Preliminary Impact Assessment to demonstrate the limited impact of the MEIOP on subterranean fauna. Unpublished report to Roy Hill Iron Ore Pty Ltd, 25th June 2021	Environmental Factor Guideline: Subterranean fauna (EPA 2016c) Technical Guidance – Sampling methods for subterranean fauna (EPA 2007)
Bennelongia (BEC) 2019 Appendix 8a	Mulga East Subterranean Fauna Desktop	Desktop study on the subterranean fauna data for the Mulga East Iron Ore Project. Incorporates the findings of previous surveys: ecologia 2011. Murray Hill Troglofauna Survey Phoenix 2013. Subterranean fauna survey of the Mulga Downs Project Bennelongia 2014. Mulga Downs Project Troglofauna Assessment – Letter	Technical Guidance – Sampling methods for subterranean fauna (EPA 2007) Technical Guidance – Subterranean Fauna Surveys (EPA 2013)
Bennelongia (BEC) 2021 Appendix 8b	Mulga East Subterranean Fauna Baseline Survey	Report detailing the results of the baseline survey completed in 2019 and 2020.	Environmental Factor Guideline: Subterranean fauna (EPA 2016c) Technical Guidance – Sampling methods for subterranean fauna (EPA 2007) Technical Guidance – Subterranean Fauna Surveys (EPA 2013)
AQ2 2024b Appendix 9	Mulga Downs Iron Ore Mine: Troglofauna habitat assessment. Memo 171Y_505b.	Troglofauna Habitat assessment and model development using 3D Leapfrog modelling software. This study incorporates an initial assessment of potential troglofauna habitat compiled from drill hole logs (Strategen-JBS&G 2021).	Technical Guidance –Subterranean fauna surveys for environmental impact assessment (EPA 2021)

Reference	Title	Survey/Study Type and Area	Guidance
	Mulga Downs Iron Ore Mine: Stygofauna habitat assessment. Memo 171Y_508c	Stygofauna Habitat assessment and model development using 3D Leapfrog modelling software. This study incorporates stygofauna sampling data competed for the mine.	
Bennelongia (BEC) 2024a Appendix 26	Mulga Downs Iron Ore Mine: Subterranean Fauna Survey 2019-2024. Report 595.	Detailed (2019-2022) and targeted (2023-2024) survey. Report compiles and assesses all the data to date. Molecular analyses undertaken on up to 188 specimens.	Environmental Factor Guideline: Subterranean fauna (EPA 2016c) Technical Guidance –Subterranean fauna surveys for environmental impact assessment (EPA 2021)
		Targeted subterranean fauna survey November 2023 to January 2024. Intense 3 months survey targeting restricted taxa anincreased sampling of regional areas (reference sites).	
Bennelongia (BEC) 2024b Appendix 22	Memo 675: Salinity tolerance of stygofauna at Mulga Downs Iron Ore Mine	Information on the likely upper salinity tolerances of a selection of restricted stygofauna which occur in MDIOM.	
Biologic 2025a Appendix 31	Peer review of Salinity tolerance of stygofauna at Mulga Downs Iron Ore Mine. Memo 675	Review of memo 675 on request of EPA. The review considers the approach taken in memo 675 and the appropriateness of the outcomes based on the information for the purpose of this EIA.	
Biologic 2025b Appendix 32	MDIOM Subterranean fauna baseline peer review	A peer review of the subterranean fauna data supplied with Report 595 (Bennelongia 2024a).	
Biologic 2025c Appendix 34	Targeted Troglofauna Survey 2025	A targeted troglofauna survey to address areas within the mine where there was a high number of potentially restricted troglofauna. This survey was completed in July 2025 and analyses are underway. Report expected in Nov 2025	
JBS&G 2025 Appendix 33	Analysis of stygofaunal associations with groundwater salinity and potential salinity tolerances based on observations, for the MDIOM (in progress)	Study to develop appropriate thresholds for stygofauna for the MDIOM.	

In addition to the subterranean fauna surveys, the following items were identified in the ESD:

- Item 3 - detailed habitat characterisation and ecological requirements of relevant subterranean fauna.
- Item 4 – the preparation of an objective based monitoring and management plan to mitigate the impacts to subterranean fauna during the operational activities of the mine.

To address the ESD item 3, subterranean fauna habitat assessments were completed for both troglofauna and stygofauna using Leapfrog 3D modelling software (AQ2 2024b) (Appendix 9).

The objectives of the assessments were to:

- Identify the extent and continuity of geological units potentially habitable to troglofauna and assess the volume of habitat which may be impacted as a result of implementation of the Proposal; and
- Identify the extent and continuity of geological units potentially habitable to stygofauna and assess the volume of habitat which may be impacted by groundwater level drawdown from mine dewatering.

This assessment defined the likely troglofauna and stygofauna habitat stratigraphy and the amount of potential habitat lost from implementation of the Proposal. The assessment also defined the extent and continuity of the habitats which have been identified as potential subterranean fauna habitat within the area modelled. The likelihood of this habitat extending beyond the area of impact is addressed in Section 8.6 of this document.

This approach aligns with other Proposals which have been assessed under the EP Act and follows the steps outlined by the EPA in the Technical Guidance – Subterranean Fauna Surveys for Environmental Impact Assessment (EPA 2021i).

In addition to the above habitat assessments, the inferred salinity tolerances for stygofauna were investigated in Memo 675 - Memo 675: Salinity tolerance of stygofauna at Mulga Downs Iron Ore Mine (BEC 2024b; Appendix 22).

Additional work completed in 2025:

To address the number of potential restricted troglofauna which were identified in the impact assessment of the 2019-2024 survey data, a targeted troglofauna survey was commissioned. In May 2025 Biologic undertook this survey. This is discussed in more detail in Section 8.3.2.2.

On request from the EPA a peer review was completed on Memo 675. This review was completed by Biologic Environmental Survey (Biologic) –Peer review of Salinity tolerance of stygofauna at Mulga Downs Iron Ore Mine. Memo 675 (Biologic 2025a; Appendix 31).

To further address ESD item 3 and following review of memo 675, the ecological requirements (the focus being salinity) on the stygofauna was investigated using a statistical approach. Statistical analyses were applied to assess the association between salinity and stygofauna occurrence. The salinities used in these analyses were based on a groundwater salinity block model developed by AQ2 in 2025 for the MDIOM. This work will be completed in September 2025. Memo - Analysis of stygofaunal associations with groundwater salinity and potential salinity tolerances based on observations, for the Mulga MIOIM (in progress) (JBS&G (2025); Appendix 33).

Extensive hydrogeological investigations undertaken for the Proposal and detailed in Section 7 have also considered groundwater chemistry (AQ2 2024a; 2025; Appendix 4 and Appendix 5). This information supports item 3 of the ESD and provides further information on the likely ecological requirements of the stygofauna in particular salinity ranges and the groundwater type that forms the baseline data used to establish triggers and thresholds for effective management of impacts to the subterranean fauna from implementation of this Proposal (Item 4).

Following submission of the Rev 4 ERD it was apparent that there was a high level of inconsistencies with respect to the subterranean fauna identifications. This is a common issue when reconciling data where identifications

are based on limited information such as morphological features and comparing with molecular analyses. To overcome this a peer review of the Bennelongia data in the 2024b report was commissioned by the Proponent. The purpose of the peer review was to address any inconsistencies in the identifications and reconcile the data where possible. The outcome was an updated dataset where there was greater confidence in undertaking the EIA on the subterranean fauna for the MDIOM. This work was undertaken by Biologic and the outcome is discussed in more detail in Section 8.3.2. Peer review of Subterranean fauna survey for Mulga Downs Iron Ore Mine (report 595) (Biologic (2025b); Appendix 32).

To address the ESD item 4, a Water Management Plan (WMP) has been prepared (Appendix 6). Specifically, the Water Management Plan defines preliminary trigger and threshold criteria relating to groundwater. It also outlines the methodology and inputs which will be used to refine these criteria specific to each site upon completion of further works and collection of baseline data from finalised groundwater infrastructure.

The approach for the assessment of this key environmental factor aligns with the process outlined in Figure 1 of the EPA (2021g). Each progressive step was implemented following review of the outcomes of each survey and against the scale and nature of the impacts from the Proposal. The primary aspect driving each survey was the lack of taxonomic resolution of the species, which is a persistent issue with this key environmental factor and many of the taxa collected in Western Australia continue to remain unresolved. As such, the assessment included detailed subterranean fauna surveys, targeted surveys, review of the data and reconciliation where appropriate, the use of DNA, the inclusion of habitat connectivity following extensive sampling and the use of models to develop management measures which are measurable.

8.3.2 Subterranean Fauna (Data)

The subterranean fauna surveys completed for the Proposal were undertaken in accordance with EPA (2021g) and (EPA 2016a). Surveys implemented prior to 2021 aligned with the relevant earlier versions. The assessment guidance for this factor is provided in Table 8-1. The individual survey reports describe how each of the surveys align with relevant guidance. The desktop assessment (BEC 2019), baseline survey (BEC 2021) and detailed and targeted survey report (BEC 2024a) are provided in Appendix 8a, Appendix 8b, and Appendix 26 respectively).

Surveys were designed based on the requirements of the different stages of the assessment and ranged from reconnaissance (basic) to detailed and targeted surveys within and in the vicinity of the Proposal. Targeted surveys were developed based on the likely scale and nature of potential impacts from the Proposal. This aligns with the process for determining the required level of survey as outlined in EPA (2021g). Changes to the extent of the Proposal, based on refinement of the mine design and ongoing mitigation of potential impacts, also steered the targeted surveys which is described in greater detail in Section 8.3.1.

A peer review of the information in report 575 is presented in Biologic (2025b). The outcome of the review is a reconciled dataset. This updated dataset has now been applied in this updated Rev 5 ERD. Details on the approach and the outcome of the review is presented in Appendix 32.

8.3.2.1 Survey Area

Unlike the other key environmental factors of Terrestrial Fauna and Flora and Vegetation, the extent of potential impacts to subterranean fauna may extend beyond the Development Envelope. The survey design for

subterranean fauna is to take this into consideration (as defined in EPA (2021g)) and adequate sampling is to be undertaken within the area of impacts and beyond. This section defines these areas.

Changes in the groundwater levels and groundwater physio-chemistry as a result of MAR and mine pit dewatering may affect the physiology and persistence of stygofauna and troglofauna and are therefore considered within this impact assessment. These have been considered in the supporting reports when identifying potentially restricted taxa and defining habitats (refer to Appendix 8).

Potential impacts to troglofauna are defined as:

- Areas required for the excavation of the mine pits; and
- Extent of predicted mounding associated with MAR (shown as 1 m mounding contours in all figures).
- Potential impacts to stygofauna are defined as:
- Areas below the groundwater table which will be excavated (i.e. the pits);
- Extent of groundwater drawdown from abstraction (shown as 2 m drawdown contour in all figures); and
- Areas where reinjection of excess mine dewater via MAR potentially altering groundwater salinity (area is shown as extent of 1 m contour). The predicted extent of the changes to groundwater salinity is displayed as a polygon. This area is defined as the Salinity Impact Area (SIA).

The extent of subterranean fauna surveys undertaken for this assessment are presented in Figure 8-1 to Figure 8-4.

8.3.2.2 Survey Effort

Surveys have been undertaken for the Proposal since 2009. A detailed survey was undertaken by Bennelongia between 2019-2022 over five phases. Up to 292 samples were collected from previously sampled sites with repeat sampling where required.

Based on the outcomes of the 2019 – 2022 sampling, an additional targeted survey was undertaken from November 2023 to January 2024 targeting areas which had a higher number of restricted taxa for both stygofauna and troglofauna and areas outside of the expected impact areas. The targeted survey included three rounds of intense sampling over three consecutive months (November 2023 through January 2024).

On review of the information collected, a number of potentially restricted troglofauna were found in the proposed mine pit area. An additional targeted survey was undertaken to further investigate these habitats. The survey considered the location of the potential SRE troglofauna. The survey was completed in July 2025 and the sample effort has been included in this updated ERD. The location of the targeted survey sites is shown in **Figure 8-15**.

The outcome of the detailed and targeted surveys is presented in Appendix 26 (BEC 2024a). The outcome of the 2025 targeted survey is in progress and will be provided as Appendix 34. High level initial identifications have been included in the context of this updated ERD where appropriate.

The survey effort for 2009 to 2014 and 2019 to 2024 and 2025 are summarised in Table 8-3 and Table 8-4 respectively.

Between 2009 to 2024, 1,208 samples were collected from 664 sites. This included 636 troglofauna samples, of which 292 were traps, and 572 samples for stygofauna, 555 of which were phreatic net hauls.

In 2025, 69 sites were surveyed. Traps were placed in 62 selected drill holes in May 2025 and 60 were retrieved in July 2025. Additionally, 73 scrapes were collected in total; from the 62 drill holes where traps were placed plus an additional 11 locations targeting selected troglofauna groups.

Overall, 1,341 samples were collected from 2019 to 2025.

The extent of the troglofauna survey and sampling effort is shown in Figure 8-1; Figure 8-3 and Figure 8-15. The survey sites sampled from 2019 to 2025 are presented. While earlier surveys for the Mulga Iron Ore Project were undertaken (as discussed in Bennelongia (2024a) and shown in Table 8-3, the majority of the sites were revisited in the 2019 – 2025 surveys. This data range was also selected as the survey method was consistent and could be validated with field data. The bore hole codes for the surveys completed from 2019 onwards were consistent.

Specific details of survey methods used for each respective survey are provided in Appendix 8. The sampling methods completed or the 2025 targeted troglofauna survey are presented in Appendix 34 (final report pending). All methods aligned with the EPA Guidelines for sampling subterranean fauna (EPA 2021i).

Table 8-3: Survey Effort Subterranean Fauna 2009-2014

Target fauna and method	Method	2009 – 2010 ecologia	2011-2012 Phoenix	2014 Bennelongia	Total
Stygofauna	Net - Phreatic	-	106	37	151
	Karaman-Chappuis	-	8	-	
Troglofauna	Scrape	68	122	119	315 (scrapes + traps)
	Single Trap	-	120	77	
	Double Trap	97	-	24	
	Banana Trap	-	4	-	

Table 8-4: Subterranean Fauna Survey Effort -Detailed and Targeted Surveys (2019-2025)

Target fauna	Method	2019	2020	2022			2023		2024	2025		Total
		Aug	Jan	Mar	Jul	Nov	Nov	Dec	Jan	May	July	
Stygofauna	Net - Phreatic	40	79	71	71	31	37	53	30			421
	Bou Rouche	-	9	-	-	-	-	-	-			
Troglofauna	Scrape	60	60	25	25	19	136	-	-	64	9	454 (scrapes + traps)
	Trap1	58	55	25	-	18	136	-	-	60	-	
	Trap2	1	-	-		2	8	-	-			

Early subterranean fauna surveys were designed to characterise the subterranean community present within and surrounding the Development Envelope. The detailed surveys from 2019-2022 and the targeted survey from 2023 to 2024 were designed to understand the potential impacts to subterranean fauna that may result from

the Proposal, incorporating the outcomes of modelling of predicted groundwater changes from mine dewatering and reinjection of surplus water through MAR (AQ2 2025).

The survey effort for impact and reference sites is skewed towards impact areas primarily as a result of access to, and the availability of, sample boreholes outside of the Development Envelope. Therefore, an assessment of habitat connectivity has also been undertaken to address the potential impacts to any restricted taxa that cannot be resolved at this time.

As with many subterranean fauna surveys for the purpose of environmental impact assessment there was a greater number of sample sites for troglofauna in the area of impact. From 2019-2022, 327 sites were sampled for troglofauna and included scrapes and traps. The targeted survey involved the sampled of 48 holes (traps and scrapes) for troglofauna. Figure 8-2 shows the extent of the detailed and the targeted surveys with sampling occurring in the proposed pit areas and outside the area of impact.

With respect to stygofauna, 421 samples were collected from 356 sample sites (drill and bore holes, including pastoral) within the expected area of impact and in areas which will not be impacted (Figure 8-3). Of these 412 were using a phreatic haul net.

The survey data collected between 2019 and 2024 is considered the most current. Given the changes in the taxonomy in the past 20 yrs this data will be the focus of the assessment. To align with recommendations in Framenau et al. (2021) this survey data was also considered the most reliable as all required sampling information was consistent. The currency of the data from 2009 to 2014 was considered in the context of this assessment. The earlier surveys lacked sufficient field data and while the information collected is relevant as baseline, many of the specimens were not identified past higher order and cannot be retrieved for validation or comparison, including DNA. Molecular analyses were undertaken on the specimens collected from the pre-2019 surveys. Where successful, this information has been considered in this assessment to determine which taxa are at most risk from implementation of the Proposal. The same sites sampled pre 2019 were resampled from 2019 to 2024. This limitation has been considered in the survey report (BEC 2024a). Further limitations on data are discussed in Section 8.3.2.6, including the provision of an updated dataset.

Overall, the sampling effort for this Proposal is considered extensive and the sampling effort for the detailed and targeted surveys can be described as intensive. The survey effort for the subterranean fauna for this Proposal is now considered adequate for assessment of impacts from implementation of the Proposal.

8.3.2.3 Habitat Assessment

An assessment of suitable troglofauna habitat was undertaken by AQ2 (2024d) and is discussed further in Section 8.3.2.1.

Groundwater salinity profiles (measured in situ) were used to identify the range of salinities within the groundwater profile which are known to support stygofauna habitat. The assessment on the impacts to groundwater and surface water by AQ2 (2025) (Appendix 5) addresses the potential changes in groundwater following drawdown and mounding. A block model prepared for the MDIOM was developed by AQ2 which investigates the changes in baseline salinity at depth. This model provides further information on the nature of the groundwater habitat at depth. This model was used as part of further investigations on the distribution of stygofauna based on salinity (baselines) at depth. This is further discussed in Section 8.3.2.5.

The information from the above studies has been used to develop baseline thresholds and trigger values for inclusion in the Water Management Plan; Appendix 6.

8.3.2.4 Habitat Connectivity

Where adequate sampling has been completed, and the data shows records where taxa still appear to be restricted to impact areas, the EPA considers the interpretation of habitat connectivity as appropriate in assessing whether a Proposal will meet the EPA's objective for Subterranean Fauna (EPA 2012; EPA 2021i). This is a method which is now considered standard for the purpose of environmental impact assessments on subterranean fauna. Both physical and biological connectivity were investigated for this assessment to determine if the taxa recorded within the Proposal impact zones were truly restricted (that is displaying true short-range endemism, or whether they are classed as restricted because of poor taxonomic resolution. The latter is characteristic for subterranean fauna in Western Australia and has been investigated in numerous studies (refer to Framenau et al.2021).

Habitat connectivity for subterranean fauna within the Development Envelope was considered based on physical, biological, ecological, and where possible, genetic data collected to support the Proposal. The use of statistical analysis and application of the information from the AQ2 block model were also used to determine connectivity. This was presented as the distribution of the stygofauna based on baseline salinity modelled from the top 30 m bgl (refer to Section 8.3.2.5).

8.3.2.5 Ecological criteria

There are a number of physicochemical factors which influence biotic distributions in groundwater. However, it is generally accepted that salinity is one of the more important measures to assess distribution (i.e. presence) (Strayer 1994). Basic groundwater measurements were collected in situ during each of the subterranean fauna field surveys. The limitations with this approach are stated below in Section 8.3.7 - constraints and limitations.

Salinity was chosen as an ecological criterion for the stygofauna. Modelling has predicted changes to the salinity profile within the aquifer as a result of MAR. As such, salinity was considered as a suitable parameter for use in the assessment of impacts to the stygofauna. Other parameters are being collected which may be included in establishing the ecological criteria for the stygofauna, however salinity is considered the most appropriate. The dominance of certain groups is to be considered when establishing criteria, and in areas of impact any potential SREs. An in-depth assessment of groundwater quality has been undertaken by AQ2 (2024a). Groundwater water quality data is being collected as part of the on-going sampling program for the Proposal (refer to the Water Management Plan; Appendix 6).

Groundwater quality data collected during stygofauna sampling is limited to the first 1 m below the surface of the groundwater. Stygofauna samples are collected by lowering a phreatic net to the bottom of the sample hole and sampling the entire water column. As a result, the actual salinity of the groundwater where the stygofauna occur at the point of collection is unknown using this method.

A salinity tolerance memo (memo 675) was prepared by Bennelongia –(2024b) (**Appendix 22**) using the data collected in the field. The purpose of this memo was to include any available salinity data on the stygofauna within the MDIOM. This memo was found to have limitations, and a peer review was undertaken on request of EPA (Biologic 2025a); **Appendix 31**.

To address the limitations with collecting suitable salinity data for stygofauna at depth, the approach was to use statistical analyses to assess the association between salinity and stygofauna occurrence. The salinities used in these analyses were based on a block model developed by AQ2 in 2025 for the MDIOM.

To complement the statistical analyses, maximum salinities within observed locations for key SREs and by grouping genera were quantified; and using the conservative assumption that salinities higher than those at which each group has been observed at are unsuitable, 'suitable baseline salinity' maps were compiled to show the parts of the baseline landscape where suitable salinities exist for each group. (These provide useful, conservative salinity tolerance thresholds on which to base management and mitigation measures). This memo will be completed in September 2025 (JBS&G 2025) (**Appendix 33**).

8.3.2.6 Delineation of taxa

Morphological identifications

All subterranean animals collected in the supporting studies compiled in Bennelongia (2024a) were initially identified morphologically under dissecting microscopes or, after dissection, under compound microscopes, with differential interference contrast lighting. Identifications were made using published, unpublished, and informal taxonomic keys, as well as species descriptions in the scientific literature. In the identification process, most animals were identified to undescribed species. These undescribed species were assigned voucher code names. Selected representative animals of most voucher code species were lodged with the Western Australian Museum. In some cases, the life stage, sex, or condition of specimens did not allow for identification to the species level and identification was to a higher taxonomic level. The lowest taxonomic unit (LTU) is applied to these taxa.

Genetics

Molecular sequencing has been adopted across all fields to solve the issue of cryptic species. Subterranean fauna, in general, are a problematic group taxonomically and this issue is recognised in extensive literature (refer to Framenau et al 2021) and EPA (2012; 2021g). To assist in the delineation of cryptic taxa, DNA barcoding has proven to be an acceptable tool (EPA 2021i). In the absence of a central data depository for subterranean taxa, the use of DNA barcoding and the uploading into public databanks (such as GenBank) allows for a greater understanding of the area of occupancy (distribution) for stygofauna and troglofauna and subsequently their conservation status.

For this Proposal DNA sequencing was used to assign a name for juvenile or damaged animals, confirm morphological identifications, and for comparison with available DNA barcodes. The species records from each survey were reviewed and their names were updated to the most current iteration. BEC (2024a) outlines these analyses (Appendix 26). The outcome of the genetic analyses is presented in Appendix 2 of BEC (2024a) and discussed further in Section 8.3.4 .

8.3.2.7 Constraints and Limitations

There is much uncertainty regarding subterranean fauna, in particular with respect to taxonomy as taxonomic frameworks are in development. This places limitations on the interpretation of results in particular when historical data is combined with recent data. Historical data for the purpose of this assessment was used to

define the significance of the area to subterranean fauna. The supporting documents have also applied this information in the survey reports. The assessment of impacts to subterranean fauna is based on the results from the 2019 to 2024 surveys as they are considered the most reliable in terms of identifications and consistency in methods. This was considered when assessing the subterranean fauna found to be limited to the areas of impact and therefore at higher risk from implementation of the Proposal. The ranking of the risk to the subterranean fauna from low to high and the rationale for this ranking is outlined in Section 8.3.2.8.

Limitations to these 2019 to 2024 surveys included:

- Extent of sampling – this was limited to the availability of suitable bores across all habitats. Access due to tenure was limited to Hancock tenure or pastoral stations. Suitable hole for troglofauna were skewed toward the impact area as this had the highest concentration of suitable drill holes. This is standard for subterranean surveys. All efforts were made to locate sufficient holes outside the area of impact. With the reduction in the Proposal extent from 20 Mtpa capacity to 12 Mtpa many sampled holes could be classified as reference sites.
- Groundwater physicochemical measurements were collected using a bailer. This limits the understanding of the groundwater salinity at the time of sampling to the first meter of the groundwater column and do not reflect the conditions of the wider aquifer.
- Weather – heavy rainfall interrupted the scheduled sampling and collection of traps on occasions and prevented access to many sites. However, seasonality was captured with multiphase surveys.
- Taxonomy and genetics – specimen identifications were assessed by a combination of morphology and genetic analyses wherever possible. While it is expected, best practice was followed in the field and laboratory to ensure genetic success rates; given the extreme conditions in the Pilbara and distance to Perth, some sequencing failure was unavoidable. This is addressed in the supporting reports.
- Incorporation of previous results - many taxa/ morphospecies recorded from previous surveys could not be compared to the operational taxonomic units (OTUs) from the 2019-2024 survey data as specimens or DNA was unavailable. There have been updates to the taxonomic frameworks between pre 2019 and current (2019-2024) surveys. This has been addressed in this assessment with the focus on the 2019-2024 data. However, the supporting reports include the historical data and base their interpretation of this data. This information remains in their dataset. This limitation was addressed with a peer review of the data and a resulting updated dataset (refer to Section 8.3.2.6).

8.3.2.8 Assessment of data

As stated in Section 8.3.2.7, the inclusion of older data and how this was reconciled in the supporting survey reports has limitations. As such, the assessment of impacts to subterranean fauna in this ERD is based on data collected from the 2019 to 2024 surveys presented in Bennelongia (2024a).

Reconciliation of data

To address the limitations identified with the subterranean fauna dataset, a peer review was commissioned and undertaken by Biologic Environmental Survey (Biologic) – Memo: Peer review of the Mulga Downs Iron Ore Mine: Subterranean fauna survey (dataset) Biologic (2025b).

The data submission provided by Bennelongia (2024a), which includes historical (2009-2014) and recent (2019-2024) surveys of subterranean fauna (stygofauna and troglofauna) at the MDIOM was reviewed considering the challenges of integrating molecular and morphological identifications described above. The review also included

integrating a reanalysis of the molecular data in Bennelongia (2024a). The outcome was a "cleaned"/reconciled dataset which allows for a more robust assessment of impacts to the subterranean fauna. The final identifications provide the operational taxonomic unit (OTUs) for the specimens, and this unit is applied in this ERD intermittently with the term taxon. This updated dataset with the subsequent OTUs is presented in Appendix C of Biologic (2025b). A reanalysis of the molecular data for stygofauna and troglofauna are provided in Appendix A and B of Biologic (2025b), respectively.

The Biologic (2025b) peer review confirms that one of the biggest challenges in developing a consolidated subterranean fauna dataset is reconciling taxonomic identifications between different collections, undertaken by different consultants. This was also acknowledged in Bennelongia (2024b).

It is well documented that subterranean fauna is dominated by poorly described and cryptic invertebrate taxa, with many belonging to undescribed species and / or can be difficult to identify morphologically (refer to Biologic (2025b) section 2.2 re supporting studies). The constraints of the state of knowledge for subterranean fauna is recognised in current and previous EPA guidance for this key environmental factor (EPA 2012). The use of both morphological and molecular data as recommended in EPA (2021i) overcomes these challenges. However, integrating dataset sets is still problematic as there is no standardised approach (Biologic 2025b).

The updated dataset (Biologic 2025b) retained Bennelongia morphological identifications, except for those morpho-codes that were found to be corrected by molecular analysis in Appendix 3B of Bennelongia (2024) and still retained in the unsequenced morpho-identifications. These morpho-codes were rolled back to 'sp. indet.' based on the assumption that the morphological identifications cannot be trusted in the absence of molecular support. This approach was necessary without any explanation of how these incongruencies were reconciled in Bennelongia (2024). Identifications were also updated based on the re-analysis of molecular data in Appendix A and B of Biologic (2025b).

This peer review is presented in Appendix 32. The resulting dataset has been applied in this updated ERD, including the Water Management Plan. This dataset will be submitted as an updated IBSA package as part of this assessment.

The molecular analyses completed for MDIOM (previous and future) will be uploaded into GenBank on completion of the Targeted Troglofauna 2025 survey report (Biologic 2025c – in preparation). Where agreements were in place, data from other projects in Biologic's database were compared to the data from the MDIOM. The comparisons are presented in Biologic (2025b).

The Biologic 2025b peer review also categorised the OTUs based on their ecological dependence of subterranean habitat. These predictions were based on the lowest taxonomic classification available from the updated dataset. The information on ecological dependency, while having limitations based on available ecological information, has been applied to the risk rationale where appropriate.

The level of risk to the subterranean fauna from the Proposal was designated a rank. These were Low, Moderate or High. The rationale for this ranking is outlined below. This ranking is applied to the stygofauna and troglofauna OTUs considered to have limited (or restricted) ranges within the areas of impact and are termed as short range endemics (SREs). The subterranean fauna are referred to as either SREs or restricted.

SREs are considered by the EPA be restricted to areas considered to be directly impacted by the Proposal activities. These are excavation of habitat (mine pits/borrow pits), mounding caused by MAR (1 m contour areas), drawdown of the water table from dewatering activities (2 m contours) and the extent of the predicted groundwater salinity changes (SIA) as a result of rejection.

Risk ranking:

The level of risk to potential SRE troglofauna and stygofauna OTUs were ranked as either Low Risk, Moderate Risk or High Risk:

Low Risk: Implementation of the Proposal will not impact the biological diversity of subterranean fauna within the MDIOM and ecological integrity, that is the composition, structure, function and processes which make up the subterranean environment supporting the troglofauna and stygofauna, can be maintained. The EPA's objective for this factor can be met, and if required, standard management conditions may be applied, with the natural variation taken into consideration.

Moderate Risk: The EPA's objective for Subterranean Fauna may be met, however there are one or two aspects which may require further consideration (in the assessment of significant residual impacts). A further level of consideration is required to provide confidence that the residual impact will not be significant and can be mitigated with the information presented at the time of assessment.

High Risk: Following consideration of the information provided at the time of assessment, implementation of the Proposal, without further mitigation, will result in a significant residual impact. Additional information will be required to mitigate impacts (including conditions for compliance).

The risk ranking is based on the updated dataset and the linear ranges identified by Biologic (2025b). The number of restricted subterranean fauna identified as "restricted" in Bennelongia (2024a) is based on their dataset, which has now been updated. The risk ranking for troglofauna OTUs potentially impacted by the Proposal are considered in Table 8-6. The stygofauna OTUs are presented in Table 8-7. These tables consider the final OTUs presented in Biologic (2025b). To take a precautionary approach, the taxa identified as restricted by Bennelongia 2024a are also included.

OTUs which were identified as having Moderate or High risk (from the direct impacts) were considered further in Section 8.4.1. Those identified as Low risk were not considered further and an explanation is provided. Table 8-10 and Table 8-13 present the outcome of that further assessment. The rationale for the rankings is outlined below.

Rationale

The risk ranking for the restricted troglofauna and stygofauna taxa is based on the EPA's objective for all biota that biological diversity and ecological integrity are to be maintained. In terms of subterranean fauna, the high number of cryptic taxa is problematic when assessing diversity. As such, the area of occupancy for many of the unnamed species cannot be easily defined.

Restricted taxa (those with limited rangers) are at greater risk from direct impacts. The distribution of taxa, especially outside of these areas of impact, is essential in mitigating any impacts. Singletons (specimens which

are only found once in one sampling location) are common in subterranean fauna surveys and this is well documented (refer to Eberhard et al, 2009; EPA 2012; Framenau et al, 2021). To mitigate impacts, evidence of habitat connectivity (both biological and physical) is required. This also includes identifying any barriers.

The following information was included in the assessment for the MDIOM:

- The extent of the direct impact (pit and/or mounding for troglofauna; drawdown and salinity for stygofauna);
- The extent of supporting/suitable habitat (from the habitat assessment);
- The presence of barriers which may restrict the movement of subterranean fauna;
- The linear extent of taxa;
- The ecology of subterranean groups including their ecological dependencies;
- The reliability of identifications (in the absence of resolved taxonomy – that is the species has a recognised name) or a DNA barcode has been applied which can be used to identify this specimen (either a LTU – lowest taxonomic unit or an OTU). This naming unit can be cross checked on a publicly available database or, if there is an agreement in place, sharing of data between companies. Where taxa were clearly identified as new species from successful DNA analyses; and
- Currency and reliability of data (as defined by EPA (2021) Technical Guidance – Subterranean fauna surveys for environmental impact assessment and strongly advised in Data should be comparable – this includes information which is collected in situ.

Based on the above, the rationale applied to rank (as high, moderate or low) restricted taxa is summarised below. A combination of all, or the majority of, the factors listed above (as a minimum) determined the risk ranking.

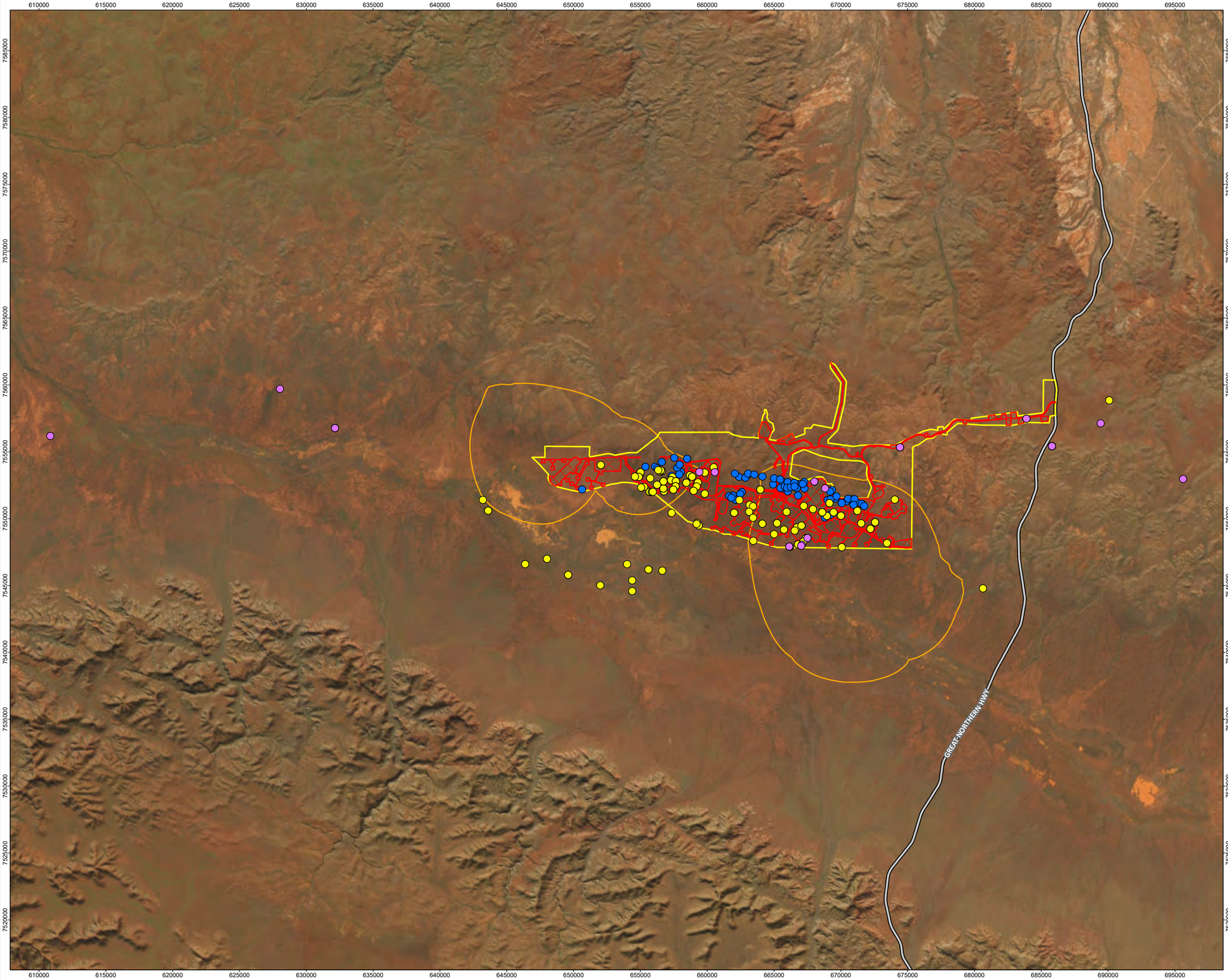
Low Risk: Specimens collected prior to 2019, with little or no collection information, identifications were based on limited morphology and usually the specimen was either incomplete, juveniles, or the final identification was on speculation/level of uncertainty, no molecular analyses was undertaken or sequencing failed.. There is evidence that the specimen was collected from an area which is now excluded from direct impact (avoidance applied); specimen is known to have a linear range which extends beyond direct impact.

Moderate Risk: Specimens which were collected prior to 2019 and repeat sampling yielded a similar specimen; DNA sequencing was successful, and a barcode assigned; displays evidence of dispersal (though sampling was limited to area of impact); ecological dependency.

High Risk: Singletons; DNA successful and new species identified; found only in habitat which is not continuous; ecological dependencies.

Note the risk rankings have been revised and are now based on the updated dataset. The risk rankings have considered distribution of the taxa in more detail and applies ecological dependency where required. The rankings follow the EPA (2021i) guidance when assessing subterranean fauna for EIA, which considers the application of habitat connectivity to determine risk.

Figure 8-1: Troglofauna survey extent - 2019-2025



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

Roads (LGATE-195)

- Highway

Collection date

- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)
- 2025 Targeted survey (Biologic)

JBS&G

Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 20-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:260,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

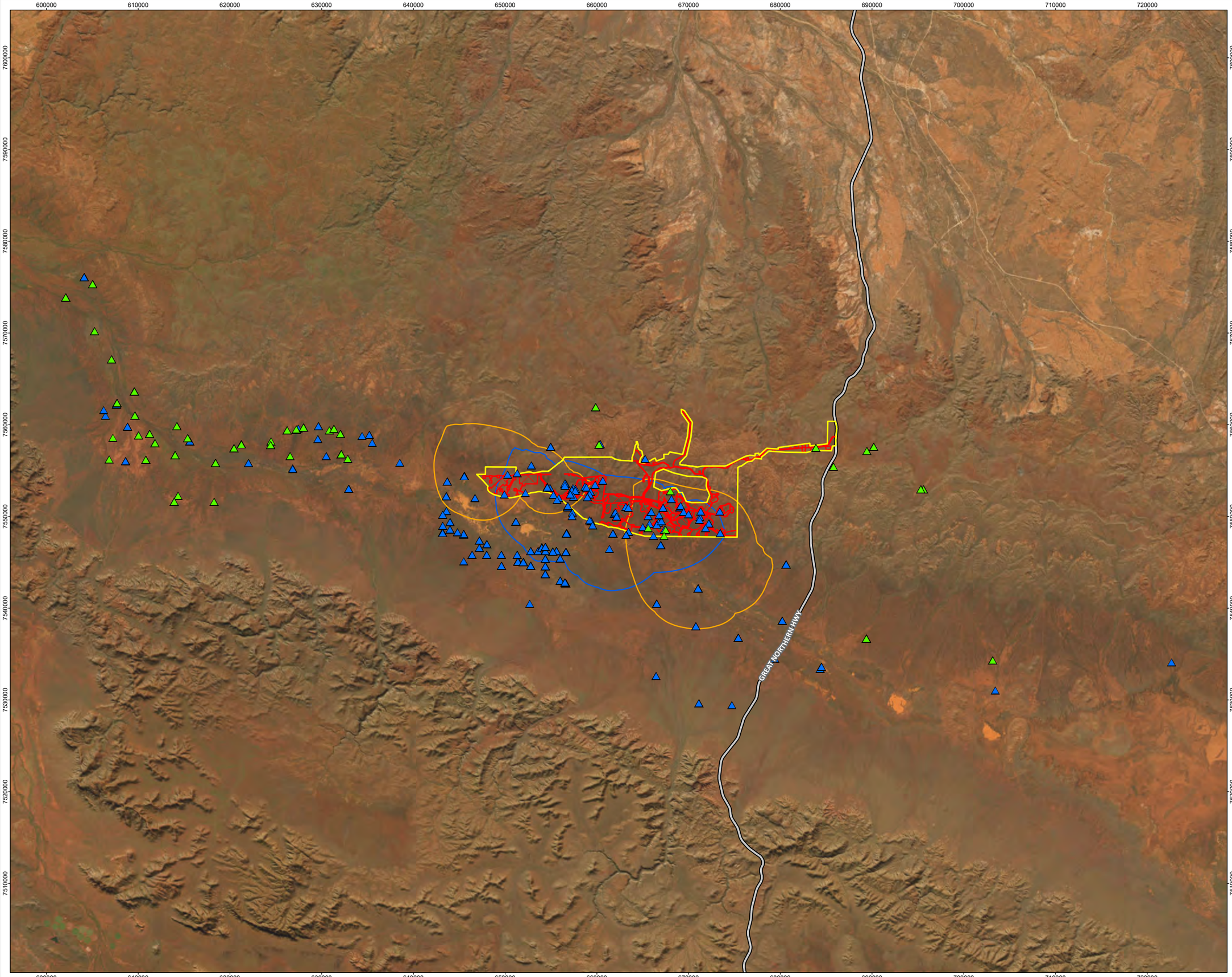
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA
SURVEY EXTENT 2019-2025

FIGURE 8.1

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_01_Troglofauna survey extent 2019-2025

Figure 8-2: Stygofauna survey extent 2019-2024



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown

Collection date

- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)

Roads (LGATE-195)

- Highway

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Drawn By: jcrute	Checked By: VC

Scale 1:380,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA
SURVEY EXTENT - 2019-2024

FIGURE 8.2

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 8-3: Troglofauna sampling effort with respect to mine pits and mounding) (2019-2025)

610000 615000 620000 625000 630000 635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000

7590000 7585000 7580000 7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000 7525000 7520000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Roads (LGATE-195)

- Highway

Collection date

- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)
- 2025 Targeted survey (Biologic)

JBS&G

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Client: Hancock Prospecting Pty Ltd

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Scale 1:260,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT, AREAS OF IMPACT (PITS AND MOUNDING) 2019-2025

FIGURE 8.3 Map 1 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_03_MS_Troglos sampling effort (pits)

654500 655000 655500 656000 656500 657000 657500 658000 658500 659000 659500 660000 660500 661000

7556000 7555500 7555000 7554500 7554000 7553500 7553000 7552500 7552000 7551500 7551000

Legend

- Development Envelope
- Indicative Footprint

MDIOM Pits

- Anticline Hill
- Murray's Hill

Collection date

- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)
- 2025 Targeted survey (Biologic)



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Scale 1:20,000 at A3

0 0.35 0.7
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT, AREAS OF IMPACT (PITS AND MOUNDING) 2019-2025

FIGURE 8.3 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_03_MS_Troglos sampling effort (pits)

661500 662000 662500 663000 663500 664000 664500 665000 665500 666000 666500 667000 667500 668000

7553500 7553000 7552500 7552000 7551500 7551000 7550500 7550000 7549500 7549000 7548500

Legend

- Development Envelope
- Indicative Footprint

MDIOM Pits

- Fridge Central
- Fridge Hill
- Fridge West

Collection date

- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)
- 2025 Targeted survey (Biologic)



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Scale 1:20,000 at A3

0 0.35 0.7
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT, AREAS OF IMPACT (PITS AND MOUNDING) 2019-2025

FIGURE 8.3 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_03_MS_Troglos sampling effort (pits)

668500 669000 669500 670000 670500 671000 671500 672000 672500 673000 673500 674000 674500 675000

7553000 7552500 7552000 7551500 7551000 7550500 7550000 7549500 7549000 7548500 7548000

Legend

- Development Envelope
- Indicative Footprint

MDIOM Pits

- Fridge Hill
- Horseshoe Hill
- Horseshoe West

Collection date

- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)
- 2025 Targeted survey (Biologic)

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Job No: 68676

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 20-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:20,000 at A3

0 0.35 0.7
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SAMPLING EFFORT, AREAS OF IMPACT (PITS AND MOUNDING) 2019-2025

FIGURE 8.3 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery, Earthstar Geographics
Layout: 68676_A3L_08_03_MS_Troglos sampling effort (pits)

Figure 8-4: Stygofauna sampling effort with respect to extent of drawdown and mounding (2019-2024).

600000 610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000 720000

7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000 7520000 7510000 7500000

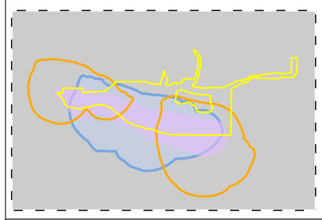
GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change

Roads (LGATE-195)

- Highway
- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)



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Job No: 68676

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 20-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:380,000 at A3

0 7.5 15
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT, AREAS OF IMPACT (DRAWDOWN AND EXTENT OF GROUNDWATER CHANGES) 2019-2024

FIGURE 8.4 Map 1 of 4

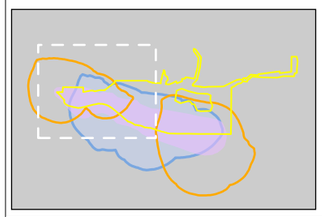
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Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_04_MS_Stygos sampling effort

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change
- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)



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Job No: 68676

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 20-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT, AREAS OF IMPACT (DRAWDOWN AND EXTENT OF GROUNDWATER CHANGES) 2019-2024

FIGURE 8.4 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_04_MS_Stygos sampling effort

657000 658000 659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000 673000 674000 675000 676000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change
- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)

JBS&G

Job No: 68676

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 20-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

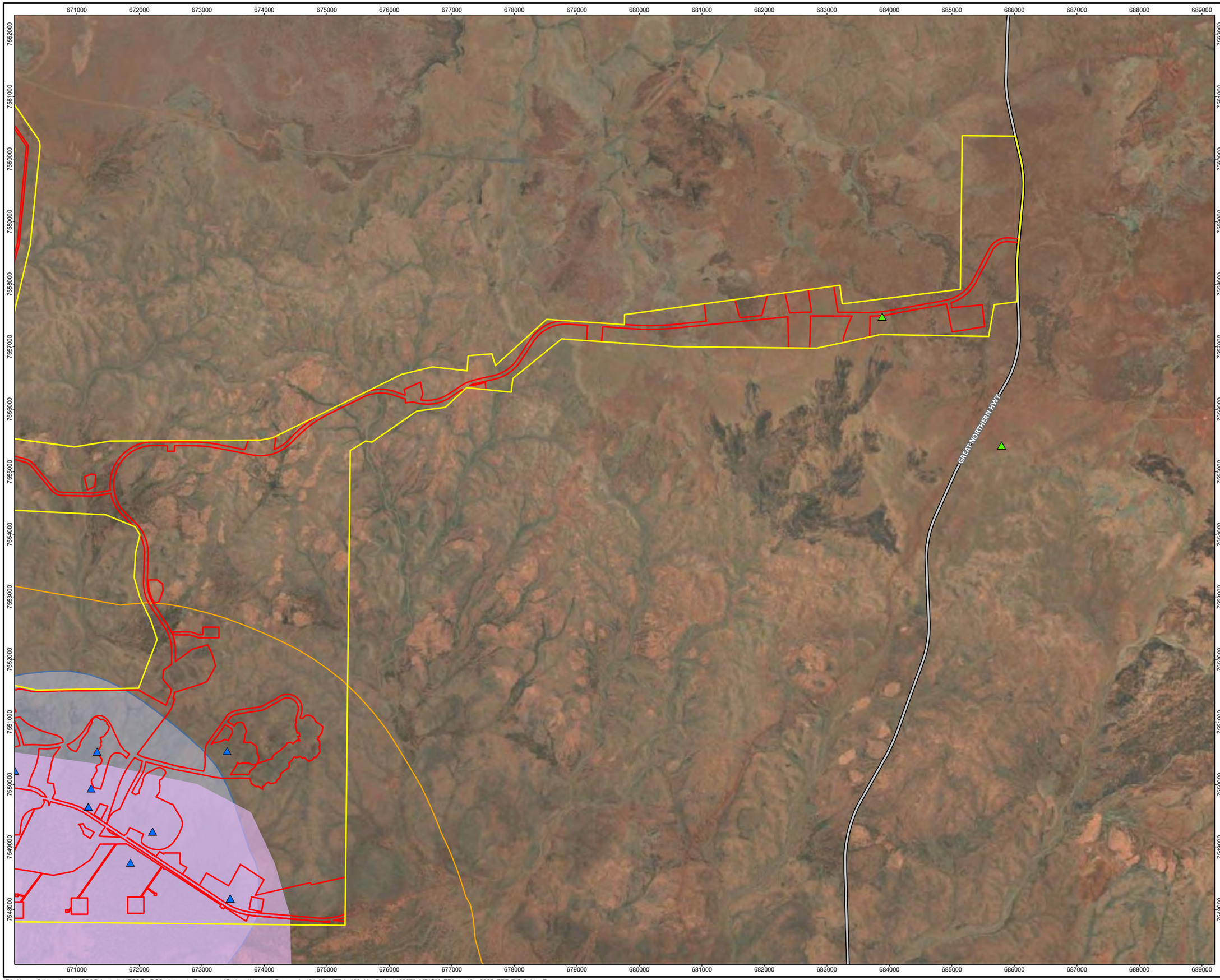
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT, AREAS OF IMPACT (DRAWDOWN AND EXTENT OF GROUNDWATER CHANGES) 2019-2024

FIGURE 8.4 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_04_MS_Stygos sampling effort

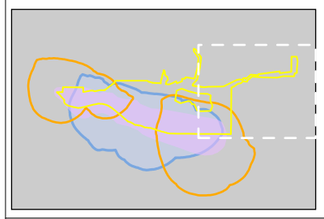


Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change

Roads (LGATE-195)

- Highway
- 2019-2023 Detailed survey (BEC)
- 2023-2024 Targeted survey (BEC)



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Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 20-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SAMPLE EFFORT, AREAS OF IMPACT (DRAWDOWN AND EXTENT OF GROUNDWATER CHANGES) 2019-2024

FIGURE 8.4 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_04_MS_Stygos sampling effort

8.3.3 Subterranean Fauna Habitat

The presence of subterranean fauna is strongly linked to the underlying geology and hydrology. Subterranean ecosystems are thought to have reduced habitat diversity compared to terrestrial ecosystems, primarily due to the absence of vegetation, however geology and hydrology drive habitat heterogeneity (Gilbert et al, 1994). Generally, more groundwater transmissive geologies tend to support more substantial assemblages of subterranean fauna, both in terms of abundance and diversity

8.3.3.1 Troglofauna habitat

A troglofauna habitat assessment model was developed by AQ2 using the Leapfrog Geo (3D) modelling software (AQ2 2024b; Appendix 9). The troglofauna habitat assessment was developed based on the ecological requirements and characteristics of troglofauna (AQ2, 2024b). A range of data sets were used in conjunction with data from AQ2's previous hydrogeological investigations, including topographic data, drillhole data, troglofauna survey data and groundwater data in two scenarios (with mine groundwater development and without mine groundwater development), as well as the conceptual pit shells to define zones of potential loss. The extent of the habitat model was defined laterally using all available lithological/geological data, and the base was defined by applying the maximum predicted groundwater level over the life of the mine.

Existing geological information indicates several prospective habitats for troglofauna (above water table) are likely to occur throughout the Development Envelope (Table 8-5) and into adjacent areas (AQ2, 2024b). The salient points from the habitat modelling include:

- The model indicates that the likely troglofauna habitats of Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range. The CID / Pisolite habitat is mostly continuous over the Proposal area and beyond, while Mineralised Marra Mamba occurs as discontinuous pods associated with the mineralisation.
- The likely habitat of Upper Calcrete is modelled to exist from the western side of proposed pits, and extend south, covering much of the Fortescue Valley, and west towards the Mulga West tenement. All troglofauna samples collected toward the valley centre were from drillholes within the Upper Calcrete unit. Where the Upper Calcrete occurs below the water table (i.e. within the Fortescue Valley), troglofauna species are not expected to occur as they do not inhabit aquatic systems.
- The possible troglofauna habitat of Undifferentiated Tertiary extends across the extent of the Development Envelope along the slopes of the Chichester Range and is continuous in nature.

The units of Upper Calcrete and CID/Pisolite which support troglofauna habitat occur across the Development Envelope and beyond and are mostly continuous. The unit Mineralised Marra Mamba occurs as discontinuous pods where they are associated with the mineralisation. Cross sections of troglofaunal habitat are presented in Figure 8-6 to Figure 8-8. The extent of the potential impacts to troglofauna habitat is shown in Figure 8-5 and the position of each of the lithological cross sections.

8.3.3.2 Stygofauna habitat

Vertical habitat for the stygofauna was considered in terms of changes in groundwater salinities (potential haloclines – defined as a distinct layer of water where there is a rapid increase in salinity at depth). This is discussed in terms of suitable aquifers (in prospective lithologies, distance from surface) and groundwater quality (varying types of groundwater driving the community structure).

Palaeovalleys, such as the Fortescue Valley, are often synonymous with the presence of stygofauna because they represent old drainage lines. This indicates the presence of extensive groundwaters, usually with high hydraulic connectivity and fed by drainage lines (also habitat and means of dispersal for many subterranean fauna).

Groundwater levels across the Proposal range from 385 m AHD to 420 m AHD and groundwater flows from the topographically higher areas into the Fortescue Valley, and then in a north westerly direction along the Fortescue Valley. A detailed assessment of groundwater with respect to the Proposal is provided in Inland Waters – (Section 7).

The hydrogeological conceptualisation of the Proposal and immediately beyond, indicates the Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection, while there are local areas of hydraulic disconnection between aquifers due to the presence of localised low permeable sediments such as clay, shales and saprolitic clay (AQ2 2025). A discussion on the aquifers is presented in the Inland Waters Section 7.

Key points regarding the assessment of the lithological units as potential stygofauna habitats are as follows:

- Likely habitats comprise the Upper Calcrete and Channel Iron Deposits (CID) / Pisolite units of the Tertiary sequence and mineralised / hydrated Marra Mamba bedrock, inclusive of the hardcap which can be very vuggy.
- Between the Upper Calcrete and CID / Pisolite is a unit of Undifferentiated Tertiary which is considered a possible habitat in areas where the clay content is lower.
- The lowermost Tertiary unit (the Basal Crete) is also considered a possible habitat. It is variable in both composition and nature but can be brecciated, weathered and / or vuggy.
- The shaley, unmineralised Marra Mamba is considered an unlikely habitat. Although there is the potential for vugs / voids in the oxidised zone, the same habitat potential as has been adopted for the previous troglofauna habitat assessments, in consultation with BEC (on 21/3/23), has been assigned to this unit. Given the shaley nature of the West Angela Formation, the potential for mineralisation or vugs / voids in the oxidised zones this unit has also been identified as an unlikely habitat.
- The Jeerinah Formation is considered a non-habitat as it is dominated by low porosity shale.
- Other bedrocks units are not impacted by the predicted drawdown.

The following are salient points with respect to the extent and continuity of the stygofauna habitat units:

- The Upper Calcrete is a continuous unit that occurs to the south of the proposed mining area and extends both across the Fortescue Valley and along the strike of the valley.
- The model indicates that the Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range, with the CID / Pisolite continuous (over the extent over the Proposal area and beyond) and Mineralised Marra Mamba occurring as discontinuous pods associated with the mineralisation.
- The Undifferentiated Tertiary unit is both continuous and extensive, covering both the lower slopes of the Chichester Range and extending across the Fortescue Valley.
- The unit Basal Crete is continuous across the Fortescue Valley area, although generally occurs at depths in excess of 30 m below the water table.

For the stygofauna habitat assessment, the top of the habitat was defined by the minimum predicted groundwater level, assuming no mine development (i.e., no dewatering or MAR) over the life of the mine period (AQ2 2024d).

The lithologies identified as suitable habitat for subterranean fauna are summarised in Table 8-5. Cross sections of stygofauna habitat are presented in Figure 8-10 to Figure 8-13. The extent of the potential impact to stygofauna habitat is presented in Figure 8-9. The location for each of the lithological cross sections are also shown.

The Quaternary / Tertiary sediments (Tertiary Detritals refer to Table 8-5) form an unconfined, unconsolidated sedimentary aquifer. The alluvium is up to approximately 4 m thick and extends across most of the Fortescue Valley. The alluvium and colluvium are generally unsaturated and therefore were not investigated for aquifer properties or the stygofauna habitat assessment. The Tertiary sediments form a highly transmissive and continuous aquifer) within the Fortescue Valley to the south of the Development Envelope. These sediments are up to 60 m thick in the central part of the Valley.

The hydrogeological conceptualisation for the Proposal and beyond indicates the Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection. There are also local areas of hydraulic disconnection between aquifers due to the presence of localised low permeable sediments such as clay, shales and saprolitic clay (AQ2 2025).

Stygofauna sampling was undertaken by BEC by means of net hauls (BEC 2024a). The method involves a phreatic net being hauled from the base of the sampled drillholes / bores, with collection throughout the entire water column. As such, the depth that the stygofauna occupied at the time of collection is unknown. Unless a bore is screened over a certain interval, assumptions regarding the depth of the collected stygofauna are made based on subterranean ecology. Below a certain depth (~30 m to 40 m below the water table), low carbon and nutrient inputs are expected to severely limit the occurrence of subterranean fauna (Halse et al., 2014). As such, groundwater in the upper 30 m of the defined habitat is considered to provide 'preferential conditions' to stygofauna (Halse et al. 2014).

Groundwater as habitat

Groundwater salinity (as investigated for the extent of the subterranean fauna surveys) ranges from fresh (hyposaline) (180 mg/L as TDS) to saline (18,000 mg/L as TDS) (EC = 280 µS/cm to 28125 µS/cm respectively). Groundwater where the salinity is in the lower ranges is generally in the upper areas of the Chichester Range. Groundwater associated with the Fortescue Valley generally is of the higher salinity ranges, particularly around the claypans (refer to Section 7.3.6).

Groundwater quality in the Fortescue Valley area is generally of sodium chloride type, while groundwater over most of the Proposal has no dominant cations or anions, indicative of the mixing of different groundwater types or the ion exchange / dissolution processes during recharge or aquifer residency (AQ2 2025).

Basic water quality was measured with each stygofauna sample collected. Groundwater is primarily collected using a bailer. This limits the information to only the surface of the groundwater (standard bailer is 1 m in length). The data indicates that salinity in the first metre below the water table ranges from 60 mg/L (94 µS/cm) to approximately 10,800 mg/L (TDS) (16,875 µS/cm).

During the surveys, groundwater was found to be the most saline in the valley with a mound of saline groundwater originating from the overlying claypans and fresher groundwater occurring on the valley sides (presumably from rainwater infiltration). On the edges of the saline mound, there is a halocline, usually at a depth between 40 mbgl and 80 mbgl, with salinities usually being 20,000 mg/L -30,000 mg/L at 120 mbgl (stated in BEC 2024a).

A salinity block model was generated by AQ2 in 2025 which modelled the baseline salinity values at depth. The salinity values up to 30 mbgl were found to be uniform, and below 40 mbgl they start to increase. No fragmentation was identified in the groundwater studies caused by changes in salinity above 40 mbgl. The baseline groundwater salinity contours are shown in Figure 8-19. These values are from modelled data from AQ2. The depth to 30 mbgl was selected as this depth is recognised as the likely extent of occupancy of stygofauna (EPA 2021i). Output from the block model showed that baseline groundwater salinity to 30 mbgl was homogenous; the surface of the groundwater displaying lower salinities which is consistent with all other studies for stygofauna.

Table 8-5: Lithological Groupings with respect to Potential Subterranean Fauna Habitats (from AQ2 2024b)

Habitat Stratigraphy	Lithology / Member	Stratigraphy	Habitat Probability		Reasoning
			Stygofauna	Troglofauna	
Alluvium	Alluvium	Recent Alluvium / Colluvium	Unlikely	Unlikely	This unit typically has a clay dominant matrix with low potential for porosity. Where drill data is available it predominantly occurs above the water table
Calcrete	Upper Calcrete	Tertiary Detritals	Likely	Likely	This unit typically has a high primary porosity.
Undifferentiated Sediments/Tertiary	Undifferentiated Sediments		Possible	Possible	Areas of lower clay content have the potential for high porosity.
CID / Pisolite	CID / Pisolites		Likely	Likely	CID unit is often vuggy, while pisolitic units typically have high primary porosity.
Basal Crete	Basal Crete (Calcrete / Silcrete)		Possible	None	Unit always encountered below water table within project area.
Jeerinah	Jeerinah Shale	Jeerinah Formation	None	None	Unit is dominated by shales with a low primary porosity.
Mineralised Marra Mamba	Mineralised / Hydrated BIF	Marra Mamba Formation	Likely	Likely	Units likely to have enhanced secondary porosity due to weathering/mineralisation processes.
Shaley / Unmineralised Marra Mamba	Undifferentiated	Marra Mamba Formation	Unlikely	Unlikely	Vugs/voids possible down to base of oxidation but unlikely due to shale content and more localised zones enhanced porosity.
	Nammuldi Member				
	MacLeod Member				
	Mt Newman Member				
West Angela Member	West Angela Member	Wittenoom Formation	Unlikely	Unlikely	Vugs/voids possible down to base of oxidation.
-	Paraburdoo Member		None	None	Units dominated by dolomite and dolomitic shales- low porosity even after weathering. Unit is not impacted by drawdown.
-	Bee Gorge Member				

Figure 8-5: Predicted Areal Extent of Impact to Troglofauna Habitat

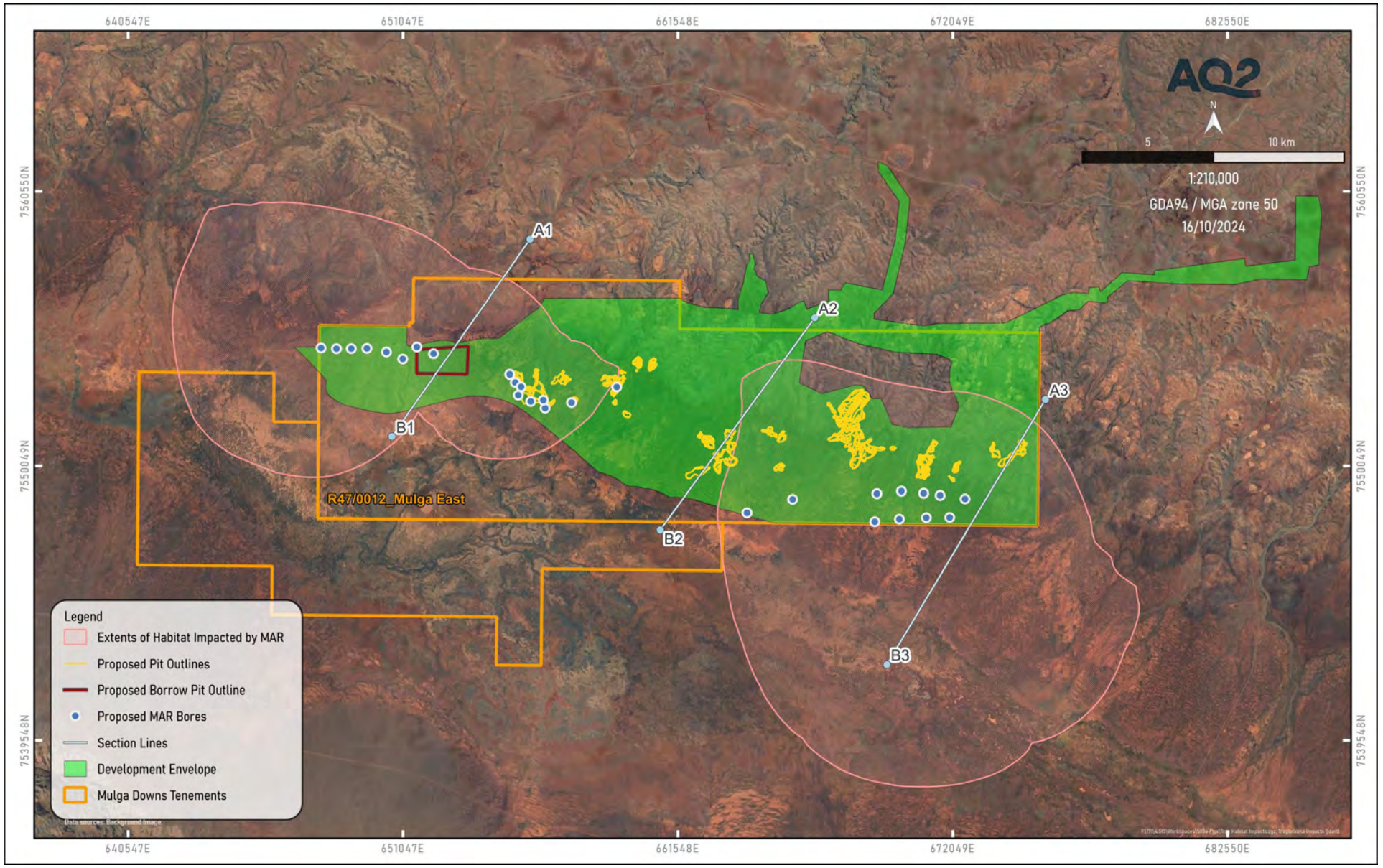
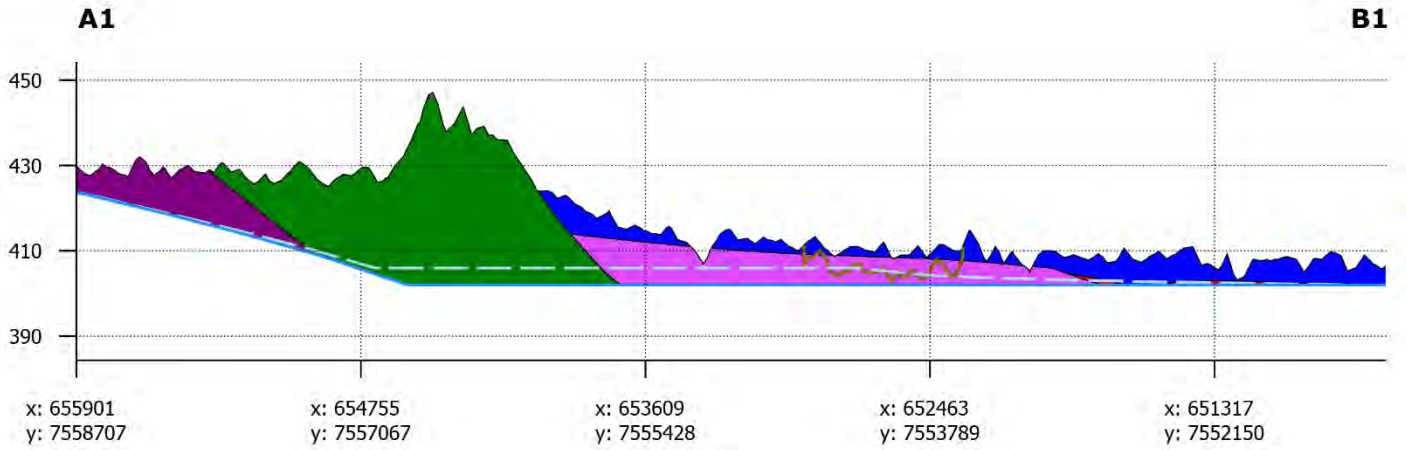


Figure 8.5 Predicted Areal Extent of Impact to Potential Troglofauna Habitat

Figure 8-6: Geological cross section of modelled troglofauna habitat (Section 1)



Legend

Troglofauna Habitat Volumes

- Alluvium (Unlikely Habitat)
- CID / Pisolite (Likely Habitat)
- Calcrete (Likely Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Jeerinah (Non-Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)

Surfaces

- Proposed Borrow Pit Outline
- Modelled 'Maximum' Water Level (With Mine Development)
- Modelled 'Maximum' Water Level (No Mine Development)

Location

A1: 655901, 7558707
B1: 650626, 7551162

Scale: 1:41,000
Vertical exaggeration: 30x
0m 1000m

Figure 8.6 Cross Section 1

Figure 8-7: Geological cross section of modelled troglofauna habitat (Section 2)

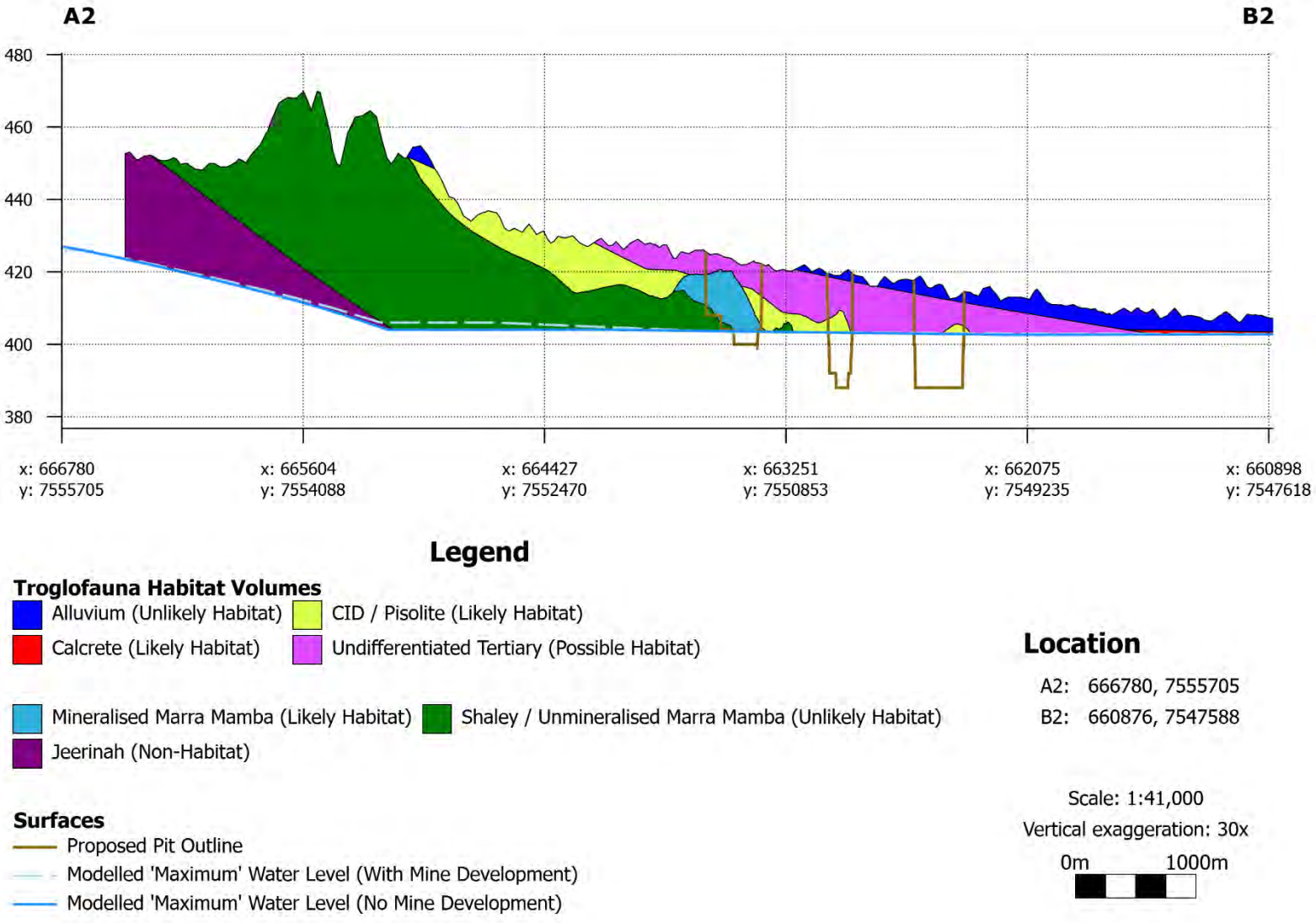


Figure 8.7 Cross Section 2

Figure 8-8: Geological cross section of modelled troglofauna habitat (Section 3)

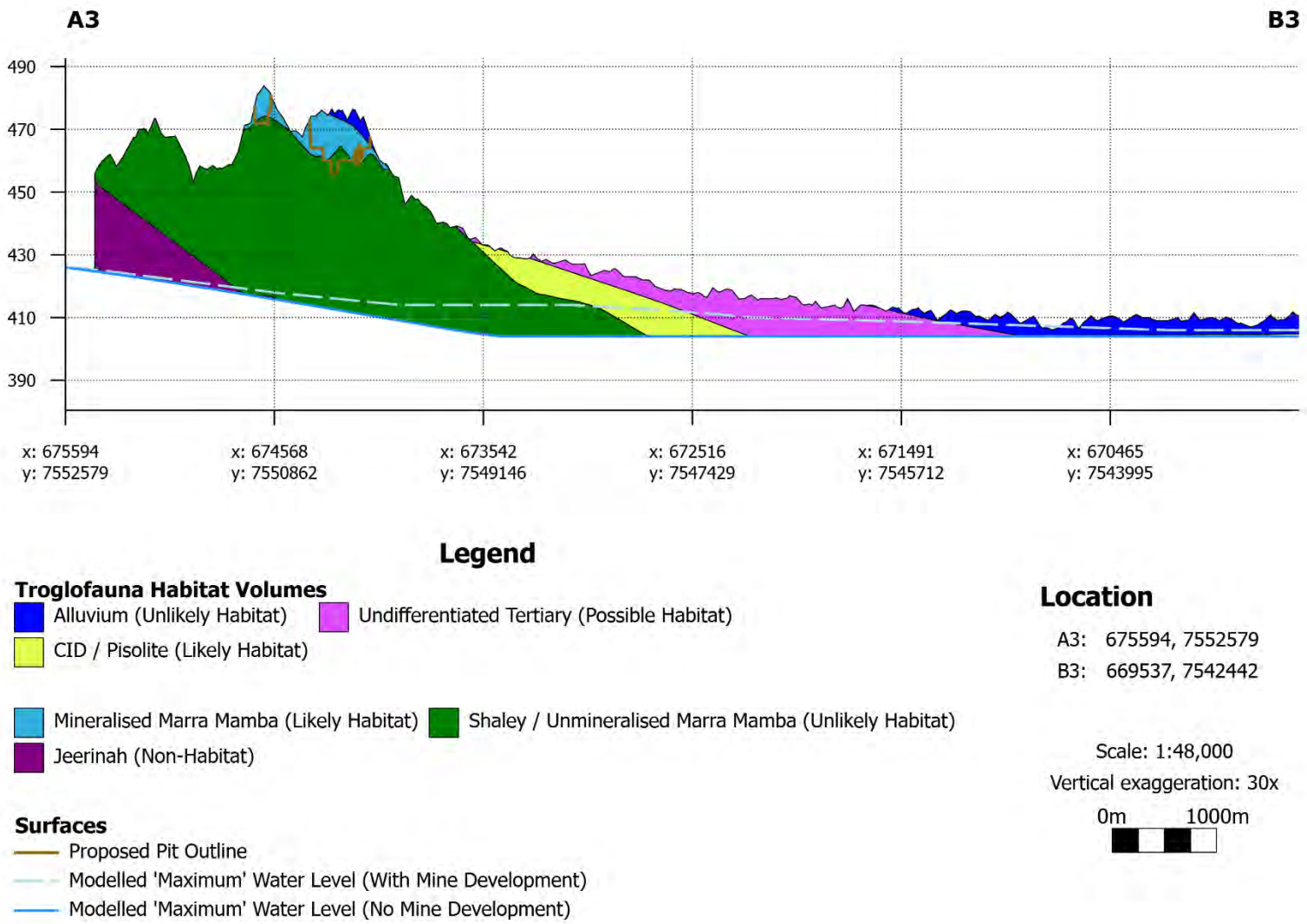


Figure 8.8 Cross Section 3

Figure 8-9: Predicted Areal Extent of Impact to Potential Stygofauna Habitat

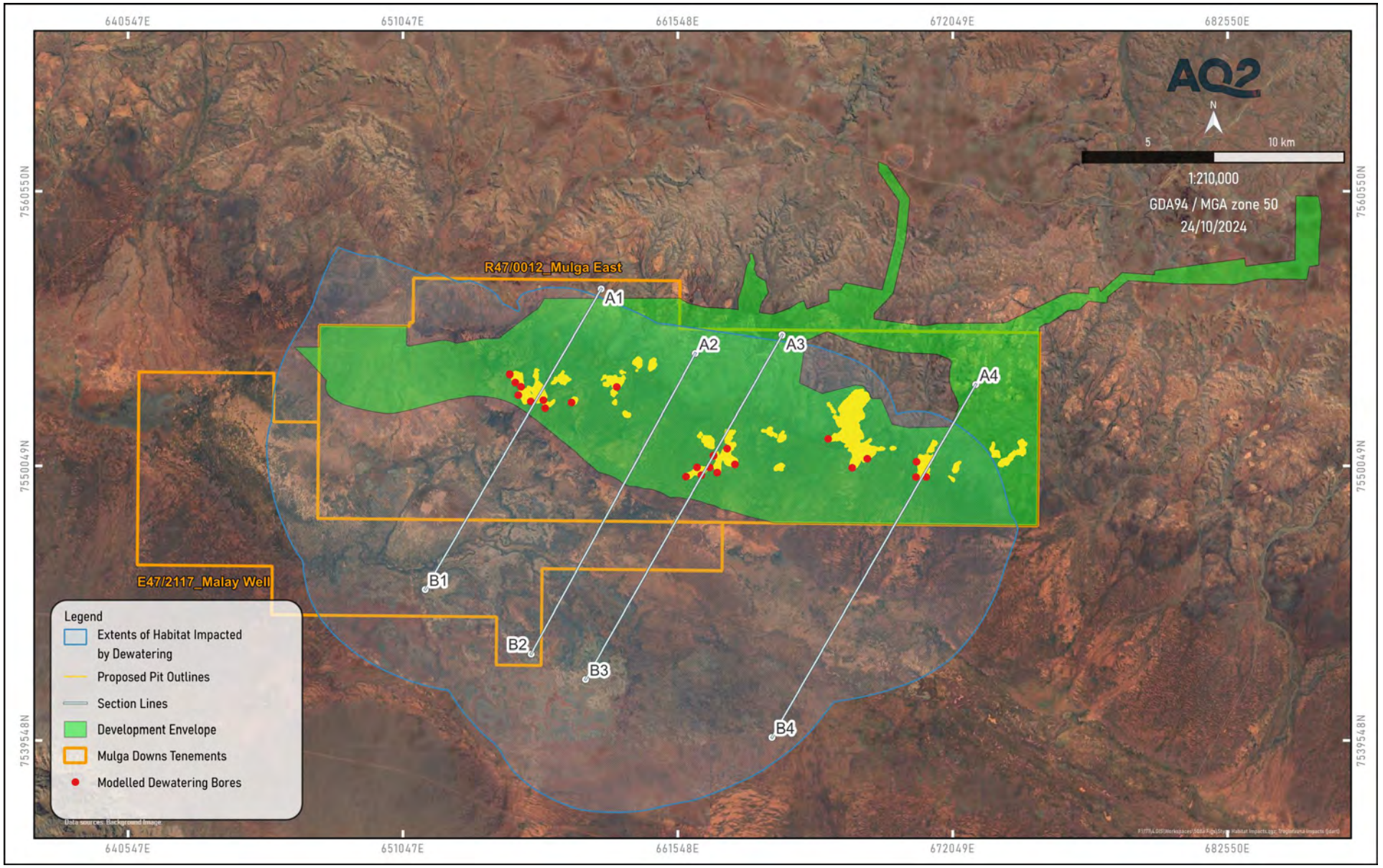


Figure 8.9 Predicted Areal Extent of Impact to Potential Stygofauna Habitat

Figure 8-10: Geological cross section of modelled stygofauna habitat (cross section 1)

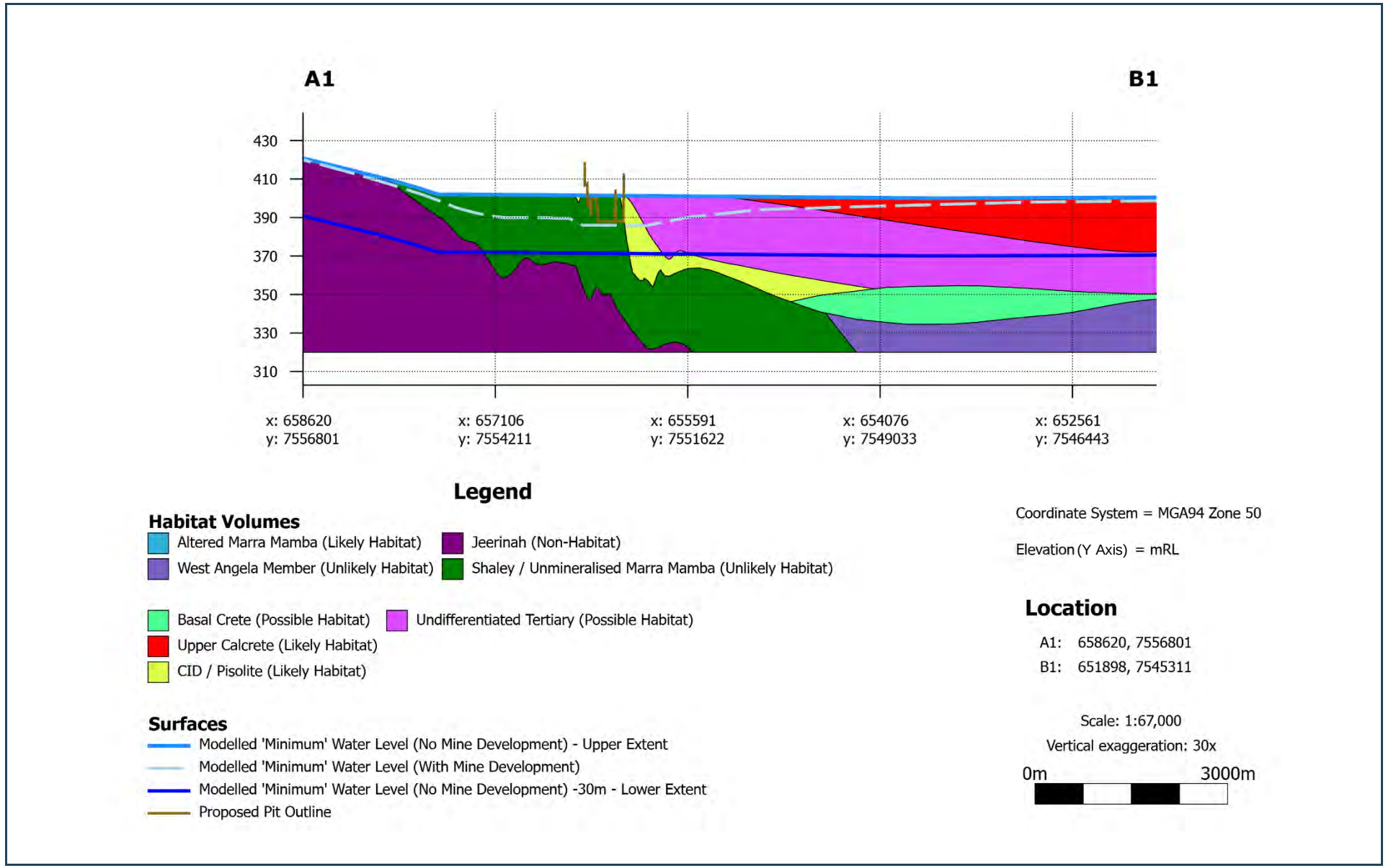


Figure 8.10 Cross Section 1

Figure 8-11: Geological cross section of modelled stygofauna habitat (cross section 2)

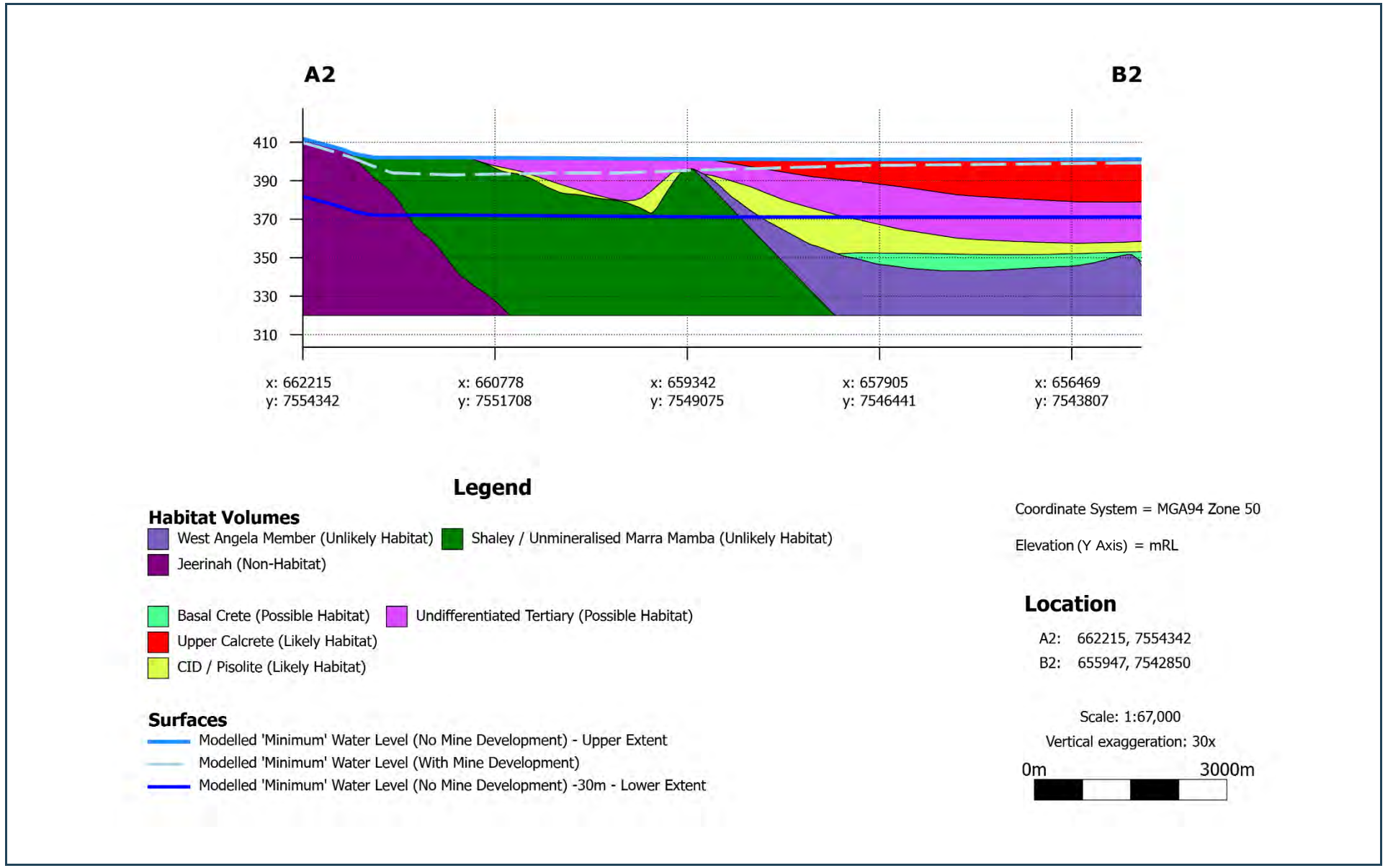


Figure 8.11 Cross Section 2

Figure 8-12: Geological cross section of modelled stygofauna habitat (cross section 3)

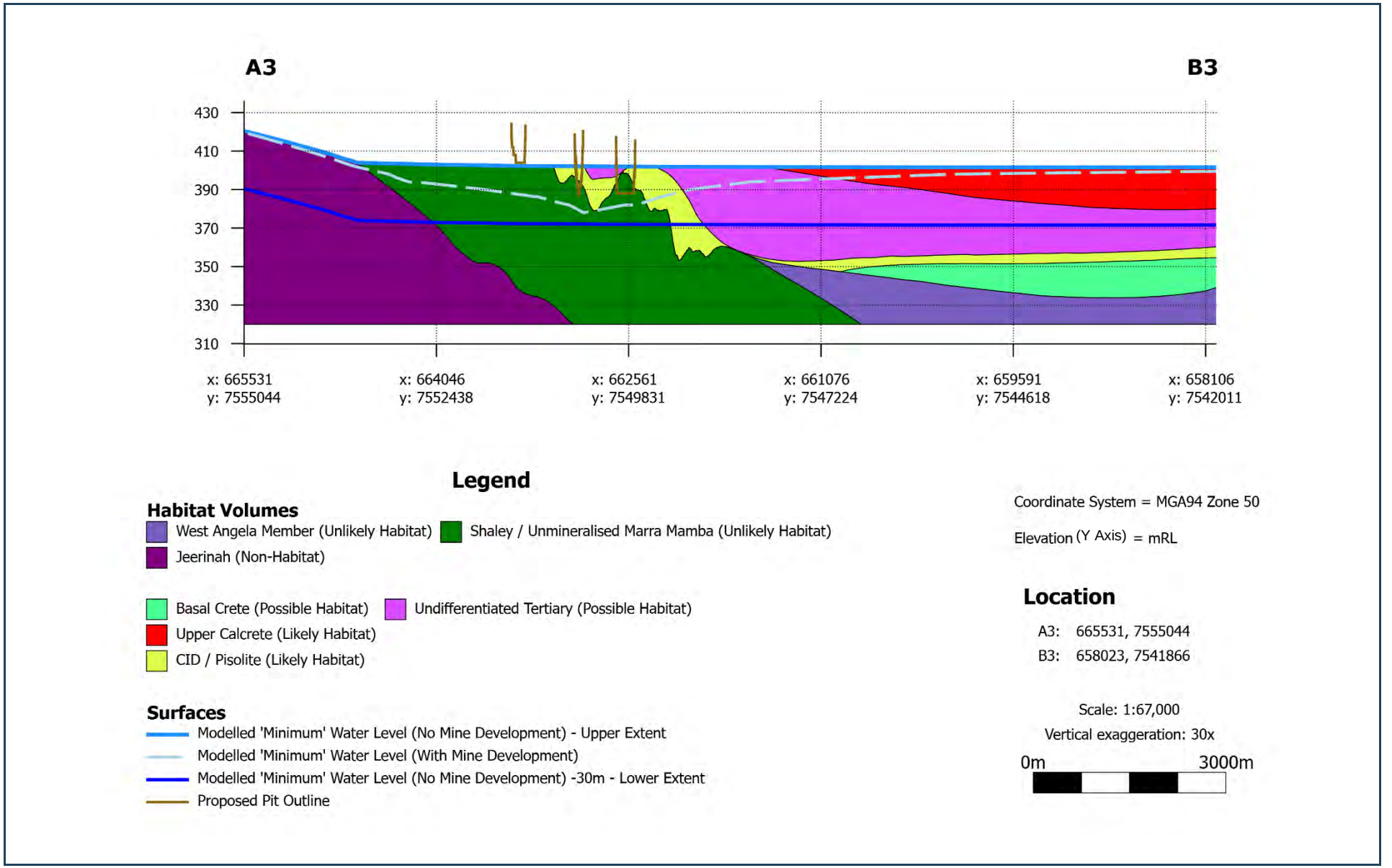


Figure 8.12 Cross Section 3

Figure 8-13: Geological cross section of modelled stygofauna habitat (cross section 4)

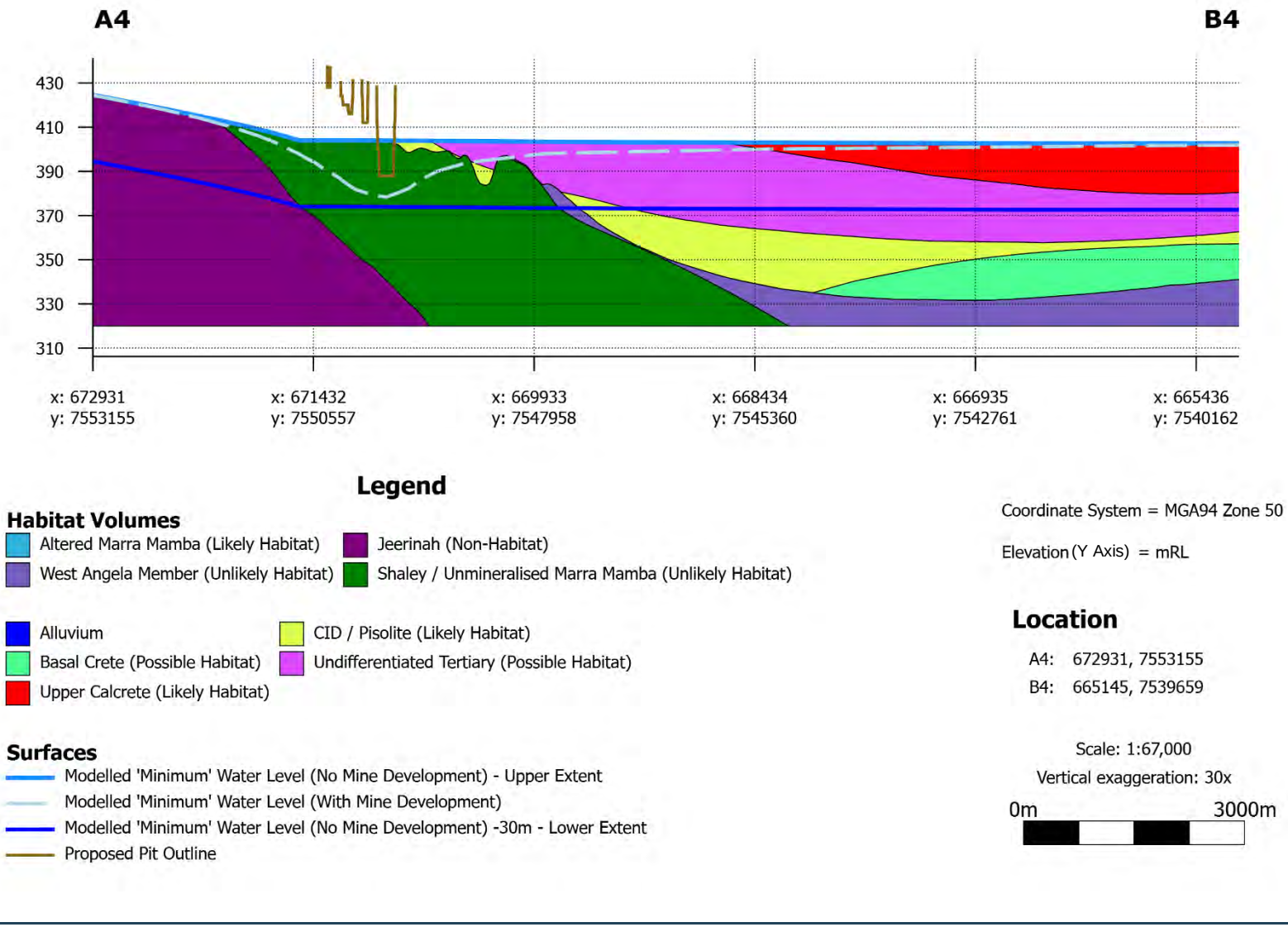


Figure 8.13 Cross Section 4

8.3.4 Subterranean Fauna Assemblages

The Proposal area supports a rich subterranean fauna community consisting of troglofauna and stygofauna which includes cosmopolitan species, those which are widespread in the catchment and potentially taxa with limited ranges due to either poor dispersal capabilities or as a result of unresolved taxonomy (that is they are poorly delineated) and can be categorised as short-range endemic fauna (SREs). Detailed and targeted surveys have been competed for the Proposal from 2019-2025 (as summarised in Bennelongia 2024a) with a reconciled dataset in Biologic 2025b) and further troglofauna targeted surveys in 2025 (Biologic 2025c). The information from the earlier surveys (pre 2019) were provided in the EIA for context for the subterranean fauna community

8.3.4.1 Troglofauna

High diversity was displayed with the troglofauna (Bennelongia 2024; Biologic 2025b). In total, 1,726 specimens (including higher order identifications) belonging to 109 troglofauna taxa have been collected from within the Development Envelope and beyond the extent of impact areas (2009 to 2024 survey data). The subterranean fauna surveys span nearly 50 kms east to west and follow the Fortescue Valley (refer to Figure 8-1). The total number of specimens during the 2019-2024 survey yielded 69 different troglofauna taxa (Otus) from 1,394 specimens. This data was compiled from the recent updated dataset (Biologic 2025b). The 2025 targeted troglofauna yielded additional potential troglofauna, however until the laboratory analyses (including molecular work) is complete, the troglomorphism of some of these specimens has not been assessed.

The groups represented in the troglofauna surveys include diplurans, isopods, beetles, pauropods, pseudoscorpions, silverfish, true bugs, schizomids, centipedes, palpigrads, cockroaches, spiders, symphylans, millipedes and flies.

The most frequently collected troglofaunal species was the cosmopolitan millipede, *Lophoturus madecassus*, which was collected 91 times (1,006 specimens). This species dominated the samples collected from within and beyond the areas of impact. This species is known to be a troglophile and is common throughout the Pilbara often collected from surface samples (Clark et al. 2021). The second most collected species was the isopod, *Troglarmadillo* sp. B54, which was represented by 208 specimens from 10 drill holes. This species was also collected beyond the extent of impacts and has a known linear range of approximately 16.5 km.

An overview of the troglofauna assemblages is presented in BEC (2024a) and is summarised in Table 5 of BEC (2024a). Known linear ranges for these taxa are presented in Table 5 of BEC (2024a) and includes the outcomes of the molecular analyses. This report is provided as **Appendix 26**.

Bennelongia identified up to 42 troglofauna taxa as having linear ranges which identified them as potentially restricted. Bennelongia stated that up to 16 of these taxa may be duplicate names rather than distinct species. Another eight species will have wider distributions than the defined areas of impact if there is conspecificity. However, at present this cannot be resolved because of the typical constraints of this field of study (a taxonomic framework that is still being developed, a high number of cryptic taxa, and the artefacts of sampling subterranean environments). Bennelongia concluded that the number of troglofauna species known only from the areas of impact being the mine pits/areas of excavation and the extent of the groundwater mounding, is somewhere between 30 and 42 (BEC 2024a).

Because of these inconsistencies a peer review was undertaken of the Bennelongia data, as described in Section 8.3.2.6. The result is a revised dataset. This dataset is presented in **Appendix 32**. This dataset has been applied throughout this section and the EIA has been based on this data. As a result, the information in the supporting survey report (Bennelongia 2024a) will vary from the information in this ERD. The data presented has been peer reviewed to ensure greater consistency with respect to the taxa resulting in less uncertainty. It is considered the most reliable data to assess the potential impacts to the troglofauna. As discussed in Biologic (2025b) there were also limitations with the reconciliation as expected.

The average known linear range of 'restricted' species according to Bennelongia (2024b) with multiple records is 8 km. In relation to the size of mine pits, this is comparatively large. The extent of the groundwater mounding, is approximately 12 km. There are two areas of mounding as is shown in Figure 8-1; Figure 8-14 and Figure 8-15. The impact of these areas in terms of troglofauna habitat loss is presented in Section 8.6.1.

On review of the data, the linear ranges of OTUs were reviewed and the linear distances of any troglofauna OTU matches are presented in **Appendix 32** of this ERD. The troglofauna from the summary of OTU matches in Biologic (202b) which were considered as potential SREs based on their linear range identified as singleton or within a 5 km range are presented in Figure 8-14. This figure also presented troglofauna which have limited ranges (SREs) which were retained from the Bennelongia (2024b) data. Figure 8-14 therefore shows OTUs which are outside the areas of impact. The focus of the impact to SREs in this ERD is on the OTUs which are in the updated dataset and are located within areas of impact.

A revised assessment of the troglofauna Bennelongia (2024a) considered to be restricted is presented in Table 8-6. This table also considers any new listings (as OTUs) by Biologic based on their review and reanalysis of the molecular data. No additional specimen identifications have been added to this dataset. Table 8-6 also presents a risk ranking for these SREs. The risk ranking and the rationale for this ranking is outlined in Section 8.3.2.8. Ranking is defined as Low risk, Moderate risk or High risk from the Proposal. A further assessment on the risk of the Proposal to taxa which have moderate to high risk is provided in Section 8.6.1 (Table 8-8).

Table 8-6 presents 48 OTUs which may be considered as SREs. However, the risk ranking applied has identified that 30 of these have low risk based on their distribution throughout the mining area and their ability to disperse. This is further discussed in Section 8.4.1.2 and presented in Table 8-10. Many of the taxa have distributions greater than originally stated. Several of the OTUs/taxa have been included in this table as they were considered by Bennelongia as being at risk. However, they pre-date 2009 which was the extent of the survey data in their report. Data in Bennelongia (2024a) is stated as from 2009 to 2014 for the earlier work then 2019 to 2024 is the information considered the most reliable, and identifications cannot be verified and were uncertain at the time. Many of the potential SREs appear to be an artefact of sampling.

There are several OTUs which have been identified as potential new species based on successful molecular analyses. These are considered of conservation significance for the purpose of EIA and are addressed in Table 8-6.

The state of knowledge of subterranean fauna remains a limiting factor in understanding the true linear distances of many of these taxa. Linear distances in Biologic (2025b) are based on available matches after names were assigned from their review. As stated in Biologic (2025b) OTUs presented may change over time as more genetic and morphological data become available. Best practice has been applied in updating the data for this

assessment to produce a more consistent and reliable dataset to endure a more robust assessment. The format described in Biologic (2025b) in using both molecular and morphological identifications is the method which will be applied to all future work for this project to ensure consistency and for data sharing.

Data sharing agreements were established with other companies and information which is available on GenBank was compared by Biologic in their peer review report (Appendix 32). On completion of the further surveys which have been undertaken in 2025, the data from this Proposal will be uploaded into GenBank. The outcome of the data comparison undertaken so far is presented in Biologic 2025b.

None of the troglofauna OTUs and their associated communities which have been identified from the Development Envelope are listed, or recognised, as having conservation significance under the BC Act nor are they listed by the DBCA as Priority species.

Table 8-6: Troglofauna collected from the MDIOM subterranean fauna surveys identified as having limited linear ranges (SREs) within areas of impact. Ranking on the level of risk has been applied to each of the OTUs.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
Austrochthonius `BPS257`	Austrochthonius `BPS257`	Pit and mounding	ID on morphology only by Dr Danillo Harms (subject matter expert in field)	Collected in 2020 at MD3207. Located in CID/Pisolite on edge of pit. Habitat remains and is continuous proximal to the sample site. New species and the only specimen of this genus that was recorded.	High	Considered a new species. Collected in habitat which extends outside direct impact. Adequate habitat will remain where mounding occurs. Risk remains High as new species and a singleton.
Buddelundia sp. B57	Buddelundia sp. B57	Pit and mounding	ID on morphology only.	Has a linear range of 4.5 km within the Development Envelope. Specimens collected in 2020 (from traps) at MD3028 and in 2023 from scrapes at MDRC2104. Other two specimens were collected in 2014 from MD3771 and MD3087. Located in areas outside of pits in habitat such as CID/Pisolite and Undifferentiated Tertiary. Shows high dispersal.	Moderate	Specimens collected outside of the pits and recent targeted surveys yielded numerous specimens. Awaiting confirmation. Specimens recorded in habitat which is extensive and continuous across the mine area.
Campodeidae `BDP216`	Campodeidae `BDP216`	Pit and mounding	Final ID is based on molecular analyses. Closest genetic match is Campodeidae p. B04 which is 18.4% divergent.	Singleton. Collected in 2019 from MD3980. Located in Undifferentiated Tertiary, CID /Pisolite and Mineralised Marra Mamba. Dispersal is possible as habitat is continuous from area of collection. Other Campdeidae (C. Sp. B10) in survey was located in Undifferentiated Tertiary in southern section of mounding.	Moderate	As this is a singleton and in the pit, the risk remains Moderate.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
Coleoptera 'BCO207'	Coleoptera 'BCO207'	Pit and mounding	Final ID is based on molecular analyses. Genetic match with Coleoptera `BCO207` which is 0-0.5% divergent	Linear range estimated at 3 km Collected in 2019 to 2020 surveys from MD1545, MD1796, MD1813, MD3809. Located in Undifferentiated Tertiary which is extensive and continuous throughout mine and outside. OTU shows dispersal across these habitats.	Moderate	Habitat extensive and shows dispersal.
Cryptops 'MH1' (=DNA05)	Cryptops 'Phoenix-MH1'	Mounding	Molecular sequencing completed. May be Cryptops sp. B42 Genetically identified from Cryptos sp. to C. MH1 (1.1% divergence in COI)	Linear range 12 km; Collected in 2012 from MD0525 and 2020 from MD4821. Collected in Undifferentiated Tertiary and CID/Pisolite and found to be distributed across large areas.	Low	Large linear range and collected from habitat which is extensive and continuous.
Cryptops sp. B42	Cryptops sp. B42	Mounding	Molecular analyses unsuccessful	Singleton collected in 2014 MD0298. This OTU was collected only from areas of mounding within the CID/Pisolite which extends beyond area of direct impact to the troglofauna . Additionally other Cryptops were collected using Karaman-Chappuis indicating not at depth.	Low	Collected in habitat which extends outside direct impact. Adequate habitat will remain where mounding occurs.
Cryptops sp. B41	Cryptops sp. B41	Mounding	Molecular analyses unsuccessful	Singleton Collected in 2014 MD0974. This OTU was collected only from areas of mounding within the CID/Pisolite which extends beyond area of direct impact to the	Low	Collected in habitat which extends outside direct impact. Adequate habitat will remain where mounding occurs.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
				troglofauna . Additionally other Cryptops were collected using Karaman-Chappuis indicating not at depth.		
Cryptorhynchinae sp. B18	Cryptorhynchinae sp. B18	Mounding	ID on morphology only. Specimens prior to 2019-2024	Linear range 8 km. Sampling in MD0225 and MD3094. Other Cryptorhynchinae have been found to also have wider linear ranges (eg at Miralaga Creek) and not considered to be restricted.	Low	Linear range does not restrict this taxon to direct impact.
Draculoides `BSC028`	Draculoides `BSC028`	Mounding	Molecular analyses.	Singleton. Site now located in the Fauna Habitat Exclusion Zone (FHEZ) (MD3683). This OTU occurs at the north eastern extent of the 1 m mounding and sufficient habitat is expected. Other Draculoides have been found within the southern section of the study area within the Upper Calcrete showing they occupy a variety of habitats.	Low	In area of mounding and habitat is available. This sample location is also outside the Development Envelope within an area of conservation.
Draculoides `MH2`	Draculoides `MH2`	Mounding	ID on morphology only.	Singleton. Collected in 2012 (Hole ID MD0525). This site is located at the edge of the pit and within a CID/Pisolite with extensive habitat remaining.	High	This OTU has been included as a target species in the 2025 targeted survey to understand the connection of habitat for the Draculoides in the mining area. This group is known as troglobitic and therefore likely to have low dispersal abilities.
Draculoides `SCH084-DNA`	Draculoides `sp. WAM-SCH084`	Pit and Mounding	DNA confirmed by Bennelongia (2024a). OTU match with Biologic /	Collected in 2019 at MD6444 (mounding) and 2011 at MD0408 (pit). MD6444 is located within the CID/Pisolite and does not appear to	High	This OTU has been included as a target species in the 2025 targeted survey to understand the connection of habitat for

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			GenBank name and was renamed.	intersect the Mineralised Marra Mamba indicating this OTU has habitat which it may disperse across.		the Draculoides in the mining area. This group is known as troglobitic and therefore likely to have low dispersal abilities.
Gnaphosidae sp. B03	Gnaphosidae sp. B03	Pit and mounding	Singleton not a full specimen, ID on morphology	Collected in 2014 from MD2889. This site occurs in the pit however the drillhole is in CID/Pisolite which extends outside the area of impact. Recent high level troglofauna IDs from the 2025 targeted survey have identified other Gnaphosidae from outside the pits in more extensive habitat. Taxonomic resolution is poor.	Low	Habitat is CID/Pisolite and dispersal is possible.
Gracilanillus `BCO176`	Gracilanillus `BCO176`	Mounding	ID on morphology only.	Linear range 3 km, located in FHEZ, Hole ID MD3027 and MD6444	Low	In area of mounding and habitat is available. This sample location is also outside the Development Envelope within an area of conservation.
Hanseniella `MH1`	Hanseniella `MH1`	Mounding	ID on morphology only. May be same as Hanseniella `BSYM117`	Linear range 3 km. Collected in 2011 and 2012 from md_kar6, MD0393, MD0397. Hansiella BYM117 not restricted. Located in CID/Pisolite which is extensive and dispersal is possible as is seen by this OTU.	Low.	Habitat is CID/Pisolite and dispersal is possible.
Japygidae `BDP213`	Japygidae `BDP213`	Mounding	Closest match is from the Bennelongia database, Japygidae `MH1` which is 12.15% different	Linear range 6.2 km. Collected from MD7642 and MD9401 in 2022. This OTU was located in Mineralised Marra Mamba which is outside the pits and habitat remains from dispersal with mounding. Japygidaes	Low.	Located outside the pit area and sufficient habitat remains for dispersal.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			May be Japygidae 'MH1' or 'MH2' (not restricted)	have been found if different habitats in the mine area and appear to be able to disperse		
Japygidae `MH1`	Japygidae `MH1`	Pit and mounding	ID on morphology	Linear range 13.5 km. Collected from MD0266 and MD0486 in 2011 and 2012. Found in CID/Pisolite which allows for dispersal.	Low	Located outside the pit area and sufficient habitat remains for dispersal. Large linear range
n/a	Japygidae `sp. new OTU 1'	Mounding	Biologic determined Japygidae `BDP214`as two distinct taxonomic units (16.4% divergence between the two sequences). Therefore, one sequence required a new OTU code.	Located outside the pit area in Unmineralised Marra Mamba which is continuous. This OTU may also occur in Mineralised Marra Mamba which habitat exists proximal to the sample site.	Low	Located outside the pit area and sufficient habitat remains for dispersal. Large linear range
Linnaeolpium `BPS502`	Linnaeolpium `BPS502`	Mounding	Identified from juvenile, probably Linnaeolpium sp. B03	Singleton. Collected in 2019 MD4757. Located outside the mining area in Undifferentiated Tertiary Habitat which is extensive	Low	Habitat is considered extensive and dispersal possible.
Nocticola 'BLA008'	Nocticola 'BLA008'	Pit and mounding	Very juvenile specimen. No close matches, closest is Noticola sp. McP from Genbank which is 13.2% different (accession code OP242126).	Linear range 15.5 km. Collected from MD0398 (2019), MD0882 (2014). The Nocticola are known trogloxenes/troglophiles and show extensive dispersal. Was collected from CID/Pisolite in the MDIOM.	Low	Species shows dispersal capabilities and is known across the Pilbara for high dispersal capabilities.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
nr Andricophiloscia sp. B18	nr Andricophiloscia sp. B18	Mounding	ID on morphology of juvenile	Singleton. Collected from MD4542 in 2014. Located within unmineralised marra mamba. Ecological dependence is uncertain and given ID is on a juvenile the risk is considered low.	Low	Located within extensive habitat – may be edaphic.
Palpigradi `BPAL053`	Palpigradi `BPAL053`	Mounding	Very poor condition. Molecular completed, no genetic matches. may be Palpigradi `MH2`	Singleton. Collected from MD0401 in 2014. Sample site within CID/Pisolite which is extensive. Suitable habitat will remain with mounding. Recent targeted survey found Palpigradi across other CID/Pisolite habitat. Molecular work in underway.	Low	OTU occurs in CID/Pisolite which is extensive. Targeted group in 2025 survey with a number of Palpigradi yielded across mine area within CID/Pisolite.
Palpigradi `MH2`	Palpigradi `MH2`	Mounding	ID on morphology	Singleton. Collected from MD0398 in 2011. Noted as not being restricted in range. Located in CID/Pisolite which is extensive.	Low	OTU occurs in CID/Pisolite which is extensive. Targeted group in 2025 survey with a number of Palpigradi yielded across mine area within CID/Pisolite.
Palpigradi sp. MH1	Palpigradi 'Phoenix-MH1'	Pit and mounding	Genetically from Palpigradi sp. to MH1 (0.3% divergence in COI from 2014 specimen, only face was in sample. OTU updated to avoid confusion.	Linear range 0.3 km. Collected from MD0467 (2012) and MD2038 (2020) (not in pit). Both sites are in CID/Pisolite which is extensive.	Low	OTU occurs in CID/Pisolite which is extensive. Targeted group in 2025 survey with a number of Palpigradi yielded across mine area within CID/Pisolite.
Palpigradi sp. B18	Palpigradi sp. B18	Pit and mounding	May be Palpigradi 'MH1'. Difficult to	Linear range 4 km. Collected from MD0716 and MD1284 (2014). Both	Low	OTU occurs in CID/Pisolite which is extensive. Targeted

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			know if DNA completed	were collected in CID/Pisolite. Both sites are in CID/Pisolite which is extensive.		group in 2025 survey with a number of Palpigradi yielded across mine area within CID/Pisolite.
Parajapygidae sp. B30	Parajapygidae sp. B30	Pit and mounding	Probably Parajapygidae 'MH1'. Molecular analyses failed	Singleton. Collected from MD2094 in 2014. Located in CID/Pisolite habitat which is extensive	Moderate	Considerate moderate risk as this OTU only in occurs in the pit. Parajapygidaes have been found across the mine area. The recent 2025 survey found this group in the Unmineralised marra mamba where this OTU may occur.
Parajapyx `BDP217`	Parajapyx `BDP217`	Pit and mounding	ID on morphology	Singleton. Collected from MD3207 in 2020. This OTU is in Undifferentiated Tertiary over Mineralised Marra Mamba habitat which extends from sample site. Targeted in the recent 2025 survey.	High	While habitat exists for this OTU only one was recorded in the surveys. Parajapygidaes have been found across the mine area. The recent 2025 survey found this group in the a number of sites within the same habitat type. Molecular analyses are pending.
Pauropodidae `MH1`	Pauropodidae `MH1`	Pit and mounding	ID on morphology.	Singleton. Collected from MD0487 in 2011 in CID/Pisolite where extensive habitat remains and dispersal possible	Moderate	Level of risk remains as in CID/Pisolite though in pit and a singleton.
Pauropodidae `MH2`	Pauropodidae `MH2`	Pit and mounding	Pauropodidae 'MH1' and 'MH2' are distinct species. Pauropodidae 'BPU089' and 'BPU090' were separated by	Linear range 18 km. Collected from MD0396, MD0415, and MDH0143. Two sampling sites in CID/Pisolite which is extensive and outside of the pit.	Low	Located in habitat where dispersal is possible outside impact of the mounding.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			Biologic (see below).			
Pauropodidae 'MH3'	Pauropodidae 'MH3'	Pit and mounding	ID on morphology	Linear range 15 km collected in 2011 MD0467, MD2038	Low	Large linear range
Pauropodidae `BPU090`	Pauropodidae `BPU090`	Pit and mounding	Biologic determined Pauropodidae `BPU090`as two distinct taxonomic units (the two sequences are approximately 30% divergent from one another). Therefore, one sequence required a new OTU code (Pauropodidae New OTU 1 (not in area of impact – located on Northern haul road)	Found in pit but within the Undifferentiated Tertiary which is extensive. MD1545	Moderate	Located in habitat which is extensive, however it cannot be defined if in Mineralised Marra Mamba or Undifferentiated Tertiary
Phaconeura 'BHE036'	Phaconeura 'BHE036'	Mounding	Did not match P. sp. B04, 15% different in general. Genetic match on Genbank with Meenoplidae sp. WAM-PHAC001/H-HEM003 (accession	Singleton collected in 2020 from MD3805. Located in CID/Pisolite which is extensive and continuous from sample site	Moderate	Located in CID/Pisolite which is extensive and continuous from sample site

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			code MZ427776) which is 9.5% different. Potential new species			
Phaconeura sp. WAM `PHAC002`	Phaconeura sp. WAM `PHAC002`	Pit and mounding	Not P. B04, 15% different in general. Genetic match with Phaconeura sp. WAM PHAC002 (accession code MW021247) which is 1.5% differen	Linear range 14 km. Collected from MD0398 and MD2936 2019 and 2020. Several of these occur in the Undifferentiated Tertiary and CID/Pisoltite habitats which are extensive and connectivity occurs for dispersal across both. The majority of the other Phaconeuras were in Undifferentiated Tertiary habitat.	Low	Large linear range and in habitat with dispersal possible.
Projapygidae 'MH1'	Projapygidae 'MH1'	Pit and mounding	ID on morphology. May by synonomous with Projapygidae `BDP182`	Linear range 3.2 km. Collected from MD0259, MD0397 and MD0467 in 2019. Found in CID/Pisolite in mounding areas. Dispersal possible in habitat proximal to where they were collected.	Moderate	Habitat is considered extensive and dispersal possible
Projapygidae `BDP182`	Projapygidae `BDP182`	Pit and mounding	ID on morphology. Specimen in poor condition.	Singleton. Collected from MD2936 in 2019. Collected from Mineralised Marra Mamba.	Moderate	Located in Mineralised Marra Mamba and a singleton
Symphylella sp. B20	Symphylella sp. B20	Pit and mounding	DNA not successful. ID on morphology.	Linear range of 10 km. Collected from MD2926, MD6163 and MDRC2367. Collected in Undifferentiated Tertiary over Mineralised Marra Mamba.	Low	Large linear range and in habitat which is continuous.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
	Symphylella `BSYM137`	Pit and mounding	Sequence name was left at morphological ID and not updated to Genetic ID. This code does not appear in Bennelongia (2024a) tables, only in the appendix.	Singleton. Located in CID/Pisolite overlying Mineralised Marra Mamba.	Moderate	Considered moderate as a singleton though in habitat which is considered extensive.
Trinemura `BZY102`	Trinemura `BZY102`	Pit and mounding	Genetic match between two samples. Closest match is Trinemura sp. B28 from Mulga East which is 11.1% different. Sequence name reflects ID from the COI sequence for the same specimen. One specimen from MD0790 has been split into two OTUs by Biologic (see below)	Singleton. MD2453 in 2014. Located in Undifferentiated Tertiary and in Mineralised Marra Mamba. The Trinemura are known troglofauna however they show high dispersal throughout the footprint.	Moderate	As it is a singleton a level of risk remains. However the Trinemura show dispersal capability as a group. Located in habitat which is connected through mine area.
n/a	Trinemura New OTU 1	Pit and mounding	Formerly Trinemura BZY102. With 9.7% Intraspecific divergence, this specimen was split from specimen collected at	MD2453 (2014) is located in Mineralised Marra Mamba. Dispersal may be possible within this habitat. As this only occurs in this habitat this OTU may not have dispersal capabilities	High	New OTU and a singleton located in a pit.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			MD0790 which is consistent with previous Biologic Zygentoma OTU designations.			
Trinemura sp. B28	Trinemura sp. B28	Mounding	ID on morphology	The Trinemura are known troglofauna however they show high dispersal throughout the footprint. Located in CID/Pisolite in areas of mounding and shows dispersal across the mining area.	Low	Dispersal is possible through known habitats.
Trochanteriidae sp. B01	Trochanteriidae sp. B01	Mounding	ID on morphology. Not definite troglofauna	Singleton collected from MD0635 in 2014. Located at extend of mounding away in Undifferentiated Tertiary which is extensive. Given the question of troglomosphism of this specimen it is considered low. Other Trochanteriidae collected east of the project area outside.	Low	High dispersal in connected habitat. Troglomorphism questionable.
Troglarmadillo 'BIS392'	Troglarmadillo 'BIS392'	Mounding	14.1% divergent to Troglarmadillo sp. B03. Different species	Singleton. Collected from MD0350 in 2020 in Undifferentiated Tertiary which is extensive. Other Troglarmadillo appear to high dispersal capacity from survey data.	Low	Located in habitat where dispersal is possible
Troglarmadillo 'BIS562'	Troglarmadillo 'BIS562'	Mounding	Very juvenile individuals. Closest matches are Troglarmadillo BIS345 and Buddelundia sp. Biologic-ISOP006	Only collected from one site - MDRC1351 in 2023 in Undifferentiated Tertiary which is extensive. Other Troglarmadillo appear to high dispersal capacity from survey data.	Low	Located in habitat where dispersal is possible

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level	Reason
			(17.7 and 17.6% similarity).			
Troglarmadillo 'MH1'	Troglarmadillo 'MH1'	Pit and mounding	ID on morphology (2012)	Singleton. Collected from MD0467 in 2012 which is in CID/Pisolite habitat. Other Troglarmadillo appear to high dispersal capacity from survey data.	Low	Located in habitat where dispersal is possible.
Troglarmadillo sp. B04	Troglarmadillo sp. B04	Mounding	ID on morphology and 2008 collection specimen no longer avaiable.	Singleton. Collected from WF0138. Old specimen (2008) and in Undifferentiated Tertiary to the far west of the mounding area of impact. This OTU was included as in Bennelongia (2024a) report	Low	Located in habitat where dispersal is possible,. Not considered in high impact area. ID uncertain.
Troglarmadillo sp. B05	Troglarmadillo sp. B05	Mounding	ID on morphology and 2008 collection specimen no longer available	Singleton. Collected from WF0138. Old specimen (2008) and in Undifferentiated Tertiary to the far west of the mounding area of impact. This OTU was included as in Bennelongia (2024a) report	Low	Located in habitat where dispersal is possible,. Not considered in high impact area. ID uncertain.
Tyrannochthonius `BPS229`	Tyrannochthonius `BPS229`	Mounding	Nearest match is Tyrannochthonius aff. basme H-PC050 (accession code MZ425011) which is 18% divergent. New species	Linear range 11 km. Collected from MD1556 and MD4821 in 2019 and 2020. Located in Undifferentiated Tertiary in the far south east section of the mounding which is continuous.	Low	New species but has a large linear range which reduces risk and located in extensive habitat.
Tyrannochthonius sp. B35	Tyrannochthonius sp. B35	Pit and mounding	This specimen is synonomous with B36 (outside impact).	Linear range 11 km MD0884 and MD3661 in 2014. Located in Undifferentiated Tertiary and in CID/Pisolite, both which are continuous	Low	Large linear range and in habitat which is connected outside areas of impact.

8.3.4.2 Troglofauna Distribution and Habitat Connectivity

Physical Connectivity

The lithological units of Upper Calcrete and CID/Pisolite which support troglofauna habitat occur across the Development Envelope and beyond and are mostly continuous. The unit Mineralised Marra Mamba occurs as discontinuous pods where they are associated with the mineralisation (AQ2 2024b).

While the likely troglofauna habitats have been proposed, the occupancy by troglofauna within each unit is assumed. It is understood that troglofauna tend to migrate within the open drill hole, meaning trap depths are not necessarily representative of the habitat location of the sampled troglofauna. Troglofauna have been identified from traps and scrape samples collected from drillholes both within the proposed pit footprints and outside of the pits across the Development Envelope.

Many of the troglofauna identified as restricted (having limited liner ranges) were from drillholes located within the CID/Pisolite habitat and the Mineralised Marra Mamba lithologies (Figure 8-6). This is to be expected as this was the focus of the intense sampling effort. Not all these taxa were confined to the proposed pits. Table 8-6 identifies the type of impact they are in. The distribution of the troglofauna which have limited ranges based on the outcomes of the surveys are shown in Appendix 6 of the Bennelongia (2024a).

On review of the data the troglofauna determined to be SREs within the areas of impact based on the updated dataset are presented in Figure 8-14. Additionally, these OTUs are also presented in Figure 8-15 in the context of the 2025 targeted troglofauna survey. The purpose of this figure is to highlight that further work has been undertaken to determine the level of dispersal for several of the OTUs which were restricted to the Mineralised Marra Mamba habitat in particular those restricted to the proposed pits. To date several of the same groups which were targeted in this survey have been collected, though the identifications are only high level. Molecular analyses are pending for this work.

The location of selected troglofauna (primarily those with very limited ranges considered to be at the most risk from the Proposal) have been mapped over the lithologies as identified in the 3D habitat assessment (AQ2 2024b). These OTUs are presented in Figure 8-16. The areas of impact are the direct impact caused by loss of habitat through excavation of the pits as this is considered the greatest risk. Many of the OTUs which occur in areas of mounding are in habitat which allows for dispersal. The troglofauna are also considered to occur within the upper 40 m (this is consistent with many of the surveys undertaken in the Pilbara as stated in Lopez et al. 2025). As such, the area of impact considered the greatest risk is from the excavation of the mine pits.

Biological Connectivity

Habitat characterisation suggests that most of the troglofauna known only from the mine pits may have limited ranges. Troglofauna located within the Mineralised Marra Mamba and the Upper Calcrete habitats are considered most likely to have more limited distribution as these two habitat types are discontinuous above the water table.

A review of the survey data indicates that dispersal across the habitats is likely, however the Mineralised Marra Mamba forms discontinuous pods which can fragment the troglofauna. Many taxa following targeted surveys and further taxonomic resolution were found to have greater linear ranges than initially concluded.

Figure 8-15 shows the location of restricted troglofauna within mapped habitat. The distribution of the different troglofauna groups across habitat is shown in Bennelongia (2024a). Several of the groups show dispersal across similar habitat. This is noted in Table 8-6 where troglofauna such as the various Cryptos OTUs are found across the Undifferentiated Tertiary habitat as well as the CID/Pisolite. Additional troglofauna such as the Draculoides were found in habitat varying from the Undifferentiated Tertiary to only occurring in Mineralised Marra mamba. However, the troglobitic status of these would suggest dispersal is still limited. Many of the troglofauna are located in the same sample site as a number of other congeneric taxa which show a high level of dispersal.

While the term surrogate has not been applied to this assessment, the location of many of the SRE taxa within the same habitat as congeneric OTUs indicates that dispersal is highly likely across continuous habitats.

Many of the troglofauna collected from the surveys were found in lithologies which were contiguous. The sequence of the habitat is shown in **Table 8-5.** The Unmineralised Marra Mamba habitat is not contiguous across the landscape and occurs in areas where the overlying lithologies were contiguous. These habitats were found to continue across the landscape and are shown in **Figure 8-16**. It was therefore considered highly likely that the troglofauna occurred in these lithologies closer to the surface. It is assumed from other surveys and literature that troglofauna are primarily in the upper lithologies. A study by Lopes Paula et al (2025) looking at the distribution of troglofauna in the Pilbara concluded that troglofauna were primarily in the lithologies within the first 40 mbgl.

Figure 8-14: Distribution of SRE troglofauna at MDIOM

645000 650000 655000 660000 665000 670000 675000 680000 685000 690000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000

Troglofauna

- Austrochthonius `BPS257`
- Buddelundia sp. B57
- Campodeidae `BDP216`
- Coleoptera `BCO207`
- Cryptops `Phoenix-MH1`
- Cryptops sp. B41
- Cryptops sp. B42
- Draculoides `MH2`
- Draculoides `sp. WAM-SCH084`
- Hanseniella `BSYM117`
- Holoparamecus `BCO208`
- Japygidae `BDP213`
- Japygidae `BDP214`
- Japygidae `sp. new OTU 1`
- Japygidae `sp. new OTU 2`
- Linnaeolpium `BPS502`
- Olpiidae `BPS565`
- Palpigradi 'Phoenix-MH1'
- Palpigradi sp. B18
- Parajapygidae 'Phoenix-MH1'
- Parajapyx `BDP217`
- Pauropodidae `BPU089`
- Pauropodidae `BPU090`
- Pauropodidae `BPU098`
- Pauropodidae `sp. new OTU 1`
- Projapygidae `BDP182`
- Projapygidae `BDP215`
- Symphylella `BSYM137`
- Trinemura `BZY102`
- Trinemura `sp. new OTU 1`
- Trinemura sp. B28
- Troglarmadillo `BIS392`
- Troglarmadillo `BIS562`
- Troglarmadillo sp. B54

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Roads (LGATE-195)

- Highway

JBS&G

Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC
Scale 1:150,000 at A3	

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Kilometers

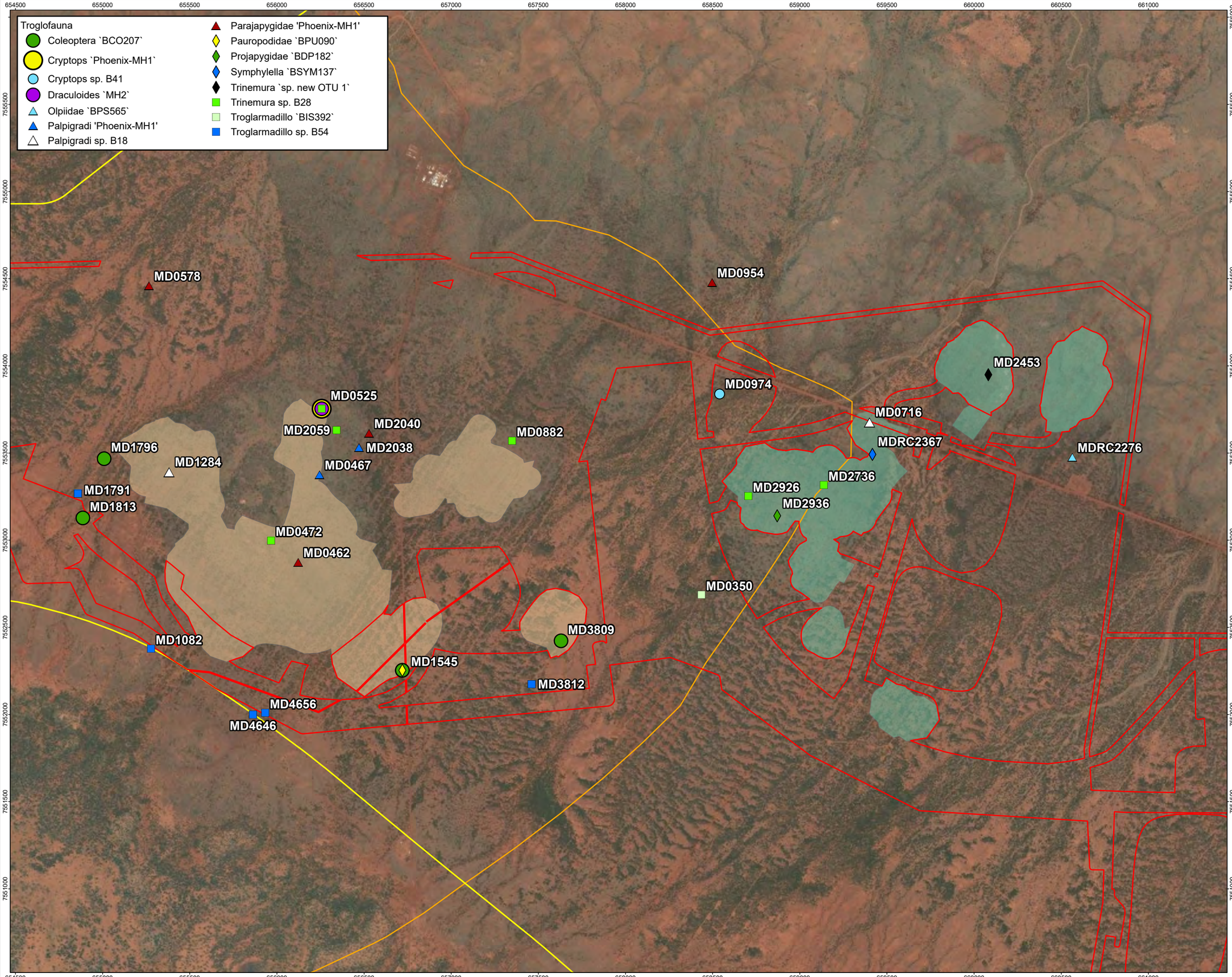
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SRES WITHIN AREAS OF IMPACT

FIGURE 8.14 Map 1 of 4

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Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Murray's Hill



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Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:20,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SRES
WITHIN AREAS OF IMPACT

FIGURE 8.14 Map 2 of 4

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Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_14_MS_ Troglofauna SREs within areas of impact

Troglofauna
- Buddelundia sp. B57
- Campodeidae `BDP216`
- Cryptops `Phoenix-MH1`
- Cryptops sp. B42
- Japygidae `sp. new OTU 1`
- Linnaeolpium `BPS502`
- Pauropodidae `BPU089`
- Trinemura `BZY102`
- Trinemura sp. B28
- Troglarmadillo sp. B54

MD2674
MD3087
MD9401
MD3771
MD0790
MD3980
MD0298
MD4969
MD4757
MD4821
MD4824

661500 662000 662500 663000 663500 664000 664500 665000 665500 666000 666500 667000 667500 668000

7553500 7553000 7552500 7552000 7551500 7551000 7550500 7550000 7549500 7549000 7548500

Legend
- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits
- Fridge Central
- Fridge Hill
- Fridge West

JBS&G

Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:20,000 at A3

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Kilometers

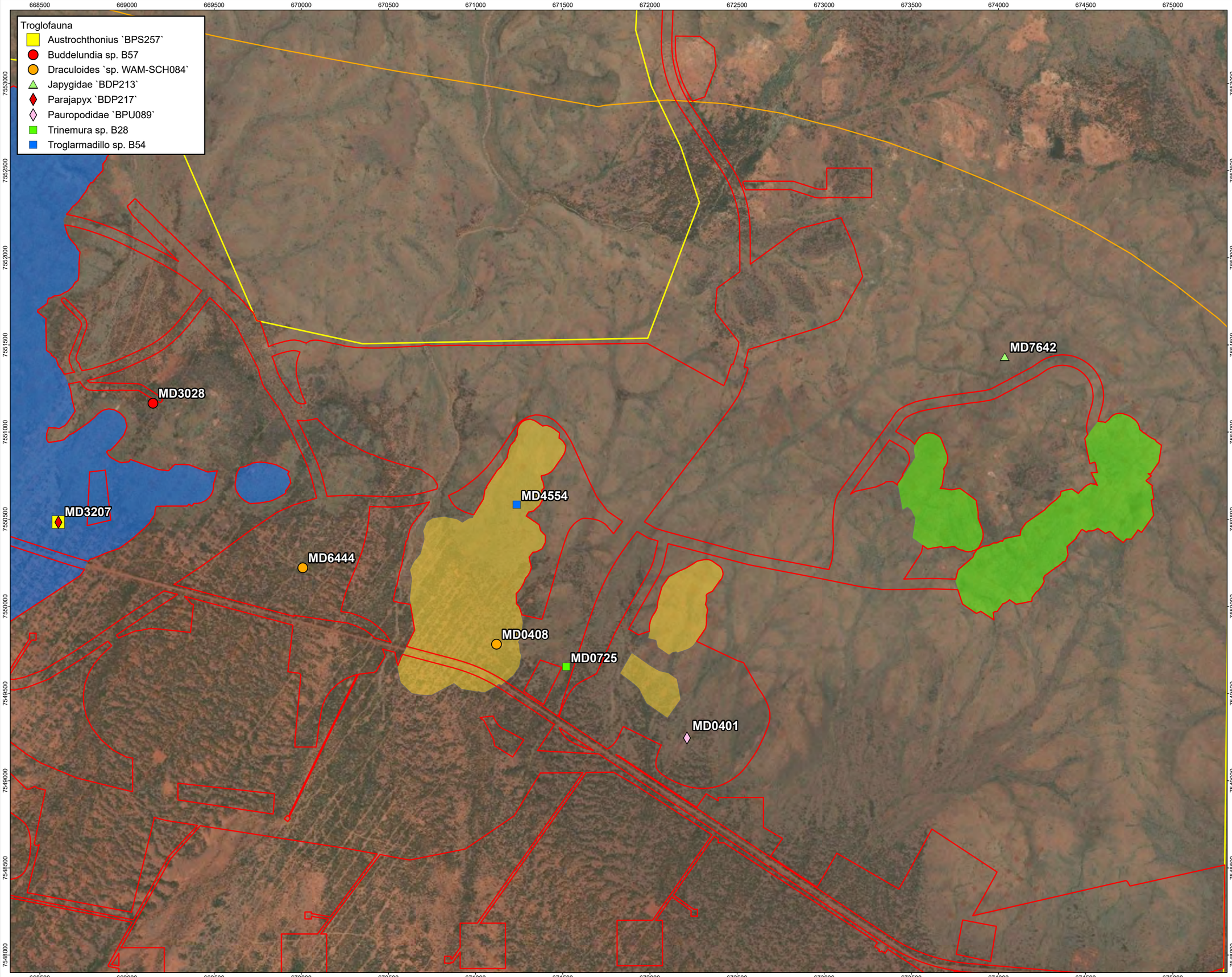
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SRES WITHIN AREAS OF IMPACT

FIGURE 8.14 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_14_MS_ Troglofauna SREs within areas of impact



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Fridge Hill
- Horseshoe Hill
- Horseshoe West



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Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:20,000 at A3

0 0.25 0.5
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

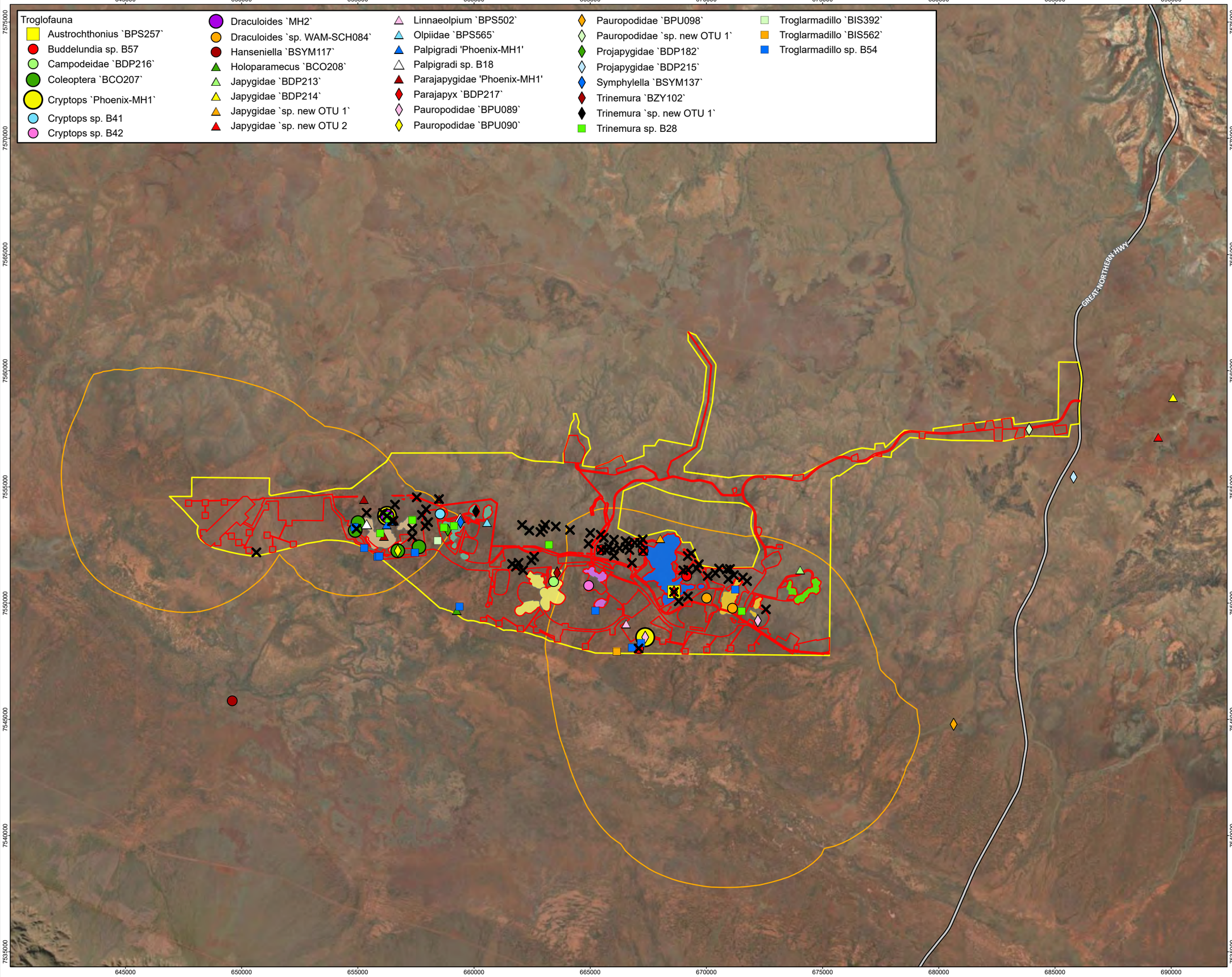
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TROGLOFAUNA SRES WITHIN AREAS OF IMPACT

FIGURE 8.14 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_14_MS_ Troglofauna SREs within areas of impact

Figure 8-15: Location of potential SRE troglofauna and sites of the 2025 targeted troglofauna survey



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Fridge Central
- Fridge Hill
- Fridge West
- Horseshoe Hill
- Horseshoe West
- Murray's Hill

Roads (LGATE-195)

- Highway
- 2025 Targeted survey (Biologic)

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Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC
Scale 1:150,000 at A3	

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Kilometers

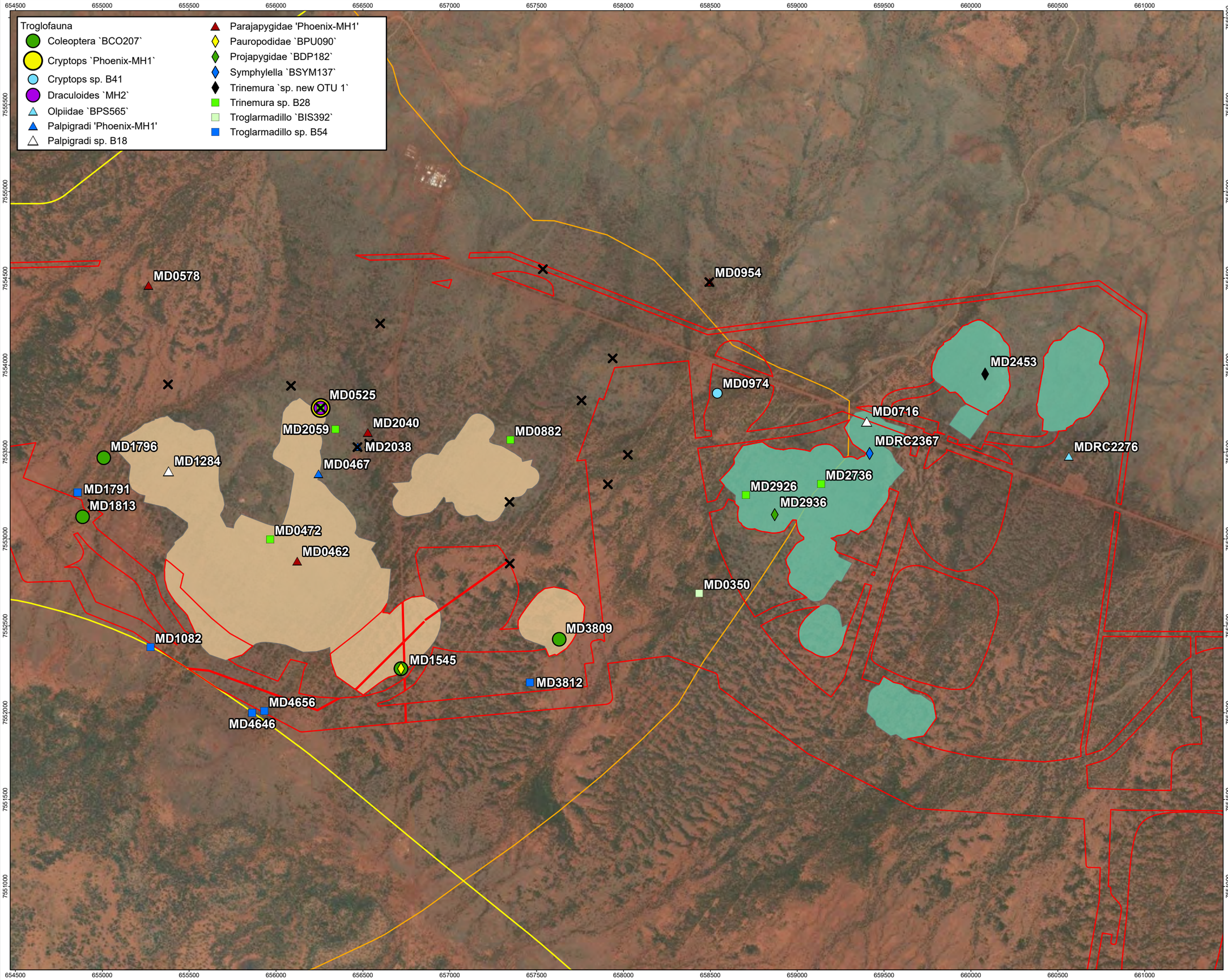
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TARGETED TROGLOFAUNA SURVEY 2025 OVERVIEW

FIGURE 8.15 Map 1 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_15_MS_ Targeted troglofauna survey 2025 overview



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Anticline Hill
- Murray's Hill
- 2025 Targeted survey (Biologic)



JBS&G

Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
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Scale 1:20,000 at A3

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Kilometers

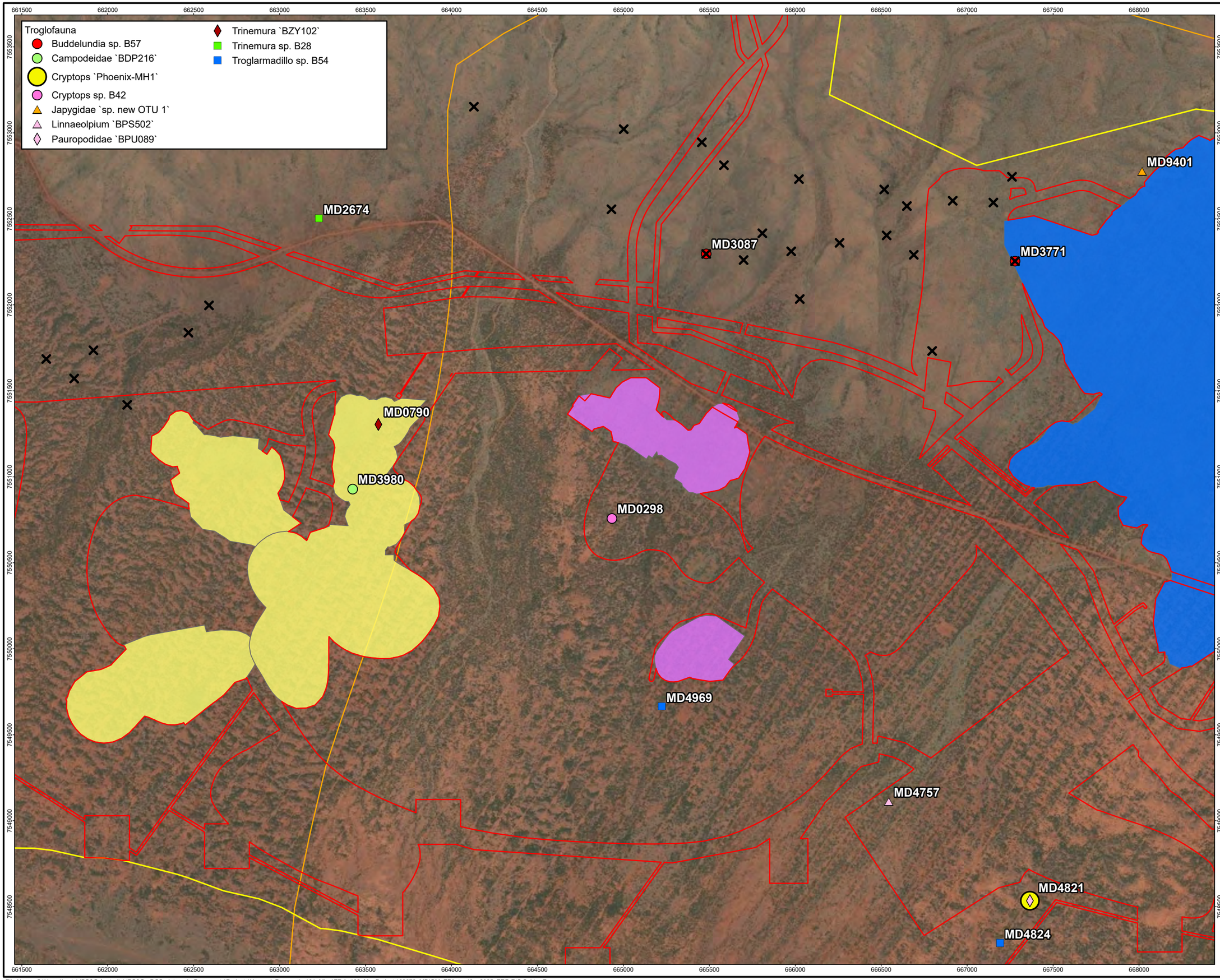
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TARGETED TROGLOFAUNA SURVEY 2025 OVERVIEW

FIGURE 8.15 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_15_MS_ Targeted troglofauna survey 2025 overview



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Fridge Central
- Fridge Hill
- Fridge West
- 2025 Targeted survey (Biologic)



JBS&G

Job No: 68676	
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Scale 1:20,000 at A3

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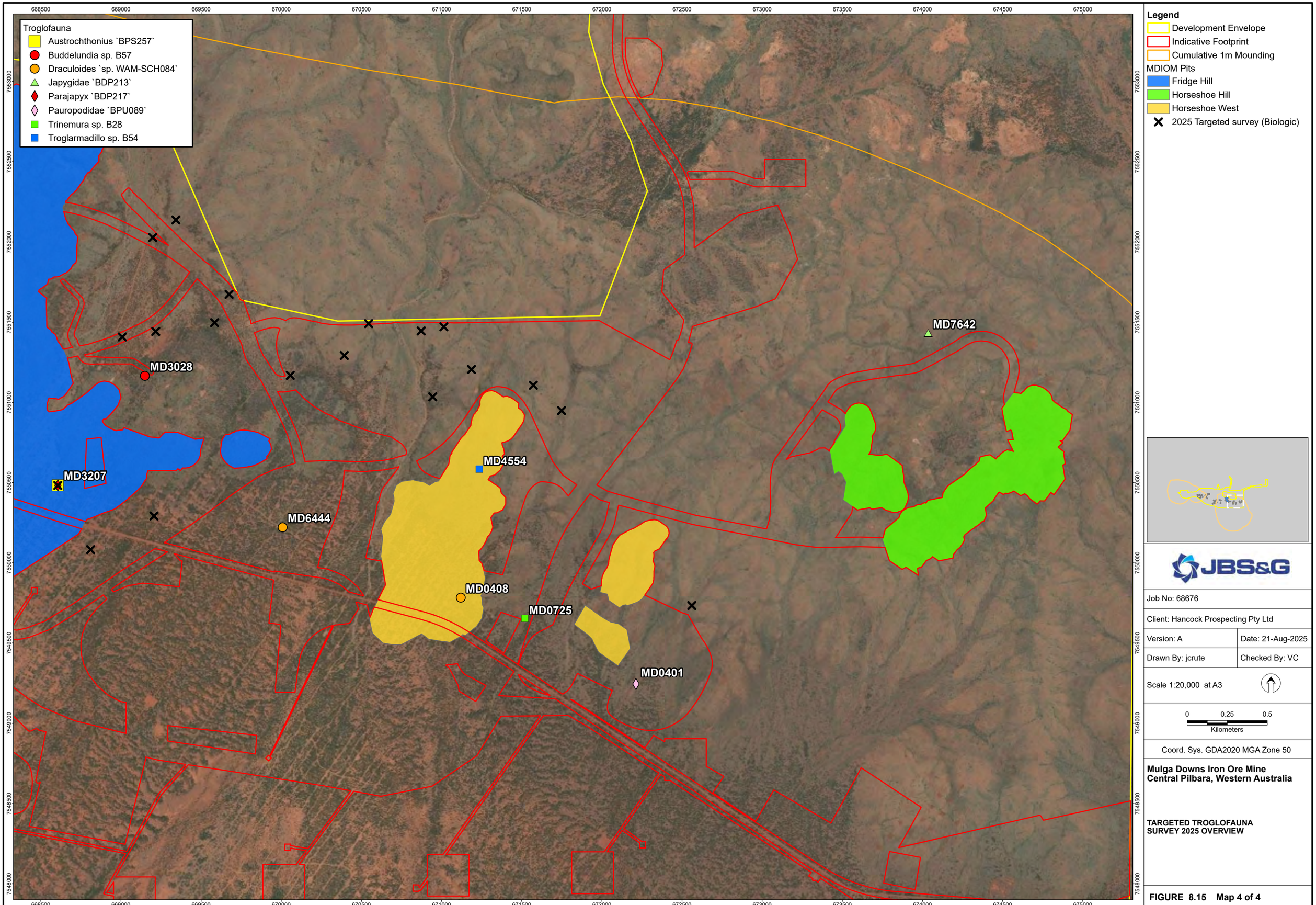
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TARGETED TROGLOFAUNA SURVEY 2025 OVERVIEW

FIGURE 8.15 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_15_MS_ Targeted troglofauna survey 2025 overview



Legend

- Development Envelope
- Indicative Footprint
- Cumulative 1m Mounding

MDIOM Pits

- Fridge Hill
- Horseshoe Hill
- Horseshoe West
- 2025 Targeted survey (Biologic)

JBS&G

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Scale 1:20,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

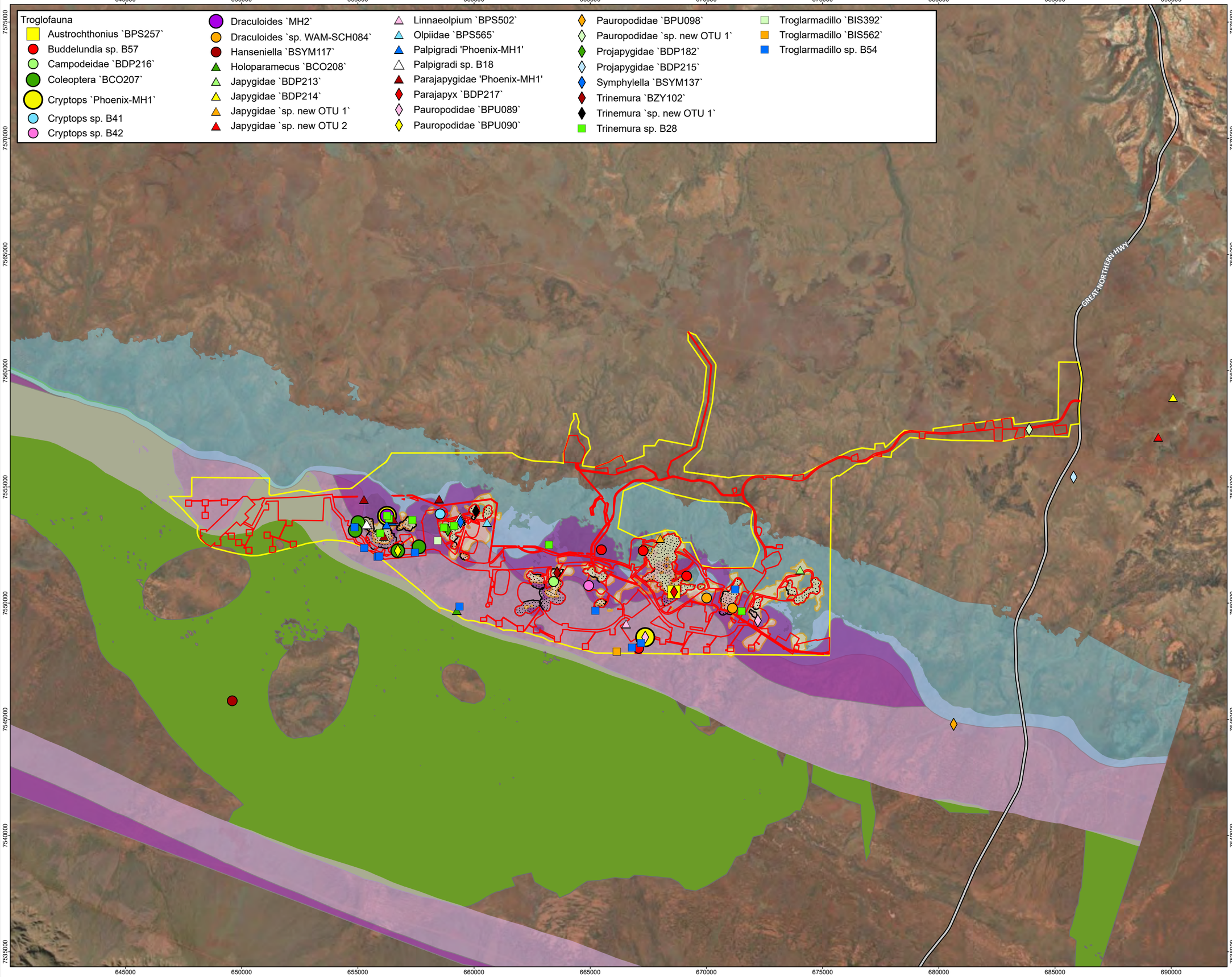
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TARGETED TROGLOFAUNA SURVEY 2025 OVERVIEW

FIGURE 8.15 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_15_MS_ Targeted troglofauna survey 2025 overview

Figure 8-16: SRE troglofauna distribution across known habitat and areas of direct impact.



Legend

- Development Envelope
- Indicative Footprint
- Pits

Troglofauna habitat

- CID/Pisolite
- Mineralised Marra Mamba
- Undifferentiated sediments
- Calcrete
- Unmineralised Marra Mamba

Roads (LGATE-195)

- Highway

JBS&G

Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:150,000 at A3

0 2.5 5
Kilometers

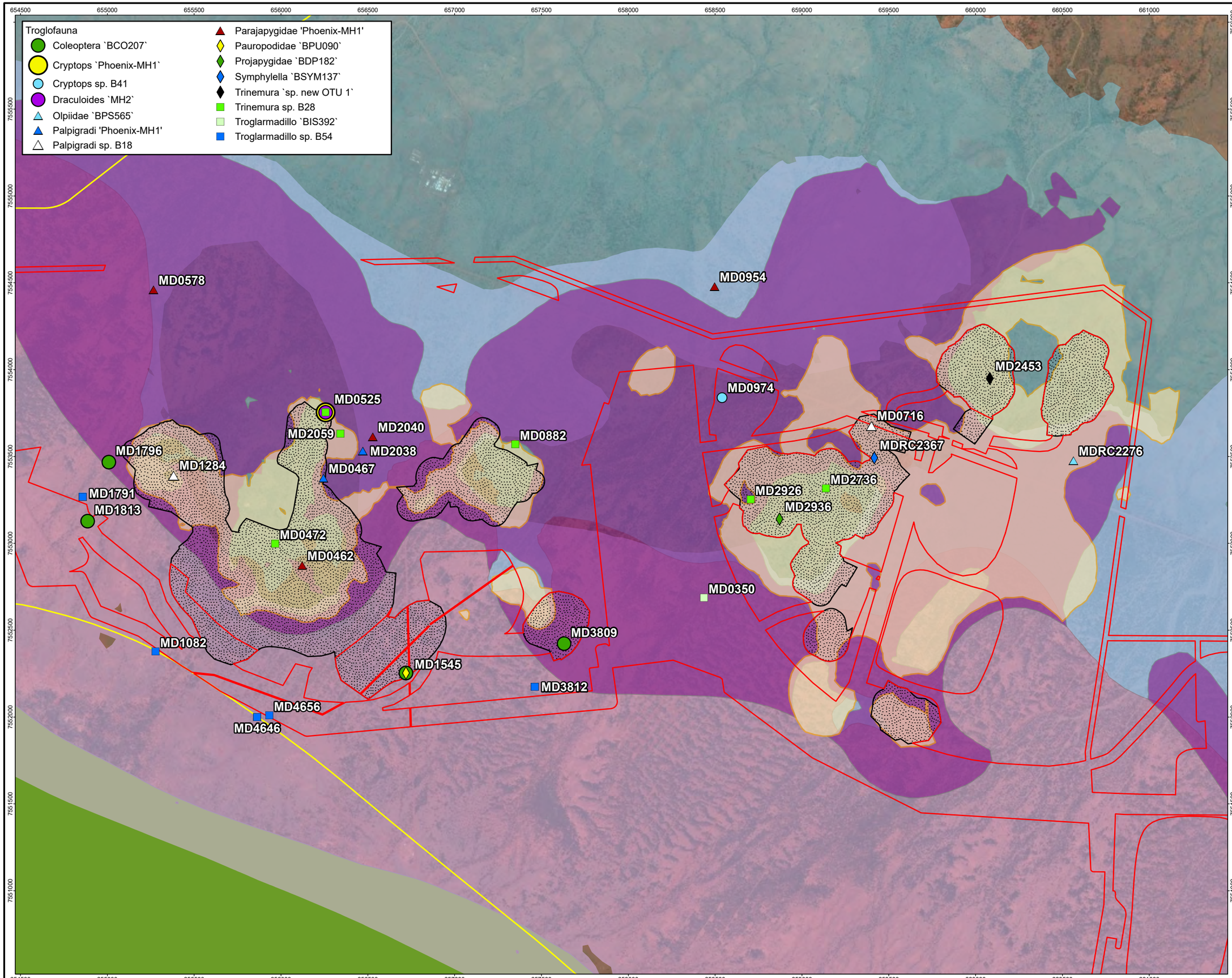
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SRE TROGLOFAUNA DISTRIBUTION ACROSS HABITAT

FIGURE 8.16 Map 1 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_16_MS_SRE troglofauna distribution



Legend

- Development Envelope
- Indicative Footprint
- Pits

Troglofauna habitat

- CID/Pisolite
- Mineralised Marra Mamba
- Undifferentiated sediments
- Calcrete
- Unmineralised Marra Mamba

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Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:20,000 at A3

0 0.25 0.5
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SRE TROGLOFAUNA DISTRIBUTION ACROSS HABITAT

FIGURE 8.16 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_16_MS_SRE troglofauna distribution

Troglofauna
- Buddelundia sp. B57
- Campodeidae `BDP216`
- Cryptops `Phoenix-MH1`
- Cryptops sp. B42
- Japygidae `sp. new OTU 1`
- Linnaeolpium `BPS502`
- Pauropodidae `BPU089`
- Trinemura `BZY102`
- Trinemura sp. B28
- Troglarmadillo sp. B54

MD2674
MD3087
MD9401
MD3771
MD0790
MD3980
MD0298
MD4969
MD4757
MD4821
MD4824

Legend
- Development Envelope
- Indicative Footprint
- Pits

Troglofauna habitat
- CID/Pisolite
- Mineralised Marra Mamba
- Undifferentiated sediments
- Calcrete
- Unmineralised Marra Mamba

JBS&G

Job No: 68676	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 21-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:20,000 at A3

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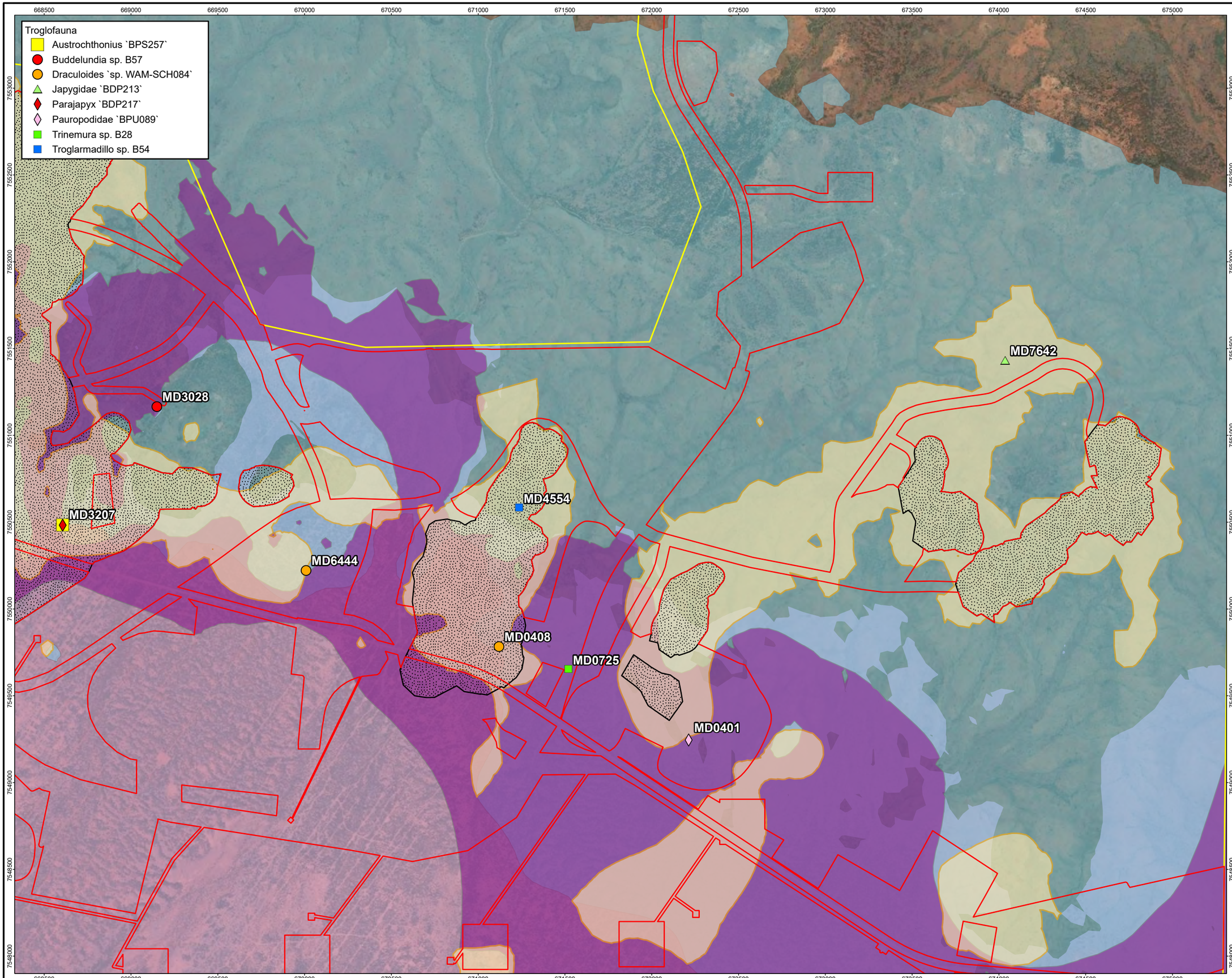
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SRE TROGLOFAUNA DISTRIBUTION ACROSS HABITAT

FIGURE 8.16 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_16_MS_SRE troglofauna distribution



Legend

- Development Envelope
- Indicative Footprint
- Pits

Troglofauna habitat

- CID/Pisolite
- Mineralised Marra Mamba
- Undifferentiated sediments
- Unmineralised Marra Mamba



JBS&G

Job No: 68676	
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Scale 1:20,000 at A3

0 0.25 0.5
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SRE TROGLOFAUNA DISTRIBUTION ACROSS HABITAT

FIGURE 8.16 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_16_MS_SRE troglofauna distribution

8.3.4.3 Stygofauna

The combined results of all surveys, as presented in the updated dataset, yielded at least 173 stygofauna operational taxonomic units (OTUs) from 11,036 specimens since 2009-2024. From the 2019-2024 dataset 146 stygofauna OTUs were confirmed in the final dataset from 8,644 specimens collected within the Proposal and in the adjacent landscape (Bennelongia, 2024a; Biologic 2025b).

Groups represented include ostracods, harpacticoid and cyclopoid copepods, amphipods and isopods, annelid worms, syncarids species), rotifers, mites, flatworms, polychaete worms, a spelaeogriphacid species and nematode worms. The nematodes, flatworms or rotifers are not routinely included in environmental impacts involving subterranean fauna and they are not included in the EIA.

The findings in the Bennelongia (2024a) report found from 12,045 specimens of at least 150 stygofauna species have been collected from the MDIOM. Up to six species may be duplicate names and at least two worm species, may comprise multiple species. Invertebrate groups represented at the MDIOM include copepods, ostracods, amphipods, annelid worms, syncarids, rotifers, isopods, mites, spelaeogriphacids, flatworms and nematode worms (treated as a single species but together with flatworms and rotifers not assessed in environmental impact assessments; EPA 2016).

Thirteen stygofauna species were identified as having limited ranges and considered restricted by Bennelongia (2024a). While there were no potential duplicate species in their list there was still some uncertainty regarding the final identifications of some of the taxa.

A revised assessment of the stygofauna Bennelongia (2024a) considered to be restricted is presented in Table 8-7. This table also considers any new listings (as OTUs) by Biologic based on their review and reanalysis of the molecular data. No additional specimen identifications have been added to this dataset. Table 8-13 also presents a risk ranking for these SREs. The risk ranking and the rationale for this ranking is outlined in Section 8.3.2.8. Ranking is defined as Low risk, Moderate risk or High risk from the Proposal. A further assessment on the risk of the Proposal to taxa which have moderate to high risk is provided in Section 8.6.3).

Table 8-7 presents 12 OTUs which may be considered as SREs. However, the risk ranking applied has identified that none were considered at high risk based on their distribution throughout the mining area and their ability to disperse. This is further discussed in Section 8.4.3.2 and presented in Table 8-13. Many of the taxa have distributions greater than originally stated. Several of the OTUs/taxa have been included in this table as they were considered by Bennelongia as being at risk. A number of the taxa which present as restricted were from identification completed pre 2019 and there was no information supporting the identification, including field data. The data from 2019 to 2024 is the information considered the most reliable.

Ranges of stygofauna species within the MDIOM are very variable, even when known stygophiles (with potential for surface dispersal) are excluded. Bennelongia concluded that when stygophiles are included, nearly half of the species recorded at MDIOM have linear ranges >70 km. While the known ranges of most species expand as the amount of sampling increases, it would still be expected and the theoretical considerations put forward in Eberhard et al. (2009) and Halse et al. (2014) that most species known only from single sites at the MDIOM have linear ranges of <30 km. According to Bennelongia (2024a), fifty-seven per cent of stygofauna species known only from areas of groundwater disturbance were collected from single holes on one or more dates, compared

with 18% of all stygofauna species. Thus, a substantial proportion of the species known only from areas of groundwater disturbance are likely to have relatively small ranges.

These taxa were also collected from more than one sampling location. While still considered within a limited linear range and within the areas of proposed impact, this demonstrates dispersal. Many of the syncarids in the Pilbara are known to disperse along drainage lines within the same catchment. However, in more complex hydrological settings where there is discontinuity, dispersal is limited (Perina et al, 2024). The hydrological setting at Mulga Downs is continuous.

On review of the data, the majority of the taxa listed as restricted were collected from sites which hadwith a high diversity of other stygofauna, including species from the same taxonomic group. This is to be considered when assessing dispersal capability of stygofauna, particularly in environments where there is connectivity. While these 13 taxa have been categorised as SREs, their capacity to disperse is considered in this assessment.

None of the stygofauna taxa, nor the communities recorded in the Development Envelope, are listed or recognised as having conservation significance under the BC Act or DBCA listings.

Table 8-7: Stygofauna collected from the MDIOM subterranean fauna surveys identified as having limited linear ranges (SREs) within areas of impact. Ranking on the level of risk has been applied to each of the OTUs.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact Type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level
Areacandona `BOS1381`	Areacandona `BOS1381`	Drawdown and predicted extent of salinity changes	Taxonomy was based on morphology. One specimen was collected in 2011 and was integrated male. 2019 identifications on valves only. Specimen was noted as potentially being *A. clementia*. No molecular analyses completed.	Known Linear range of 7 km. Collected from Robinson Well and MD0462. Collected from habitat which is considered extensive (Upper Calcrete). Given the distribution of other Areacandona it is unlikely that this OTU is restricted.	Moderate. The SRE status of this OTU is now considered the result of poor taxonomic resolution, based on two specimens and very limited morphological feature.
Atopobathynella sp. B09 (Parabathynellidae `MH1`)	Atopobathynella sp. B09 (Parabathynellidae `MH1`)	Drawdown and predicted extent of salinity changes	Taxonomy on morphology. Two specimens from 2012 collected using a Karaman-Chappuis. Specimens collected using net included 3 juveniles. No molecular analyses completed.	Known linear range of 3 km. Karaman-Chappuis used at md_kar7 no details on depth to SWL or end of hole (EoH). Other specimens were from MD0429 collected in 2012. No field data collected. Specimens collected from Marra Mamba habitat.	Low. Collected in 2012 IDs on limited morphology and could not be further reconciled. Considered in terms of habitat which is extensive.
Billibathynella `BSY244`	Billibathynella `BSY244`	Drawdown	Closest match from BLAST search was with Parabathynellidae sp. Biologic-PBAT003. DNA may be uncertain as definite morphological feature present on one male specimen	Ony collected from one site – MDWB0037 in 2022. This OTU was collected within the Upper Calcrete habitat which is extensive throughout the Fortescue Valley	Low. Considered in terms of habitat which is extensive.
Brevisomabathynella `BSY233`	Brevisomabathynella `BSY233`	Drawdown	Specimen was small with very long antenna signifying	Singleton collected in 2022 from MDWM0038. This	Moderate as is a new species. Considered in

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact Type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level
			stygofauna. Molecular analyses identified nearest match is Brevisomabathynella pilbaraensis which is 23.7% divergent. Considered a new species	OTU was collected within the Upper Calcrete habitat which is extensive throughout the Fortescue Valley	terms of habitat which is extensive.
Dussartstenocaris `BHA335`	Dussartstenocaris `BHA335`	Drawdown	Collected in 2022. Initial examination showed very long furca. Molecular analyses found nearest match was Laophonte longicaudata, which is 19.1%. Considered a separate species	Singleton. Collected from MDWB0038 in 2022. May be synonymous with Dussartstenocaris sp. B01 (65 specimens collected) which has a distribution range of 53 km. This OTU was collected within the Upper Calcrete habitat which is extensive throughout the Fortescue Valley	Moderate. This taxon was collected within Upper Calcrete which is extensive and unconfined.
Maarrka `BAM182`	Maarrka `BAM182`	Drawdown	Molecular sequencing found 19.9% and 14.5% divergent from specimens at site Unknown 5 and Maarrka sp. 1 TLF-2008. New species	Collected only from one site twice in 2020 and 2022 - MDWB0038 (site renamed from MDCMB09). This OTU was collected from the Upper Calcrete from a very shallow	Moderate. This taxon was collected within Upper Calcrete which is extensive and unconfined.
nr Billibathynella `MH2` (Parabathynellidae `MH2`)	nr Billibathynella `MH2` (Parabathynellidae `MH2`)	Drawdown and predicted extent of salinity changes	No comments on this specimen and ID only on morphology	Known linear range of 18 km. Collected in 2012 from md_kar6 using Karaman-Chappuis and sites MD0369, MD0509' MD0533' MD0562 using net.	Moderate risk given the absence of information on their identifications, absence of any field records. A linear range of 18 km suggest dispersal capabilities.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact Type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level
Parabathynellidae `MH3`	Parabathynellidae `MH3`	Drawdown and predicted extent of salinity changes	ID was on morphology only with no description given. Their identifications could not be reconciled further by Biologic (2025b) and their names remain	Singleton. Collected in 2012 at MD0525 within Marra Mamba habitat. This OTU occurs in habitat which is considered continuous and extensive primarily the hydrated Marra Mamba which occurs along northern extent of the Development Envelope. This area is also at higher altitude and has extensive drainage lines, which is likely habitat for these Syncarids.	Moderate. Risk is considered in terms of habitat.
Pilbaranella `MH1`	Pilbaranella `MH1`	Drawdown and predicted extent of salinity changes	These taxa were grouped by Bennelongia as possibly being reduced to three species. IDs were on morphology only with no description given. Their identifications could not be reconciled further by Biologic (2025b) and their names remain. A match of P. MH1 with Pilbaranella BSY380 was considered 15.6 % divergent but there is not further explanation to this. P. BSY380 was collected twice within the Mula West	Linear range for this OTU is 16 km. All collected in 2012 from md_kar 6, MDO499, MD0577, MD0462, MD0974. This OTU occurs in habitats which are considered continuous and extensive primarily the hydrated Marra Mamba which occurs along northern extent of the Development Envelope. This area is also at higher altitude and has extensive drainage lines, which is likely habitat for these Syncarids.	Moderate. While this is considered a stygobitic genus and their ranges may be limited, they were collected in habitat which is considered extensive and contiguous. This group occurs in the less saline areas and remain in the higher altitude Marra Mamba habitat. The other Pilbaranella BSY380 was located at Mulga West Borefield to the east.

Lowest Taxonomic Unit (LTU) (Bennelongia (2024a)	Operational Taxonomic Unit (OTU) (Biologic 2025b)	Impact Type	Taxonomic Factor	Distribution and Ecological Factor	Risk Level
Pilbaranella `MH2`	Pilbaranella `MH2`	Drawdown and predicted extent of salinity changes	Borefield and not in an area of impact.	Singleton only collected at MD0462 in 2012. Collected from hydrated Marra Mamba habitat.	
Pilbaranella sp. B18	Pilbaranella B18	Drawdown		Singleton only collected at MD0974 in 2014. This OTU was collected from the hydrated Marra Mamba habitat flanking the Chichester.	
Schizopera `BHA277`	Schizopera `BHA277`	Drawdown	ID on morphology only	Singleton collected from MDPZ7458C in 2019 from Upper Calcrete habitat which is extensive. Collected in area with high baseline groundwater salinities (12,000 µS/cm)	Low. Occurs in habitat which is extensive.

8.3.4.4 Stygofauna Distribution and Habitat Connectivity

There has been extensive sampling for stygofauna undertaken within the Development Envelope and surrounding areas since 2009. Detailed sampling for the Proposal commenced in 2019, however sample locations have been primarily restricted to impact areas, particularly within the extent of the predicted drawdown and MAR contours (refer to **Figure 8-4**). Limitations to sampling undertaken to date are detailed in the reports provided in **Appendix 26**. As with most subterranean surveys, the taxonomic resolution of this group remains poor, and hampers understanding the true linear distance (area of occupancy) of many taxa. The uptake of molecular sequencing has provided some insight into groupings; however, the sharing of this information publicly is yet to be applied across projects. As a result, much of the status of "restricted" is due to poor resolution and an artifact of sampling. This is recognised by the EPA (2012; 2021i).

The distribution of restricted stygofauna is shown in **Figure 8-17** and **Figure 8-18**.

Biological Connectivity

The distribution of the stygofauna within the MDIOM areas and beyond the area of impact is presented in Bennelongia 2024a. The area has a highly diverse and abundant stygofauna community. The records show distribution of taxonomic groups across the different hydrogeologies/aquifers.

Stygofauna found to have limited ranges from the survey data is presented in **Figure 8-17**. These taxa have been mapped across the subterranean habitats as defined by AQ2 (2024b). The distribution is based on areal extent. Given there is a connection between each of the aquifers it is highly likely that the stygofauna exist in more than one aquifer. The extent of the stygofauna habitat is shown in **Figure 8-18**.

Records of stygofauna beyond the scope of the 3D habitat mapping, are primarily in drainage lines. This is expected as most sampling is undertaken in production or monitoring bores.

To demonstrate the distribution within the landscape, the ostracod Areacandona was mapped based on their occurrence and salinity. This is presented in Figure 8-20. The ostracods are one of the dominant taxa in the Pilbara groundwater. In the Fortescue system they can be classified into three main categories with the taxa recorded at the Proposal aligning with the "lowland group" made up of Areacandona and Humphreyscandona. Their distribution along drainage lines and near the claypans in the calcrete area demonstrates their ecology (they readily disperse within a catchment along drainage lines (Reeves et al 2007). They are often within calcrete areas because of their need to build their valves (Reeves et al 2007). The dispersal pattern seen appears to follow the extent of the aquifers and groundwater flow (refer to Figure 8-19).

Stygofauna records from the MDIOM show distribution of all taxonomic groups across all the habitat types and along mapped drainage lines. Many of the taxa occur in both the east and west sections showing the capacity for dispersal and biological connectivity. As with the majority of the subterranean studies in the Pilbara, dispersal is restricted to catchments and it is expected that the extent of many of the cryptic taxa will be within the greater Fortescue Valley Catchment – bounded by Goodiadarrie Hills and Millstream.

Figure 8-17: Distribution of SRE stygofauna within areas of impact

645000 650000 655000 660000 665000 670000 675000 680000 685000 690000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change

Roads (LGATE-195)

- Highway

Stygofauna

- Areacandona `BOS1381`
- Billibathynella sp. `BSY244`
- Brevisomabathynella `BSY233`
- Dussartstenocaris `BHA335`
- Maarrka `BAM182`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Parabathynellidae `MH3`
- Pilbaranella `MH1`
- Pilbaranella `MH2`
- Pilbaranella sp. B18
- Schizopera `BHA277`

JBS&G

Job No: 68676

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Aug-2025
Drawn By: jcrute	Checked By: VC

Scale 1:150,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

STYGOFAUNA SRES
WITHIN AREAS OF IMPACT

FIGURE 8.17 Map 1 of 3

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_17 MS_Stygofauna SREs within areas of impact

643000 644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000

7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000 7547000 7546000 7545000

MD0577
MD0499
MD0525
MD0974
MD0533
MD0509
MD0462
MD0562
MDWB0037
MDWB0038
MDPZ7458C
MDCMB09

Legend

- Development Envelope
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change

Stygofauna

- Areacandona `BOS1381`
- Billibathynella sp. `BSY244`
- Brevisomabathynella `BSY233`
- Dussartstenocaris `BHA335`
- Maarrka `BAM182`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Parabathynellidae `MH3`
- Pilbaranella `MH1`
- Pilbaranella `MH2`
- Pilbaranella sp. B18
- Schizopera `BHA277`

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0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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STYGOFAUNA SRES
WITHIN AREAS OF IMPACT

FIGURE 8.17 Map 2 of 3

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_17 MS_Stygofauna SREs within areas of impact

659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000 673000 674000 675000

7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000 7547000 7546000 7545000 7544000 7543000

MD0974

MD_KAR6

ROBINSONS WELL

MD0396

Legend

- Development Envelope
- Cumulative 1m Mounding
- Cumulative 2m Drawdown
- Potential extent of salinity change

Stygofauna

- Areacandona `BOS1381`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Pilbaranella `MH1`
- Pilbaranella sp. B18



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0 1 2
Kilometers

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STYGOFAUNA SRES WITHIN AREAS OF IMPACT

FIGURE 8.17 Map 3 of 3

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Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_17 MS_Stygofauna SREs within areas of impact

Figure 8-18: Location of SRE stygofauna across known habitat.

645000 650000 655000 660000 665000 670000 675000 680000 685000 690000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000

GREAT NORTHERN HWY

Legend

- Development Envelope

Stygofauna habitat

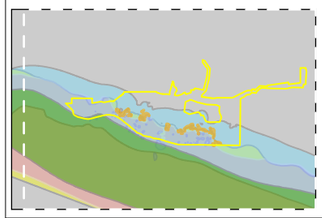
- Mineralised Marra Mamba
- Unmineralised Marra Mamba
- Calcrete
- CID/Pisolite
- Undifferentiated sediments

Roads (LGATE-195)

- Highway

Stygofauna

- Areacandona `BOS1381`
- Billibathynella sp. `BSY244`
- Brevisomabathynella `BSY233`
- Dussartstenocaris `BHA335`
- Maarrka `BAM182`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Parabathynellidae `MH3`
- Pilbaranella `MH1`
- Pilbaranella `MH2`
- Pilbaranella sp. B18
- Schizopera `BHA277`



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0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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STYGOFAUNA SRES AND HABITAT

FIGURE 8.18 Map 1 of 3

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\68676_MDIOM_EPAct_s43a_2025_ERD RtS SubterrFauna.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_18 MS_Stygofauna SREs and habitat

643000 644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000

7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000 7547000 7546000 7545000

MD0577
MD0499
MD0525
MD0974
MD0533
MD0509
MD0462
MD0562
MDWB0037
MDWB0038
MDPZ7458C
MDCMB09

Legend

- Development Envelope

Stygofauna habitat

- Mineralised Marra Mamba
- Unmineralised Marra Mamba
- Calcrete
- CID/Pisolite
- Undifferentiated sediments

Stygofauna

- Areacandona `BOS1381`
- Billibathynella sp. `BSY244`
- Brevisomabathynella `BSY233`
- Dussartstenocaris `BHA335`
- Maarrka `BAM182`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Parabathynellidae `MH3`
- Pilbaranella `MH1`
- Pilbaranella `MH2`
- Pilbaranella sp. B18
- Schizopera `BHA277`

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Kilometers

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STYGOFAUNA SRES AND HABITAT

FIGURE 8.18 Map 2 of 3

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Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_18 MS_Stygofauna SREs and habitat

659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000 673000 674000 675000

7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000 7547000 7546000 7545000 7544000 7543000

MD0974

MD_KAR6

MD0396

ROBINSONS WELL

Legend

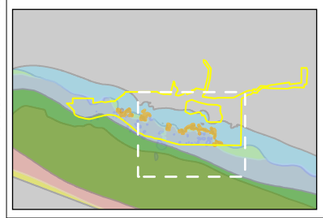
- Development Envelope

Stygofauna habitat

- Mineralised Marra Mamba
- Unmineralised Marra Mamba
- Calcrete
- CID/Pisolite
- Undifferentiated sediments

Stygofauna

- Areacandona `BOS1381`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Pilbaranella `MH1`
- Pilbaranella sp. B18



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STYGOFAUNA SRES AND HABITAT

FIGURE 8.18 Map 3 of 3

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Image Reference: World Imagery: Maxar
Layout: 68676_A3L_08_18 MS_Stygofauna SREs and habitat

Salinity ranges of stygofauna within the Development Envelope

An earlier investigation on the inferred upper salinity tolerances of eight potentially restricted stygofauna species by Bennelongia (2024b) were estimated using a formal methodology that is likely to be accurate for most species collected from a large number of sites (refer to BEC 2024b) (Appendix 22).

However, this study was based on limited data and constrained to data collected from the top 1 m of the groundwater. A peer review was undertaken on request of the EPA (Biologic 2025a, is provided in Appendix 31). The peer review concluded that the Bennelongia (2024b) memo provides a useful starting point for understanding the groundwater conditions in which stygofauna from the MDIOM have been sampled. However, the reviewers believe that in its current form, the memo (and results provided therein) should be considered with a high degree of caution with respect to inferring groundwater salinity tolerances for restricted stygofauna at the MDIOM, with further clarification required with regards to the methodology and taxonomy applied. Further contextual information regarding the complexities of the stygofauna community and groundwater system (particularly spatial and vertical variability in salinity, and other physicochemical attributes) would be beneficial.

To address the limitations with collecting suitable salinity data for stygofauna at depth, the approach was to use statistical analyses to assess the association between salinity and stygofauna occurrence. The salinities used in these analyses were based on a block model for the top 30m of groundwater developed by AQ2 in 2025 for the MDIOM.

To complement the statistical analyses, maximum salinities within observed locations for key SREs and by grouping genera were quantified; and using the conservative assumption that salinities higher than those at which each group has been observed at are unsuitable, 'suitable baseline salinity' maps were compiled to show the parts of the baseline landscape where suitable salinities exist for each group. These provide useful, conservative salinity tolerance thresholds on which to base management and mitigation measures. This memo will be completed in September 2025 (JBS&G 2025) (Appendix 33).

The statistical analyses showed limited predictive power of salinity variables (min, mean and max within the top 30 m of the water table) for all functional groups and genera assessed, although some associations between inferred salinity and stygofauna occurrence and/or abundance were found to be statistically significant. The majority of significant associations were positive, indicating greater predicted occurrence probability and/or abundance with greater salinity. Although associations for certain groups including Nematoda, Oligochaeta, Enchytraedia were negative, indicating that reduced occurrence probability and/or abundance are associated with increases in salinity over the ranges observed.

Selected stygofauna were mapped showing their potential distribution based on the inferred baseline salinity ranges. Examples are provided in Figure 8-20 which shows the distribution of the various Areacandona recorded across the landscape. The same was undertaken for the Syncarid Billybathynella and is presented in Figure 8-21.

The information from this work is applied further in the WMP to established trigger and threshold to manage the groundwater changes which will result from MAR. The focus is on groups which show more SRE than other taxa.

Figure 8-19: Extent of SRE stygofauna within predicted changes to groundwater salinity.

642000 644000 646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000

7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000 7538000 7536000

2,000 3,000 4,000 6,000 8,000 10,000 12,000 1,000 2, 000 1000 2000 3000 4000 6000 4,000 3000 2000 1000

Legend

- Development Envelope
- Cumulative 1m Mounding
- Potential extent of salinity change
- Surface EC (EC value in uS/cm)
- Groundwater flow direction

Roads (LGATE-195)

- Highway

Stygofauna

- Areacandona `BOS1381`
- Billibathynella sp. `BSY244`
- Brevisomabathynella `BSY233`
- Dussartstenocaris `BHA335`
- Maarrka `BAM182`
- nr Billibathynella `MH2` (Parabathynellidae `MH2`)
- Parabathynellidae `MH3`
- Pilbaranella `MH1`
- Pilbaranella `MH2`
- Pilbaranella sp. B18
- Schizopera `BHA277`

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Scale 1:110,000 at A3

0 2.5 5
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SRE STYGOFAUNA - BASELINE SALINITY (GROUNDWATER) AND PREDICTED EXTENT OF CHANGES

FIGURE 8.19

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Image Reference: World Imagery: Earthstar Geographics
Layout: 68676_A3L_08_19_Stygo SRE Stygo - baseline salinity and predicted changes

Figure 8-20:Potential areas of Areacandona salinity tolerances

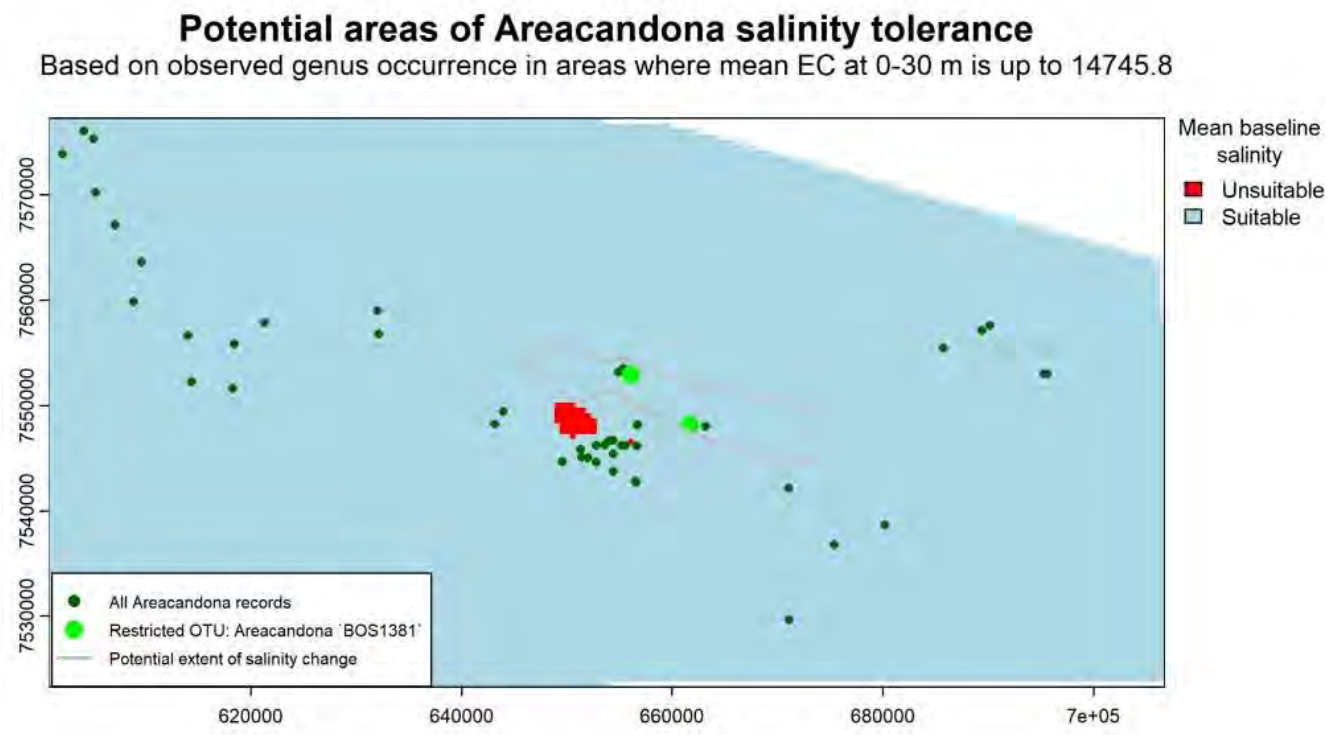
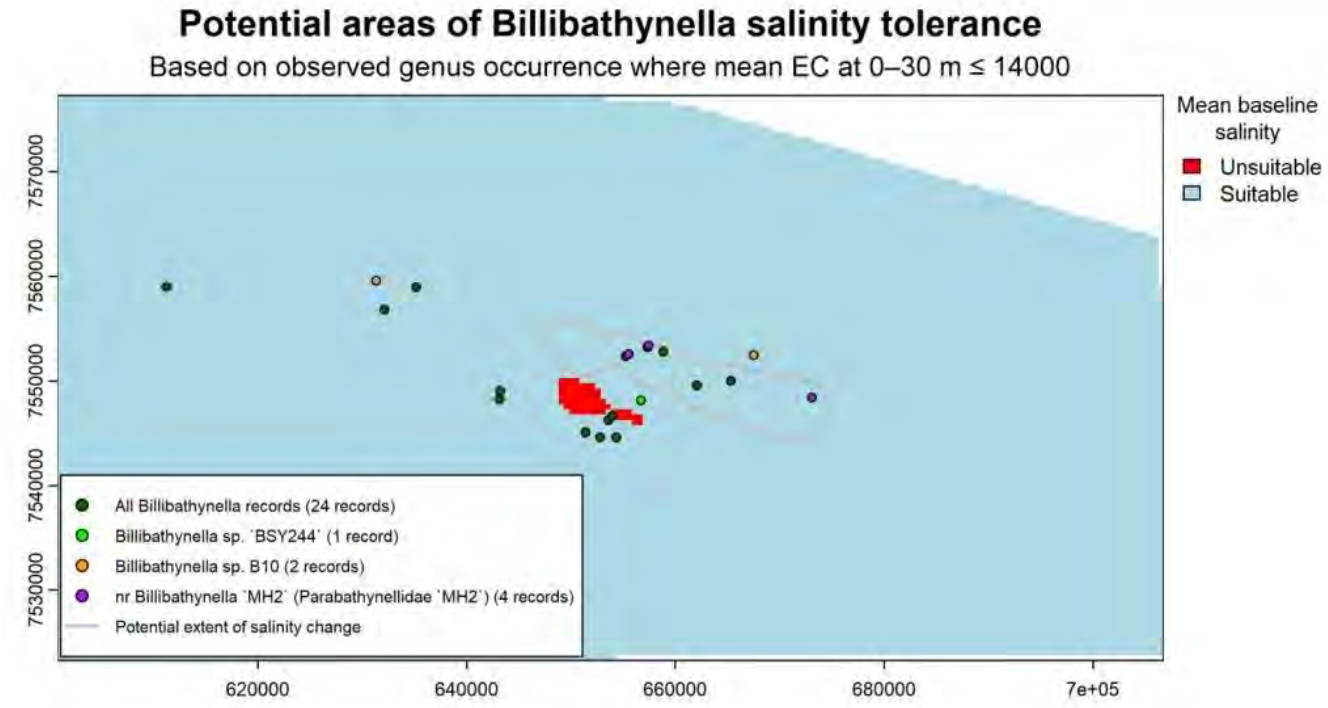


Figure 8-21:Potential areas of Billibathynella salinity tolerances



8.4 Potential Impacts

An impact assessment requires knowledge of the distribution of species within and beyond a development footprint, and therefore it is important to determine the range of each species and the availability of suitable habitat beyond the impact area. Limitations in the ability to survey subterranean fauna result in uncertainties in modelling their distribution patterns and are compounded by a lack of knowledge of habitat preferences and responses to impacts. In addition, the ecology of subterranean fauna also presents specific problems in delineating species (EPA 2012; Halse 2018; Framenau et al, 2021).

An assessment of the potential direct, indirect and cumulative impacts of the Proposal to troglofaunal and stygofauna values in consideration of the EPA objectives is provided below.

8.4.1 Direct impacts to Troglofauna

The direct impacts to troglofauna from implementation of the Proposal are from the excavation of the mine pits (including some proposed borrow pit areas) and MAR leading to mounding. These impacts have the potential to result in:

- Loss of troglofauna habitat; and
- Loss of troglofauna species.

8.4.1.1 Loss of Troglofauna habitat

Direct loss of habitat is typically considered the most significant impact to subterranean fauna. The excavation of the mine pits will result in permanent removal of troglofaunal habitat. Habitat may also be impact from groundwater mounding from MAR. These impacts have been presented as a volumetric area and percent of potential habitat loss are presented in in Table 8-8.

The geological units considered Likely habitat are the Upper Calcrete, Mineralised Marra Mamba and CID / Pisolite units (Tertiary Detritals).

In total an estimated 195,127,440 m3 of Tertiary Detritals will be impacted across both mining and predicted MAR.

Of this:

- An estimated 66,731,740 m3 will be permanently lost during excavation of ore and formation of pits. Of which, the greatest volume lost will be in the Mineralised Marra Mamba unit; and
- An estimated 128,395,700 m3 of habitat will be altered because of mounding levels from MAR. There is the capacity for the groundwater to return to baseline conditions and therefore while a significant impact, it is not permanent. The greatest impacts are to the Upper Calcrete and CID/Pisolite units.

The Undifferentiated Tertiary unit in which troglofauna habitat is Possible will be reduced by an estimated 285,573,000 m3. Of this:

- An estimated 25,833,000 m3 will be permanently removed through mining; and
- An estimated 259,740,000 m3 will be temporarily lost from MAR.

Table 8-8: Potential Troglofauna Habitat (volumetric) which will be impacted from excavation and/or mounding (MAR)

Troglofauna Habitat	Habitat Likelihood	Predicted Volume (m3) Impacted (Excavation)	Predicted Volume (m3) Impacted (Mounding)	Total Predicted Volume Impacted (m3)
Upper Calcrete	Likely	374,740	71,185,000	195,127,440
CID / Pisolite		12,275,000	53,598,000	
Mineralised Marra Mamba		54,082,000	3,612,700	
Undifferentiated Tertiary	Possible	25,833,000	259,740,000	285,573,000
Alluvium	Unlikely	11,922,000	90,168,000	373,795,500
Shaley / Unaltered Marra Mamba		7,895,500	263,810,000	
Total		112,382,240	742,113,700	854,495,940

Table 8-9: Predicted Percentage of Habitat Lost within the Area of Impact (excavation and mounding)

Troglofauna Habitat	Habitat Likelihood	Total Habitat (m3) Within Predicted Area of Impact (Pre-Mining)	Predicted Volume (m3) Impacted (Excavation and Mounding)	Predicted Percentage of Habitat Lost Within Area of Impact
Upper Calcrete	Likely	193,130,000	71,559,740	37%
CID / Pisolite		255,490,000	65,873,000	26%
Mineralised Marra Mamba		82,491,000	57,694,700	70%
Undifferentiated Tertiary	Possible	1,036,600,000	285,573,000	28%
Alluvium	Unlikely	839,190,000	102,090,000	12%
Shaley / Unaltered Marra Mamba		2,178,600,000	271,705,500	12%
Total		4,585,501,000	854,495,940,	19%

8.4.1.2 Loss of Troglofauna species

The mining of the ore involves the excavation of material will results in the loss of troglofauna habitat. This has the potential to cause the loss of troglofauna species. The species which have been identified as having limited ranges and considered restricted, are the most at risk. Troglofauna typically have less dispersal capabilities compared to stygofauna and naturally shorter ranges. The troglofauna identified from Mulga Downs which occur within the Mineralised Marra Mamba are primarily either singletons or their ranges only extend 500 m outside of the pit. This habitat exists as discontinuous pods. Areas of Mineralised Marra Mamba occur outside of the pits which allows for a level of dispersion for these taxa.

Of the troglofauna assessed, only two are considered still to have limited dispersal abilities and further investigation is underway as part of the targeted troglofauna survey, these are presented in Table 8-10. The Draculoides MH2 and Draculoides sp. WAM-SCH084 are considered to have limited dispersal abilities and were recorded from within the Mineralised Marra Mamba Unit.

The majority of the taxa appear to be present within the Undifferentiated Tertiary Detritals. This unit lies between the Upper Calcrete and CID/Pisolite habitats. It was found to be continuous, extending across the Development Envelope along the slopes of the Chichester Range. There are several records of restricted troglofauna from holes which intersect this unit.

One of the defining characteristics of subterranean fauna globally is the high level of regional and short-range endemism (Eberhard et al. 2007). Troglofauna are less likely to have the dispersal extents that stygofauna have. Troglofauna have been found to live within working pits and to recolonise areas where mining has ceased (for example at Mesa A (EPA 2012).

Mining will result in potential risk to two troglofauna taxa only found within the Mineralised Marra Mamba habitat. However, with respect to the EPA's objective for this factor, if the taxa are found to have a greater extent of occurrence, then mitigation measures can be applied to meet the EPA's objective. The physical and biological connectivity observed in the data at MDIOM indicates that there is the ability for these taxa to disperse and therefore have greater ranges than is presented in BEC (2024a) in particular within the Undifferentiated Tertiary and CID/Pisolite habitat. Over 99 % of this habitat will not be impacted by the Mine.

Table 8-10: Troglofauna identified as most at risk from implementation of the Project

OTU	Impact type	Distribution within Likely Habitat	Significance
SREs which were identified as having a High risk ranking			
Arachnida			
Schizomida			
Draculoides `MH2`	Mounding	Collected in 2012 (Hole ID MD0525). This site is located at the edge of the pit and within a CID/Pisolite with extensive habitat remaining. These are known troglobites and therefore their ability to disperse is less than other troglofauna.	Up to five different Draculoides OTUs were identified from the survey data. While four of the OTUs were primarily in the mining area dominated by Undifferentiated Tertiary and CID/Pisolite and in some locations overlaying the Mineralised Marra Mamba, one OTU was located within the Upper Calcrete Habitat which extends to the south of the mine across the valley area. Given the ecological dependency of this group (troglobitic), the Draculoides were included as target group in the 2025 targeted survey to better understand the movement across this habitat and areas proximal to the pits where the SREs were collected. High level identifications from this survey have yielded three Draculoides and molecular analyses are pending.
Draculoides `sp. WAM-SCH084`	Pit and mounding	This OTU was collected from a proposed pit in 2011 and then in an area which will only be impacted from mounding, approximately 1 km apart. While it was found in potentially one of the three habitats of Undifferentiated Tertiary and CID/Pisolite these were also overlaying the Mineralised Marra Mamba habitat. The location of this OTU outside a proposed pit does not place this OTU at High risk, however the Draculoides are known troglobites and as such their ability to disperse is less than that of other troglofauna. With respect to Mineralised Marra Mamba habitat, there will be remaining areas proximal and contiguous to that where this OTU was collected allowing dispersal even for this SRE.	
Pseudoscorpiones			
Austrochthonius `BPS257`	Pit and mounding	This Pseudoscorpion is a new species which was only collected once in the mine pit which has Undifferentiated Tertiary and CID/Pisolite overlaying the Mineralised Marra Maba habitat. Other Pseudoscorpions such as Tyrannochthonius	Where subterranean taxa have been found to occur in one area despite extensive surveys the default is to address the possibility of dispersal through habitat. Where habitat continues

		`MH1`occurs in numerous locations across the survey area in Undifferentiated Tertiary and CID/Pisolite and not in Mineralised Marra Mamba. The majority of the Pseudoscorpions were yielded from holes which intersected these two lithologies. It would be reasonable to expect that this OTU occurs primarily in the top two lithologies. Should this OTU prefer the deeper Mineralised Marra Mamba where this OTU was collected has this habitat extending outside of the proposed mine pit which would allow for a greater area of occurrence.	outside the area of impact there is the potential for troglofauna to disperse, however it is understood that dispersal is within a short range. The habitats which are fragmented is the Mineralised Marra Mamba. However, where the pits are proposed the entire Mineralised Marra Mamba will not be excavated and the same habitat remains, proximal and continuous from where these taxa were yielded. Additionally, it is unlikely that these taxa will be at the greater depth where the ore is located. Rather they would be in the upper two lithologies which in the majority of the areas is the upper 40 m. Where data was limited in these areas for these restricted taxa, a targeted survey was undertaken. the same drill holes where the restricted taxa were collected were resampled and scrapes taken in nearby holes to maximise the collection of similar groups. Many of these taxa were only identified on morphology; Molecular analyses will be completed on all taxa to better resolve these issues.
Diplura			
Parajapyx `BDP217`	Pit and mounding	Located within Undifferentiated Tertiary habitat which overlays the Mineralised Marra Mamba and on the periphery of CID/Pisolite habitat. This is similar to the other Dipluran area of occupancy. This species was identified on morphology only and as the only Parajapyx to be collected it was considered of conservation significance. As with other Diplurans there is the potential for this species to have a greater dispersal capability and it may not be limited to the pit. For example Parajapygidae Phoenix-MH1 is located within four separate locations approximately 3 km in distance within the CID/Pisolite. This demonstrates there is the capability of this group to disperse within this habitat.	The majority of the Diplurans at MDIOM have been recorded from sites which intersect the CID/Pisolite. It is reasonable to expect that this is their preferred habitat rather than the deeper Mineralised Marra Mamba. As a precaution this group was included as a targeted taxon in the 2025 survey. The Diplura are troglobitic. They have shown dispersal abilities though this is still unknown for this OTU. Proximal to the sample collection point, habitat whether the upper lithologies or the Mineralised Marra Mamba, remain for this OTU.
Zygentoma			
Trinemura New OTU 1	Pit and mounding	This OTU was designated a new naming by Biologic which was more consistent with their system. However all the other Trinemura collected showed high dispersal throughout the footprint. While this specimen was found only in the Mineralised Marra Mamba the entire habitat surrounding the location of this OTU will not be removed and if it is restricted to this habitat there is available habitat for this new OTUto occur proximal to its present location.	The location of other Trinemura collected from the surveys indicates the dispersal ability of this group is high for troglofauna. The specimens were collected from upper lithologies which are extensive and contiguous and as such implementation of this Proposal is not considered to have a significant risk to this OTU.
SREs which were identified as having a Moderate risk based on risk ranking			
Malacostraca			

Isopoda			
Buddelundia sp. B57	Pit and mounding	This isopoda has a linear range of 4.5 km. It was collected at multiple sites within the Undifferentiated Tertiary and CID/Pisolite habitats. Previously this OTU was considered to be at risk as it was confined to impact areas. However the Buddelundia are known to be terrestrial invertebrates (Biologic 2025b) with a high proportion being assessed as terrestrial SREs. It is not uncommon for many edaphic (soil habitats) taxa to inhabit subterranean environments especially in the Pilbara. An example is Lophoturus madecassus. This taxon while often described as a troglofauna is primarily a trogloxene at most – a surface dwelling invertebrate that will temporarily inhabit subterranean environments. The cockroaches (eg the Nocticolids) are a similar group and both are found in high numbers in subterranean samples and show the greatest abundance and occupancy across survey areas in the Pilbara. Buddelundia sp. 57 on review occupies several sites and primarily within areas of mounding which will not impact the upper lithologies where this OTU was collected. Habitat for this OTU is extensive and continuous.	The ecological dependency and the dispersal capacity indicate this OTU is not a SRE which will be confined to the mining area. Other surveys for this Proposal (terrestrial SRE) collected numerous different Buddelundia identified from leave litter. The majority are undescribed. Habitat for this OTU is extensive and contiguous. As this OTU was initially identified as a SRE this group was targeted in the 2025 targeted troglofauna survey. Several specimens identified at a high level as Buddelundia were collected during this survey, however until molecular analyses are completed it is possible this these are terrestrial species. Buddelundia sp. 57 is not considered to be at risk from implementation of this Proposal.
Insecta Coleoptera			
Coleoptera ‘BCO207’	Pit and Mounding	This OTU was collected at several sites in the mining area. Initial review stated this species had limited dispersal and was considered restricted as it was collected within proposed pit and molecular identification. A review of the rationale for the risk of the Proposal to this OTU further considered the factors which may influence the occurrence of the OTU. These were habitat, ecological dependence and linear range. This OTU was not a singleton, collected over two surveys and at four sites within Undifferentiated Tertiary habitat which is extensive. Another Coleoptera (sp. B07) was found in Upper Calcrete habitat 26 km south east of the location of the same OTU within Undifferentiated Tertiary sediment in the mining area indicating this group has dispersal capabilities.	The ecological dependency of the Coleoptera is unknown, though they often appear in subterranean data. This group are known to have dispersal abilities greater than most troglofauna and given they have been found in habitat which is contiguous and extends beyond the area of impact this OTU is not considered at risk from the Proposal. Specimens of coleoptera were collected in the 2025 targeted survey.
Hemiptera			
Phaconeura ‘BHE036’	Mounding	While this OTU was a singleton and a potential new species, it was ranked as Moderate risk from the Proposal given that it occurred in an area that would only be impacted by mounding and in CID/Pisolite habitat. Phaconeura are considered as primarily trogloxene/troglophiles rather than obligate troglophiles. While this does not diminish their SRE status or the importance of preservation of subterranean habitats for their existence, it does support their preference for upper lithologies	Other Phaconeura collected for this Proposal had large linear distances and found in the extensive upper lithologies Undifferentiated Tertiary and CID/Pisolite. This group are known as trogloxenes/troglophiles and have been found across habitats which are contiguous and extend outside areas of impact, the risk to this OTU from

		(CID/Pisolite) and a greater likelihood of more extensive area of occurrence. Other Phaconeura collected for this Proposal had large linear distances and found in the extensive upper lithologies Undifferentiated Tertiary and CID/Pisolite.	implementation of the mining Proposal is considered to not be significant.
Zygentoma			
Trinemura `BZY102`	Pit and mounding	As a singleton and collected within a proposed pit, this OTU was ranked as Moderate. This OTU was initially two specimens, however a review by Biologic (2025b) split the two and proposed a new OTU (discussed above). Trinemura `BZY102` was collected from Undifferentiated Tertiary and in Mineralised Marra Mamba (pit). The Trinemura are known troglofauna (however their dependency unknown) and show high dispersal throughout the Proposal area and beyond. At least eight Trinemura OTUs were identified from the survey data often during repeat surveys. They were located within upper lithologies and show a high level of dispersal. As such this OTU is not considered to be restricted.	The location of other Trinemura collected from the surveys indicates the dispersal ability of this group is high for troglofauna. The specimens were collected from upper lithologies which are extensive and contiguous and as such implementation of this Proposal is not considered to have a significant risk to this OTU.
Diplura			
Campodeidae `BDP216`	Pit and mounding	Campodeidae `BDP216`was collected from a site which lies within Undifferentiated Tertiary habitat, CID/Pisolite and Mineralised Marra Mamba, in order of their lithologies overlying each other. It is highly likely that this OTU occurs in the top two lithologies. Another Campodeidae sp. B10 was located in Undifferentiated Tertiary habitat to the south of the Development Envelope. The majority of the Diplurans at MDIOM have been recorded from sites which intersect the CID/Pisolite. It is reasonable to expect that this is their preferred habitat rather than the deeper Mineralised Marra Mamba.	The majority of the Diplurans at MDIOM have been recorded from sites which intersect the CID/Pisolite. It is reasonable to expect that this is their preferred habitat rather than the deeper Mineralised Marra Mamba. As a precaution this group was included as a targeted taxon in the 2025 survey. The Diplura are troglobitic. They have shown dispersal abilities though this is still unknown for this OTU. Proximal to the sample collection point, habitat whether the upper lithologies or the Mineralised Marra Mamba, remained for this OTU.
Parajapygidae sp. B30	Pit and mounding	Located in CID/Pisolite habitat which is extensive, the risk to this OTU was considered as Moderate as it was a singleton and only collected within a proposed pit. Parajapygidaes have been found across the mine area in habitat which is extensive and contiguous. The recent 2025 survey found this group in the unmineralised marra mamba where this OTU may occur.	
Projapygidae `BDP182`	Pit and mounding	Singleton. Collected from MD2936 in 2019. Collected from Mineralised Marra Mamba which does not appear to have any other habitats overlying from the modelling. As the identification was on morphology and the specimen in poor condition the SRE stats of this OTU appears to be primarily as result of poor taxonomic resolution and as such was considered to be of Moderate risk. This group are considered troglofauna however their dependence is unknown. Other Projapygidae had greater linear ranges and were found in upper lithologies, see below.	

Projapygidae 'MH1'	Pit and mounding	This OTU had a Linear range of 3.2 km and was collected from three different locations across CID/Pisolite in pit and mounding areas. Dispersal is considered possible in habitat proximal to where they were collected.	
Pauropoda			
Pauropodidae `MH1`	Pit and Mounding	A singleton which was collected in early samples (2011) limiting further taxonomic resolution. This specimen was collected within CID/Pisolite where extensive habitat remains and dispersal possible.	The Pauropdidae are known to be trogloxenes/troglophiles and as such they have a greater capability for dispersal than trilobites. The Pauropididae have been recorded across the survey area and from at least 20 different drill holes. Some OTUs have linear ranges of up to 10 km. These OTUs were found in habitat which was in the upper lithologies which are extensive and contiguous. These OTUs are not considered to be restricted to areas of high impact and therefore the risk form the Proposal is not considered significant.
Pauropodidae `BPU090`	Pit and mounding	Found in pit but within the Undifferentiated Tertiary which is extensive. MD1545. Originally two specimens were identified as P. BPU090 however on review Biologic (2025b) found that the divergence indicated two separate OTUs. The new OTU is located outside the area of impact for troglofauna in the Northern Haul Road. This may still indicate that this group is not truly troglobitic and has greater dispersal capabilities.	
Symphyla			
Symphylella `BSYM137`	Pit and mounding	This symphylan was a singleton and was not identified in the Bennelongia (2024a) report and therefore not stated as restricted. On review this OTU has been included in this assessment. It was collected within CID/Pisolite over Mineralised Marra Mamba. While this group are known troglofauna, their dependency in not clear. The other symphylan (Symphylella sp. B20 was found in several locations with a linear range of 10 km in Undifferentiated Tertiary Habitat, indicating greater ability to disperse.	The Symphylella are recognised as troglofauna however it is not known if they are true troglobites. However, this group appear to occupy the upper lithologies and show dispersal across these areas. As such implementation of the Proposal is not considered to result in a significant risk to this OTU as they have dispersal capabilities and occur I habitat which is contiguous and extends outside the areas of impact.

8.4.2 Indirect Impacts to Troglofauna

Indirect impacts to troglofauna have been identified as:

- Clearing of vegetation and construction of infrastructure (i.e. WRD, RoM pads) – resulting in the loss of energy transfer to the subterranean environment);
- Contamination of subterranean environment from mine activities – such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste dumps, and use of saline mine water for dust suppression in mine area; and
- Changes to groundwater affecting humidity in vadose zone.

8.4.2.1 Clearing of vegetation and construction of infrastructure

The trophic paths for troglofaunal subterranean environments are not well studied, however it is understood that the source is the terrestrial environment. Removal of vegetation and construction of above ground infrastructure is likely to change the subsurface environment and reduce nutrient inputs, impacting on the subterranean habitat.

8.4.2.2 Contamination of subterranean environment from mine activities

There is the potential for contaminants to seep into the subterranean environment as a result of chemicals, hydrocarbons and waste used and/or produced during construction and operation of the Proposal. There is the risk of contamination from hydrocarbon spills and leaching from the waste rock.

The use of saline mine decant water within the mine area to suppress dust has the potential to increase salinity levels of surface water which may move through into subterranean fauna habitat.

8.4.2.3 Changes to groundwater affecting humidity in vadose zone (altered hydrology)

Troglofauna are relict species that are understood to have sought refuge from the transition to a more arid continent. They rely on moisture to breath in a low oxygen environment and are susceptible to dehydration. Changes to groundwater levels have been known to alter the humidity of the subterranean environment, reducing the quality of habitat for troglofauna. However, many of the taxa recorded within pits (troglobitic taxa) belong to groups which are known to migrate vertically and horizontally moving to moist areas (Villani et al 1999).

8.4.3 Direct Impacts to Stygofauna

The direct impact to stygofauna from implementation of the Proposal will be from the excavation of pits, groundwater drawdown and changes to groundwater salinity (quality) as a result of the dewatering and MAR. These impacts will result in:

- Loss of habitat from excavation of pits below the water table or changes in groundwater levels (≥ 1 m);
- Reduction in quality of habitat due to salinity changes; and
- Loss of stygofauna species (specifically restricted taxa).

8.4.3.1 Loss of Habitat

Loss of Habitat from Pit Excavation

There will be loss of stygofauna habitat where pit excavation occurs below the water table primarily with a reduction in the groundwater level of the Tertiary Aquifer. Stygofauna habitat has been confirmed within the aquifers underlying the proposed pit areas.

Loss of Habitat from Drawdown

Groundwater drawdown has the potential to reduce the amount and quality of stygofauna habitat. From the numerical modelling, the groundwater drawdown is predicted to extend across the valley, away from the mining areas, however the extent of the drawdown along strike (i.e. in a northwest – southeast direction) is curtailed by MAR Due to the progressive approach to the mining, the maximum extent of the 2 m drawdown occurs in different directions at different times. The maximum extent of the predicted 2 m drawdown contour extends ~6 km to the west, ~3.5 km to the east and ~7.5 km to the southwest across the majority of the valley's width; however, it is not predicted to reach the Hamersley Range or Karijini National Park.

The areal extent of dewatering drawdown is shown in Figure 8-2 and Figure 8-4 and is defined as a > 2 m drawdown.

The volume of habitat loss was calculated based on the top of the habitat reducing to the predicted minimum groundwater level surface over the LOM, taking into account groundwater level changes resulting from dewatering and MAR.

The loss of stygofauna habitat is presented in Table 8-11. For the Tertiary units (which have a defined base), the percentage of habitat lost within the predicted area of impact has been calculated and is presented in Table 8-12.

Table 8-11: Potential Stygofauna Habitat Loss During Mining (dewatering)

Stygofauna Habitat	Habitat Likelihood	Predicted Volume Impacted by Mining (m3)	Predicted Volume (m3) Impacted by Dewatering	Total Predicted Volume Impacted (m3)
Upper Calcrete	Likely	0	556,380,00	671,449,100
CID / Pisolite		3,273,500	112,770,000	
Mineralised Marra Mamba		550,280	1,299,100	
Undifferentiated Tertiary /Sediment	Possible	1,415,200	482,930,000	482,930,000
Basal Crete		0	0	
Alluvium	Unlikely	0	3,776	533,134,266
West Angela Member		11,438	90,490	
Shaley / Unaltered Marra Mamba		13,937,000	533,040,000	
Total		19,187,418	1,686,513,366	1,686,513,366

Table 8-12: Predicted Percentage of Habitat Lost Within the Area of Impact

Stygofauna Habitat	Habitat Likelihood	Total Habitat (m3) Within Predicted Area of Impact (Pre-Mining)	Predicted Volume (m3) Impacted (Dewatering)	Predicted Percentage of Habitat Lost Within Area of Impact
Upper Calcrete	Likely	3,554,200,000	556,380,000	16%
CID / Pisolite		2,978,200,000	112,770,000	4%
Undifferentiated Tertiary	Possible	7,687,100,000	482,930,000	6%
Basal Crete		2,151,5000,000	0	0%
Alluvium	Unlikely	3,776	3,776	100%
Total		16,371,003,776	1,152,083,776	10%

The total pre-mining volume of Tertiary habitat within the predicted area of impact is 16,371,003,776 m3. Of this 1,152,083,776 m3 (10%) will be lost as a result of dewatering drawdown over the life of the mine.

Of this volume, the loss of likely habitat is predicted is estimated as:

- 556,380,000 m3 of Upper Calcrete which equates to 16% of habitat which is likely to support stygofauna;
- 112,770,000 m3 of the CID/Pisolite which equates to 4% of habitat which is likely to support stygofauna; and
- 482,930,000 m3 of Undifferentiated Tertiary which equates to 6% of habitat which could support stygofauna.

Of the total volume of potential habitat that is predicted to be impacted (i.e., 1,686,509,590 m3), 30% of the total predicted impact volume is within the lithological unit considered to be a likely habitat for stygofauna, 26% for possible habitat units and the remaining 44% for unlikely habitat units.

Groundwater levels are predicted to recover to 1 m below the pre-development level within 26 to 37 years after the end of mining and dewatering. The remainder of groundwater recovery to predevelopment levels is predicted to occur over a further 30 to 40 years. The loss of stygofauna habitat from drawdown is not expected to be critical given the extent of the aquifer which is unconsolidated.

Historical long-term hydrographs from the Proposal (AQ2 2025) indicate that seasonal responses to rainfall events have the potential to result in groundwater level variations of up to 1 m. As such, the predicted extent of the 1 m drawdown contour, throughout the life of the mine, has been used to define the extent of habitat impact. A more conservative extent of 2 m drawdown has been applied in respect to stygofauna survey design (BEC 2024a).

8.4.3.2 Reduction in quality of habitat due to salinity changes

Groundwater salinity will change primarily as a result of reinjection of mine dewater (MAR). The TDS (EC) of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 1,700 (2656 µS/cm) and 4,200 mg/L (6,562 µS/cm), taking into account the uncertainty associated with aquifer porosity, with this being the range of TDS concentrations that were then assigned to all MAR bores over the LOM (AQ2 2025).

The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be localised (i.e. <2 km in extent). This is demonstrated by both the simulated groundwater flow paths for the LoM and predicted salinity changes at the simulated observation points. Model predictions indicate that the key driver for groundwater salinity change is the proposed dewatering at Murray's Hill. This is predicted to result in increases to the dewatering discharge salinity as more saline water is drawn in from the valley areas. The subsequent re-injection of this more saline dewatering discharge into the Murray's West and Fridge / Horseshoe South MAR Borefields results in localised areas of increased groundwater salinity as well as subsequent increases to the combined dewatering discharge, as the re-injected water in the east is recirculated towards the Fridge West and Fridge Hill mining areas later in the LoM.

Taking into account the uncertainty associated with aquifer porosity, the greatest changes in salinity outside of the mining areas are predicted in three areas:

In the Murray's West MAR Borefield area, the TDS is predicted to increase from approximately 1,200 mg/L to between 3,600 and 4,700 mg/L (for high and low porosity scenarios), recovering to between 2,700 and 3,500 mg/L, upon the cessation of MAR in this area and the re-injection of fresher water to the adjacent Murray's Hill / Anticline Hill area.

Down-slope from the Murray's Hill mining / MAR area, the TDS is predicted to increase from 3,600 mg/L to between 4,400 and 5,600 mg/L (for high and low porosity scenarios). However, when the Murray's Hill / Anticline area is used for MAR, the TDS is predicted to reduce, reaching between 3,300 and 4,300 mg/L by the end of mining.

Down-slope from the Fridge / Horseshoe South MAR Borefield, the TDS is predicted to increase from approximately 2,300 mg/L to between 2,400 and 3,900 mg/L (for high and low porosity scenarios), with TDS at the end of mining predicted to range between 2,300 and 3,700 mg/L.

The predicted extent of salinity changes is presented in Figure 8-4, and Figure 8-17.

8.4.3.3 Loss of species

Up to 12 stygofauna were assessed based on their records being only in areas of impact. For the purpose of EIA, restricted taxa are considered the most at risk from impacts to their habitat (EPA 2021). Of these 12 taxa, seven were from pre 2019 surveys and could only be identified to high order. It is unknown if these taxa were truly stygobitic. Data from pre 2019 surveys were not available and their stygofauna status could not be confirmed. The area of impact was identified as the extent of the 2 m drawdown and the extent of the predicted changes in groundwater salinity shown as a polygon. These taxa were collected from sample sites which intersect geological units assessed as being continuous. Records of stygofauna from the MDIOM show similar groups, including congeneric taxa (taxa belonging to the same genus), across and beyond the area of impact. It is understood that biological and physical connectivity exists from within the area of impact and extending beyond, and stygofauna taxa are not restricted to sample location. Mapping of the SRE stygofauna across the known habitats is presented in Figure 8-18.

With respect to loss of taxa due to impacts to habitat (loss and changes to groundwater quality) the aquifer found to be likely to support stygofauna is considered extensive and continues along the Fortescue Valley. Dispersal of stygal ostracods is known to occur within each catchment and not between catchments in the

Pilbara. Dispersal has been found to occur along the extent of uninterrupted aquifers (Reeves et al., 2007) and the dispersal of stygofauna within the Development Envelope was evident with a number of taxa from different orders collected from several locations. A number of the singletons were also collected with stygal taxa which were found in several other locations in the Development Envelope (and area of impact extent) as well as beyond the extent of the impact.

Based on an assessment of the habitat connectivity and the volumes which will be lost from dewatering, the impacts to the stygofauna taxa considered as having moderate risk was found not significant. As outlined in Table 8-13, none of the remaining stygofauna taxa will be at risk from implementation of the Proposal. This outcome is based on the habitats where the stygofauna were collected is contiguous and extend outside of the area of impact across the landscape. Additionally, initial statistical analyses has found that there is no fragmentation within the groundwater habitats as a result of salinity that would impede the movement of the stygofauna. From 0 m to 30 m the groundwater salinity profile showed little change. At 40 m bgl the salinity increased, however at this depth habitat is not considered suitable for the stygofauna. This information has been used to develop the inferred baseline salinity ranges for a selection of stygofauna and will be applied to the management measures in the WMP.

Table 8-13: Stygofauna identified as most at risk from implementation of Proposal

OTU	Impact	Factors affecting distribution	Risk from Proposal
Plocopoida			
Areacandona `BOS1381`	Drawdown and predicted salinity changes	This OTU was identified in supporting studies as "restricted" and therefore at greater risk than other stygofauna from the Proposal. Following a peer review of the initial dataset, several ostracods were reassigned OTUs. The SRE status of this OTU is now considered the result of poor taxonomic resolution, based on two specimens and very limited morphological feature. However, as a precaution, additional studies were completed to investigate the potential risk to this OTU. The linear range of Areacandona BOS1381 was estimated at 7 km. Specimens were collected from Robinson Well and MD0462, though the later was pre 2019. Nine Areacandona OTUs were identified from the surveys completed for MDIOM. Two were identified at species level, the remaining (based on the updated data) remain unresolved. A description of OTU assignment is provided in Biologic (2025b). The majority of the Areacandona were collected from multiple sites across the survey area and only three OTUs were in abundances less than 20. With the exception of Areacandona BOS1381, the other Areacandona were located along the Fortescue Catchment boundary flanks the Chichester. Many of the Areacandona extend across the Fortescue Valley and west to the former Mulga West borefield area. This includes the distribution of the same OTUs. This indicates that this genus moves within drainage lines within the same catchment and follows the groundwater drainage flow as indicated in Figure 8.19. This is consistent with the dispersal of Pilbara ostracods (Reeves et al, 2007). It is therefore unlikely that A. BOS1381 is restricted to the two boreholes Robinson Well and MD0462. Robinson Well lies within the area shown in cross sections 2 to 3. These cross sections show the modelled likely habitat of the Upper Calcrete / Calcrete. The changes resulting from mine development appear to have limited effect on the remaining aviable habitat. This was calculated as a potential loss of 16% of this habitat. This taxon was also collected from MD0462 which lies just out of the CID/Pisolite Habitat and in the hydrated Mara Mamba Habitat. Only 4% of the CID/Pisolite is expected to be impacted from drawdown. These habitats are also continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive.	Areacandona `BOS1381` is not considered at risk from implementation of this Proposal. It is unlikely this taxon is restricted given the distribution of other Areacandona across the landscape. The habitat this OTU was collected is contiguous and occurs across the landscape.

		This taxon while only found at two locations, will not be at risk from the Proposal as it has more than 80 % of likely habitat remaining. Areacandona `BOS1381` also lies within an area which will be impact by groundwater salinity changes from MAR. The estimated extent of groundwater salinity changes from reinjection (MAR) will be approximately 7,000 µS/cm and is limited to the area shown in Figure 8.19. Modelled baseline salinity range (0-30 m depth) for this OTU was calculated at 4,647 µS/cm based on two collections. However, based on plots generated investigating the distribution of the Areacandona based on baseline groundwater salinities (0 – 30 m), the mean salinity threshold is estimated to be 14,745 µS/cm for this genus. Groundwater studies competed for this Proposal have not shown significant changes in the groundwater salinity from 0 m to 30 m, indicating that there are no known barriers formed as a result of salinity gradients within this depth. This depth is considered the area of occupancy for the stygofauna (EPA2021g). While it is unlikely that this OTU is restricted to the area of impact, thresholds have been established for this group and are provided in the WMP. The changes to salinity and the impact on subterranean fauna will be managed through the Water Management Plan.	
Syncarids			
Billibathynella `BSY244`	Drawdown	This OTU was collected as a one site – MDWB0037 in 2022. This bore is located within the Upper Calcrete / Calcrete aquifer and the cross section 2 and 3 indicate the changes which are predicted from drawdown. The Upper Calcrete /Calcrete habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive and it is expected that only 16% will be lost. This OTU is not located within the predicted extent of salinity changes (Refer to Figures 8.17 and 8.19).	Billibathynella `BSY244` is not at risk from implementation of this Proposal. The Upper Calcrete habitat is continuous across the valley within the predicted area of impact and beyond.
nr Billibathynella `MH2` (Parabathynellidae `MH2`)	Drawdown and predicted salinity changes	Known linear range of 18 km. Collected in 2012 from md_kar6 using Karaman-Chappuis and sites MD0369, MD0509' MD0533' MD0562 using net. Large linear range in 2012, No field data was provided for this OTU. Additionally, there was an absence of information on how the taxonomy was resolved and is based on morphology. This OTU was not yielded in any of the following surveys in 2019-2024. While this is a historic sample and the SRE status is based on limited information, this taxon is included in this assessment. The location of this taxon is presented in Figure 8.19 and	nr Billibathynella `MH2` (Parabathynellidae `MH2`) is not at risk from implementation of this Proposal. Habitat where this OTU was collected is extensive and there is only a total loss estimated of 6%.

		is located within the area of predicted salinity changes where groundwater is estimated to reach a maximum of 7,000 µS/cm. Given the limited information provided on this OTU, the estimated salinity ranges calculated for the Syncarida can be sued as a guide. This approach was presented in the Bennelongia (2024b) salinity tolerance memo 675. While this memo states that the majority of syncarids occur at salinities of 2800 µS/cm, compilation of data found the syncarids as a group can be found at salinity of less than or equal to 14,000 µS/cm. As a guide refer to Figure 8.21. The linear range of this OTU shows that it has good dispersal. The estimated baseline salinity of 14,000 µS/cm for syncarids and their distribution across the landscape indicate that this OTU is not considered to be restricted to the sample sites. Additionally, this OTU was included as a precaution and was not discussed in memo 675. This OTUs are located primarily in the areas of higher altitude within the Undifferentiated Tertiary habitat which is extensive. The amount of this habitat which will be lost from both drawdown and exaction is only expected to be 6%.	
Brevisomabathynella `BSY233`	Drawdown	This singleton was collected at MDWB0038. This bore is located within the Upper Calcrete / Calcrete aquifer and the cross section 2 and 3 indicate the changes which are predicted from drawdown. The Upper Calcrete/Calcrete habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive, and it is expected that only 16% will be lost. This is a new species and therefore there is risk of impacts from changes to their environment in particular as there were only found in one location. However, this OTU is not located within the predicted extent of salinity changes (Figure 8.19). However, the estimated range of their occurrence within the 0 m to 30 m of the unconfined aquifer has been estimated. Brevisomabathynella `BSY233` is a Syncarid and this group has been found to occur across salinities up to 14,000 µS/cm. This taxon was collected from a groundwater bore where baseline salinities of the aquifer (0 m to 30 m) were found to be at an average of 12, 000 µS/cm.	Brevisomabathynella `BSY233` is not at risk from implementation of this Proposal. Habitat where they occur is extensive and only up to 16% will be lost as a result of drawdown and excavation. The extent of changes to groundwater salinity are considered within the tolerance of this group.
Pilbaranella `MH1`	Drawdown and predicted extent of salinity changes	These taxa were grouped by Bennelongia as possibly being reduced to three species. ID were on morphology only with no description given. Their identifications could not	The Pilbaranella are not considered to be at risk from implementation of

Pilbaranella `MH2`	Drawdown and predicted extent of salinity changes	be reconciled further by Biologic (2025b) and their names remain. These three taxa were identified in earlier surveys and no information was provided supporting their identifications. As stated in this ERD the data from 2019 to 2024 is considered the most reliable and the assessment is based on the more robust information as is supported in the ongoing studies on the sampling efficacy for the subterranean fauna (Frameau et al.2021). The Pilbaranella have been considered in this assessment for consistency. These three OTUs are located primarily in the areas of higher altitude within the Undifferentiated Tertiary habitat which is extensive. The groundwater in this area is of lower salinity and these OTUs appear to remain within these habitats. Other Pilbaranella BSY380 collected in 2022 were collected from the Mulga West Borefield area which is to the west of the MDIOM and appears to overlie the same habitat. The habitat these OTUs were collected in is extensive across the northern section of the MDIOM and the greater landscape. This habitat is highly transmissive and numerous drainage lines intersect, which is where these OTUs were collected and appear to remain. From the information in the earlier surveys, while limited and not supported with field data, indicates that the Pilbaranella do not disperse toward the Fortescue Valley as other stygofauna do. While these OTUs appear to have limited distribution, this may be due to poor taxonomic resolution. However, they exist in habitat which is extensive. The amount of this habitat which will be lost from both drawdown and exaction is only expected to be 6%.	this Proposal. Habitat where they were collected is extensive and there is only a total loss estimated of 6%.
Pilbaranella B18	Drawdown		
Amphipoda			
Maarrka `BAM182`	Drawdown	This singleton was collected at MDWB0038. This bore is located within the Upper Calcrete / Calcrete aquifer and the cross section 2 and 3 indicate the changes which are predicted from drawdown. The Upper Calcrete/Calcrete habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive, and it is expected that only 16% will be lost. This is a new species and therefore there is risk of impacts from changes to their environment in particular as there were only found in one location. However, this OTU is not located within the predicted extent of salinity changes (Figure 8.19). However, the estimated range of their occurrence within the 0 m to 30 m of the unconfined aquifer has been estimated. The records of Maarrka from surveys was found to occur up to salinities of 14, 000 µS/cm, while amphipods as a group were found up to 17,000 µS/cm. This taxon was collected from a groundwater bore where baseline salinities of the aquifer (0 m to 30 m) were found to be at an average of 12, 000 µS/cm.	Maarrka `BAM182` is not at risk from implementation of this Proposal. The Upper Calcrete habitat is continuous across the valley within the predicted area of impact and beyond.

Harpacticoida			
Dussartstenocaris `BHA335`	Drawdown	This copepod was collected as a singleton from MDWB0038 in 2022. This bore is located within the Upper Calcrete/Calcrete. Cross sections 2 and 3 indicate that the impacts from drawdown will be minimal. Like Areacandona `BOS1381`this species is capable of dispersing across this aquifer. The Upper Calcrete/Calcrete habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive, and it is expected that only 16% will be lost. This OTU is not located within the predicted extent of salinity changes. Baseline groundwater contours in Figure 8.19 show that this taxon was collected from a bore which lies within a groundwater area with salinities above 12, 000 µS/cm.	Dussartstenocaris `BHA335` is not at risk from implementation of this Proposal
Schizopera `BHA277`	Drawdown	Singleton collected from MDPZ7458C in 2019. This bore is located within the Upper Calcrete in close proximity to MDWB0038. Cross sections 2 and 3 indicate that the impacts form drawdown will be minimal. This taxon is of the same Class as Dussartstenocaris `BHA335` and is also capable of dispersing across this aquifer. The CID/Pisolite habitat is continuous across the valley within the predicted area of impact and beyond. The extent of drawdown is not laterally extensive, and it is expected that only 4% will be lost. This OTU is not located within the predicted extent of salinity changes. Baseline groundwater contours shown in Figure 8.19 show that this taxon was collected from a bore which lies within a groundwater area with salinities above 12, 000 µS/cm.	Schizopera `BHA277` is not at risk from implementation of this Proposal

8.4.4 Indirect Impacts to Stygofauna

The indirect impact which has the potential to effect stygofauna as a result of the Proposal is the contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste rock.

There is the potential for contaminants to seep into the subterranean environment and be transported across the aquifer. There is the risk of contamination from hydrocarbon spills and leaching from the waste rock. The use of saline water within the mine area to suppress dust has the potential to increase salinity levels of surface water which move through into subterranean fauna habitat. These potential impacts may reduce the suitability of subterranean habitat.

8.4.5 Cumulative Impacts

The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:

- Changes in surface hydrological regimes.
- Change in groundwater regimes (associated with drawdown from abstraction and mounding from MAR).
- Clearing, construction and operation of the Proposal.

The Murrays Hill Mine did not consider mining below groundwater and therefore there are no cumulative impact to stygofauna.

The Mulga Downs Hub and Rail Spur will not cumulatively add to subterranean fauna impacts as no substantial excavations are proposed or substantial groundwater abstraction.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in Section 17.

8.5 Mitigation

HPPL has applied the mitigation hierarchy (avoid, minimise and rehabilitate) during Proposal design to reduce the potential impacts to subterranean fauna. The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since its referral in 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal on flora and vegetation. Overall, there has been a total reduction in the Development Envelope, Indicative Footprint and dewatering/MAR.

A summary of mitigation measures applied to address the key potential impacts on subterranean fauna are provided in Table 8-14.

The approach recommended by the EPA (EPA 2021i) has been applied in assessing the impact to subterranean fauna from the Proposal. The area is known to support a diverse subterranean community. The lack of taxonomic resolution remains the largest constraint in assessing the true range of all the restricted taxa. An extensive

sampling program was applied for this Proposal. The low success rate of molecular analyses is another limitation. A detailed assessment of the habitats confirmed that the subterranean environments are connected and extend beyond the area of impact. The mapping of subterranean fauna records shows capacity for dispersal. Similar taxonomic groups were found across both impact and reference areas indicating biological connectivity.

The impacts to the habitat have been quantified and found that 19% of troglofaunal habitat will be lost from both excavation and mounding. It is to be considered that mounding is not a permanent impact.

The amount of habitat which will be lost for stygofauna is predicted to be 10%.

The changes to habitat with respect to salinity is predicted to vary between 1,800 mg/L and 3,000 mg/L for the LoM. These may be beyond many of the species' tolerance, however the changes to the groundwater salinity are progressive, though longer lasting than changes to depth.

The Water Management Plan (WMP) (Appendix 6) has triggers and threshold to manage the risks to the subterranean fauna.

Table 8-14: Mitigation Measures for Subterranean Fauna

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts – Troglofauna			
Loss of troglofauna habitat from excavation of mine pits and mounding.	Excavation of troglofaunal habitat is contained in seven mine pits. The number of pits has been reduced and mining output has been reduced from20 Mtpa to 12 Mtpa avoiding troglofaunal habitat.	Excavate no more than 66,731.74 m3 of Tertiary Detritals identified as likely troglofauna habitat. Limit the reduction of habitat to 274,648,900 m3 of troglofauna habitat primarily in the CID/Pisolite. Undertake pit construction in stages to manage dewatering and MAR requirements – optimise the West to East mining scenario as outlined in Water Management Plan. Maintain the current beneficial use of groundwater as per the Water Management Plan, to limit the extent of groundwater extraction (and associated drawdown and MAR). Maintain groundwater levels such that there is no surface expression of groundwater (as a result of MAR) limiting troglofauna habitat. Implement management actions as defined in the WMP.	Develop and implement a MCP as approved by DEMIRS (as per the requirements of the Mining Act and DEMIRS Guidelines for Preparing Mine Closure Plan, March 2020). Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. Implement the WMP. Monitoring program targeting troglofauna which have the highest level of endemism.
Impact to troglofauna taxa (specifically restricted taxa). The number of restricted taxa may be up to 2 taxa.	Not applicable, with minimisation then being the key measure.	Apply the developed habitat assessment model to updated species list.	Implement monitoring as detailed in WMP.
Direct Impacts - Stygofauna			
Loss of stygofauna habitat from excavation of pits below the water table or changes in groundwater levels (≥ 1 m).	Complete avoidance is not possible for this Proposal; however the Proposal has been designed so that excavation is contained to seven designate mine pits as per mining schedule.	Loss of no more than 370,648,900 m3 of stygofauna habitat from extraction of mine pits for LoM. Implement mine schedule of staged pit excavation (optimise West to East mining scenario as per WMP). Limit dewatering profile to that which is necessary for mining.	Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. Implement monitoring as detailed in the WMP.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		Implement management actions as defined in the WMP.	
Reduction in quality of habitat due to salinity changes.	Not applicable, with minimisation then being the key measure.	Limit MAR profile to that which is necessary for mining.	Implement monitoring as detail in the WMP.
Loss of stygofauna species (specifically restricted taxa). No stygofauna are expected to be lost.	Further work needs to be undertaken to determine if avoidance is possible.	Limit dewatering profile to that which is necessary for mining. Implement management actions as defined in the WMP.	Implement monitoring as detailed in the WMP.
Indirect Impact - Troglofauna			
Clearing of vegetation and construction of infrastructure (i.e. WRD, RoM pads) resulting in the loss of energy transfer to the subterranean environment).	Not applicable, with minimisation then being the key measure.	Backfilling of pits to reduce ex-pit WRDs. Minimise the clearing of vegetation required where possible.	Progressive rehabilitation to be undertaken in accordance with a Mine Closure Plan assessed and approved by DEMIRS, as per requirements under the Mining Act. Backfilling of pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process.
Contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste rock, and use of saline water for dust suppression in mine area.	Not applicable, with minimisation then being the key measure.	Design of potential contaminating facilities (landfill, WRD) to prevent seepage to surface water and/or groundwater. Adhere to works approval and licence conditions under Part V of the EP Act. Storage of contaminating materials in Australian Standard compliant locations with bunding, spill controls and leak prevention. Saline water (> 5000 mg/L TDS) shall not be used for dust suppression. WRD to be designed in accordance with the Mine Closure Plan.	Implement monitoring as detailed in the WMP. Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		Design and construction of WRD with appropriate seepage and leachate control structures. Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained. Manage any spills including any contaminated material, in accordance with the internal procedures; and investigate and report incidents in accordance with internal procedures, to prevent the recurrence of incidents of the same or similar nature.	
Changes to groundwater affecting humidity in vadose zone (altered hydrology).	Not applicable, with minimisation then being the key measure.	Limit dewatering profile to that which is necessary for mining. Limit mounding to that which is necessary for mining. Implement management actions as defined in the WMP.	Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine in accordance with the Water Management Plan Implement monitoring as detailed in the WMP.
Indirect Impact - Stygofauna			
Contamination of subterranean environment from mine activities such as leaching contaminants in seepage and/or groundwater from chemical or hydrocarbon spills, landfills and leaching from waste dumps.	Not applicable, with minimisation then being the key measure.	WRD to be designed in accordance with the MCP. Design of potential contaminating facilities (e.g. landfill, WRD) to prevent seepage to surface water and/or groundwater. Storage of contaminating materials in AS compliant locations with bunding, spill controls and leak prevention. Design and construction of WRD with appropriate seepage and leachate control structures. Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained. Manage any spills including any contaminated material, in accordance with the internal procedures; and investigate and report incidents in accordance with	Implement monitoring as detailed in the WMP. Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		internal procedures, to prevent the recurrence of incidents of the same or similar nature.	

8.6 Assessment and Significance of Residual Impacts

8.6.1 Direct Impacts - Troglofauna

8.6.1.1 Loss of Troglofauna habitat

The excavation of the mine pits and areas of habitat lost as a result of groundwater mounding are considered to be a direct impact to troglofauna. The loss of habitat as a result of both activities can be presented as a volumetric area.

The geological units considered Likely habitat are the Tertiary Detritals which includes the Upper Calcrete, CID/Pisolite and Mineralised Marra Mamba units. In total 195,127,440 m3 of Tertiary/Detritals will be impacted across both mining and predicted mounding from MAR. Of this:

- An estimated 66,731,740 m3 will be permanently lost during excavation of ore and formation of pits. The greatest volume lost will be in the Mineralised Marra Mamba.
- An estimated 128,396,700 m3 of habitat will be altered as a result of changes to the groundwater levels from MAR reinjection. The greatest impact is to the Upper Calcrete and CID/Pisolite. There is the capacity for the groundwater to return to baseline conditions and therefore while a significant impact it is not permanent.
- The Undifferentiated Tertiary geology will be reduced by 285,573,000 m3. This habitat has been found to support troglofauna at Mulga Downs. Of this:
    - 25,833,000 m3 will be permanently removed through mining.
    - 259,740,000 m3 will be temporarily lost from MAR.
- The overall anticipated percentage of troglofauna habitat which may may be impacted is 19%.

The Undifferentiated Tertiary habitat is mostly continuous over the Proposal area and beyond, while Mineralised Marra Mamba occurs as discontinuous pods associated with the mineralisation.

Precedence exists with the EPA that the direct impacts to the troglofauna can be mitigated based on the capacity for dispersal (EPA Report 1402 (EPA, 2011)).

8.6.1.2 Loss of Troglofauna species

At least two troglofauna species are currently known only from the Mineralised Marra Mamba habitat. This is the area of greatest impact as this is where the pits lie. These species are also identified as being potentially locally restricted, primarily because of their ecological dependency and known limited dispersal capabilities.

Widespread species are considered to be less vulnerable to extinction following changes to their habitat than locally restricted species (EPA 2016b; Ponder and Coglan 2002). Investigation of the troglofauna taxa at Mulga Downs has shown that there is the capacity for dispersal.

8.6.2 Indirect Impacts – Troglofauna

The indirect impacts to the troglofauna fauna include:

- Contamination of troglofauna habitat from mining activities;
- Clearing of vegetation and construction of infrastructure resulting in the loss of energy transfer to subterranean environment;
- Changes to humidity from altered hydrology (changes in groundwater level).

8.6.2.1 Contamination of Troglofauna habitat from mining activities

As outlined in Section 7.7.2.2, groundwater contamination from potential sources such as the Waste Rock, hydrocarbon spills, will be considered and managed as stated in the Water Management Plan.

Waste rock generated by the Proposal will be stored in waste dumps and used to backfill pits to ensure backfill is above the water table after settlement avoiding the creation of pit lakes. This will be further informed by future infield study work as part of the closure planning process. From the studies undertaken, Potential Acid Forming (PAF) classed material was found to be a very low proportion (approximately 4%) of the waste material to be managed. If PAF is encountered during mining, waste management will consider the placement of PAF material into discrete PAF cells that can be isolated within waste rock to limit acid generation. This will allow for the control of acid mobilisation and solute release from these materials into groundwater (SRK 2023c).

Mitigation of impacts are proposed through the Water Management Plan, which includes trigger and threshold levels.

Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate the risk of contamination.

8.6.2.2 Clearing of vegetation and construction of infrastructure

Implementation of the Proposal will result in the clearing of up to 4,339.16 ha of native vegetation. While this is considered a potential indirect impact to troglofauna there is little information which has measured trophic energy pathways to hypogean environments. These environments are energy poor and there is a lack of basal trophic level which increases opportunism (Gibert and Deharveng 2002). Clearing of vegetation is not considered to affect the troglofauna.

8.6.2.3 Changes to humidity from altered hydrology (changes in groundwater level)

Surveys for troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for troglofauna has been assessed and potential for connectivity and capacity for dispersal identified.

As discussed in Sections 7.6 and 8.5, the overarching groundwater management strategy is to:

- Maintain the current beneficial use of the groundwater.

- Minimise the impact on other groundwater users and groundwater dependent ecosystems (i.e. subterranean fauna); this includes minimising the extent of groundwater level changes.
- Maintain groundwater levels such that there is no surface expression of groundwater or water logging of vegetation.

A Water Management Plan (Appendix 6) has been developed which outlines HPPL's approach to monitoring and managing groundwater in response to potential impacts associated with construction and operation of the Proposal. In particular, the impacts associated with mine dewatering and the management of excess mine dewater via MAR. The Water Management Plan defines trigger and threshold criteria relating to groundwater. It also outlines the methodology and inputs which will be used to refine these criteria specific to each site upon completion of further works and collection of baseline data from finalised groundwater infrastructure.

8.6.3 Direct Impacts - Stygofauna

8.6.3.1 Loss of habitat

Implementation of the Proposal will result in the loss of 1,152,083,776 m3 of stygofauna habitat as a result of dewatering. This equates to 10% of the volume of groundwater reduced by dewatering.

Of this volume, the loss of likely habitat is predicted as:

- 556,380,000 m3 of Upper Calcrete which equates to 16% of habitat which is likely to support stygofauna;
- 112,770,000 m3 of the CID/Pisolite which equates to 4% of habitat which is likely to support stygofauna; and
- 482,930,000 m3 of the Undifferentiated Tertiary which equates to 6% of habitat which could support stygofauna.

In respect to loss of taxa due to changes in habitat (loss of habitat and changes to groundwater quality), the stygofauna habitat along the Fortescue Valley is extensive and uninterrupted for the majority of the aquifer. This allows for dispersal and mitigates impacts to stygofauna as a result of decreased habitat quality from the Proposal.

Many of the taxa identified have a greater distribution outside the Development Envelope. For example, dispersal of stygal ostracods is known to occur within each catchment and not between catchments in the Pilbara. Dispersal has been found to occur along the extent of uninterrupted aquifers (Reeves et al., 2007). Dispersal of stygofauna within the Development Envelope was evident with a number of taxa from different orders collected from several locations. Singletons were also collected with stygal taxa which were found in several other locations in the Development Envelope and surrounds.

Habitat for stygofauna has been found to be continuous and extensive within and outside of the Development Envelope. This also includes beyond the extent of the impacts.

8.6.3.2 Reduction in quality of habitat due to salinity changes

Characteristically, stygofauna diversity decreases with depth, the highest closer to the surface level of the groundwater. Reinjection salinities have been found to be consistent with the estimated baseline ranges for the stygofauna with limited distribution.

Changes to groundwater quality is considered to be a direct impact to stygofauna. Initial investigations using the application of statistical analyses and inferred baseline groundwater values modelled from 0 m to 30 m found that many will occur at salinities greater than the expected increased to ~7,000 µS/cm.

Groundwater salinity (as investigated for the extent of the subterranean fauna surveys) ranges from fresh (hyposaline) (180 mg/L as TDS) to saline (18,000 mg/L as TDS) (EC = 280 µS/cm to 28,125 µS/cm respectively). Groundwater where the salinity is in the lower ranges is generally in the upper areas of the Chichester Range. Groundwater associated with the Fortescue Valley generally is of the higher salinity ranges, particularly around the claypans(AQ2 2024a).

Groundwater salinity will change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 2,500 and 6,200 mg/L (3,900 µS/cm to 9,687 µS/cm), with this being the range of TDS concentrations that were then assigned to all MAR bores over the LoM.

Based on preliminary analyses of modelled baseline data, the few stygofauna only found in the predicted extent of groundwater salinity changes exist across salinities greater than 7,000 µS/cm. it is not expected that these changes will impact these stygofauna as they also exist in habitat which is contiguous.

The Quaternary / Tertiary aquifer and fractured rock / bedrock aquifers are generally in hydraulic connection (AQ2 2024a) (refer to Section 7.3.2) and groundwater flow is east to west. The stygofauna habitats which extends across the Development Envelope continues beyond the areas of impact and are continuous as has been shown from the habitat assessments.

This reduces the potential risk from changes in salinity resulting from MAR and can be managed in the WMP.

8.6.3.3 Loss of stygofauna species

Up to 12 stygofauna taxa were identified as being limited to areas within predicted groundwater drawdown of ≥2 m and the extent of the predicted salinity changes to groundwater from reinjection of mine dewater . These taxa have been found in geological units which are continuous. An assessment of the risk to these taxa was undertaken and based on taxonomic factors and distribution within the identified likely habitats. Assessment based on their area of occurrence (being the likely habitat) as a factor found that no stygofauna collected, to date, were considered at risk from the effects of mining or drawdown.

8.6.4 Indirect Impacts – Stygofauna

The indirect impacts to the stygofauna may result from the contamination of stygofauna habitat from mining activities.

8.6.4.1 Contamination of stygofauna habitat from mining activities

As outlined in Section 7.7.2.2, groundwater contamination from potential sources such as the WRD landforms or spills will be considered and managed in the WMP.

Waste rock generated by the Proposal will be stored in waste dumps and used to backfill pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process. From the studies undertaken, Potential Acid Forming (PAF) classed material was found to be a very low proportion (approximately 4% of the waste material to be managed. If PAF is encountered during mining, waste management will consider the placement of PAF material into discrete PAF cells that can be isolated within waste rock to limit acid generation. This will allow for the control of acid mobilisation and solute release from these materials into groundwater (SRK 2023).

Mitigation of impacts are proposed through the WMP, which includes trigger and threshold levels.

Hydrocarbon storage facilities will be appropriately constructed and bunded in accordance with Australian Standards. Facility inspection, maintenance and spill management procedures are expected to effectively mitigate the risk of contamination.

On the basis that the direct impact areas to stygofauna largely encompass the areas of indirect impacts, the significance of the indirect impacts is considered to be negligible.

8.7 Significant Residual Impact

The significant residual impact of the Proposal to Subterranean Fauna, after the application of the mitigation hierarchy, is:

- The loss of up to 96,048,900 m3 of troglofauna habitat from the excavation of pits.
- A reduction of up to 274,648,900 m3 of troglofauna habitat as a result of changes to the groundwater levels from MAR reinjection.
- Loss of up to 370,648,900 m3 of stygofauna habitat from dewatering of mine pits for LoM.
- The loss of stygofauna habitat as a result of changes to groundwater salinity from MAR and dewatering drawdown.
- There is potential to impact up to two troglofauna taxa which have not been found outside the mine pit and mounding areas.
- No stygofauna taxa will be lost. The data shows dispersal is possible from areas of impact to areas outside any impact from the Proposal. Up to 12 were found only in areas of potential impact, however there is no evidence of isolated or fragmentated habitat where these taxa were found.

Surveys for both stygofauna and troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for stygofauna and troglofauna has been assessed and found to be extensive and continuous, dispersal has been displayed by the subterranean fauna at MDIOM. The outcome of a targeted troglofauna survey completed in July 2025 will provide further information on the ability of the two Draculoides taxa which have limited dispersal abilities.

8.8 Environmental Outcome

Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with subterranean fauna, align with the EPA's principles. The predicted environmental outcomes for subterranean fauna summarised in Table 8-15.

Table 8-15: Environmental Outcomes of Subterranean Fauna

Potential Impact	Environmental Outcome
Direct Impacts	
Loss of subterranean fauna habitat	Loss of no more than 66,731,740 m3 of likely troglofauna habitat (mostly Mineralised Marra Mamba). A reduction of up to 128,396,700 m3 of troglofauna habitat altered as a result of changes in groundwater levels (mounding) from MAR during the LoM A reduction of no greater than 16% Upper Calcrete stygofauna habitat from dewatering; A reduction of no greater than 4% CID/Pisolite habitat which can support stygofauna. A reduction of no more than 6% of undifferentiated tertiary habitat which can support stygofauna. Loss of stygofauna habitat from changes in groundwater salinity as a result of MAR of up to 4,200 mg/L TDS from baseline (6,562 µS/cm).
Impact on species	Impact on up to two troglofauna taxa from excavation of mine pits. No impact to stygofauna from changes in groundwater salinity. No impact to stygofauna from changes in groundwater levels.
Indirect impacts	
Contamination of GW/subsurface habitat from mining activities	Not considered significant, will be managed under Part V of the EP Act.
Reduction in energy input (removal of vegetation)	Not considered significant, limited transfer of energy across epigean and hypogean environments
Reduction in humidity in vadose zone (altered hydrology)	Not considered significant

9 Flora and Vegetation

9.1 EPA Objective

The EPA's objective for the environmental factor Flora and Vegetation is:

"To protect flora and vegetation so that biological diversity and ecological integrity are maintained" (EPA 2016a; EPA 2021d).

9.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to key environmental factor Flora and Vegetation which have informed the planning for the Proposal are listed in **Table 9-1**.

HPPL has specifically considered these guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and its significance;
- Identification of activities which may lead to impacts to flora and vegetation; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 9-1: Flora and Vegetation Policy and Guidance

Reference	Title	How Policy has been considered
EPA 2016c	Environmental Factor Guideline: Flora and Vegetation	The information provided in this chapter addresses the 'considerations for environmental impact assessment' listed in this document.
EPA 2016d	Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment	This document guides flora and vegetation surveys and data to be used in EIA. All studies conducted for the Proposal are in accordance with this guidance document.
GoWA 2011	WA Environmental Offsets Policy	The offset policy and guidelines have been considered in relation to the definition of significant residual impacts and the proposed offset strategy.
GoWA 2014	WA Environmental Offsets Guidelines	

Specific additional work required for assessment of the Proposal, relating to Flora and Vegetation, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

9.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to Flora and Vegetation, including details of the surveys and studies undertaken to support the Proposal.

9.3.1 Relevant Studies

A summary of the flora and vegetation studies undertaken for the Proposal and surrounding area is provided in **Table 9-2**. The assessment of potential impacts on flora and vegetation as a result of the Proposal draws on

information from these reports. The flora and vegetation surveys completed to inform the Proposal have been conducted in accordance with the *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016d) and *Environmental Factor Guideline: Flora and Vegetation* (EPA 2016c).

Since 2012, numerous flora and vegetation assessments have been completed for the Mulga Downs Iron Ore Mine. A total of 271 quadrats have been assessed both within and outside of the Development Envelope (Survey Area) by Maia Consulting Ecologists (Maia) (**Figure 9-1**). The combined results of these surveys have been consolidated into one document: *Mulga Downs Iron Ore Project, Mine and Borefield Study Area Detailed Flora and Vegetation Assessment 2019-2022* (Maia 2022).

A separate survey was undertaken by Maia (2023) across the Solar Farm and expansion of a haul road along the northern boundary of the Development Envelope[1] The results of this survey as they relate to the Development Envelope are incorporated into this ERD. The survey report is provided in **Appendix 10**.

The outcomes from additional surveys completed to support the ongoing Programme of Works applications to DEMIRS have also been incorporated into this ERD where relevant.

All supporting surveys for this ERD are provided in **Appendix 10.** The extent of the surveys undertaken for the Proposal are presented in **Table 9-2**.

[1] The Spectrum (2023) survey also included a proposed pipeline route realignment which is no longer within the Development Envelope.

Table 9-2: Flora and Vegetation Surveys

Reference	Report	Description		Guidance
		Survey Type & Area	**Survey Month**	
Maia (2022) **(Appendix 10a.1)**	Mulga Downs Project Preliminary Vegetation and Flora Impact Assessment Total survey extent is collectively known as the Survey Area in this section of the ERD.	Level 2 flora and vegetation survey (Phase 1) Within Development Envelope (refer to **Figure 9-1**): **Area 1:** Mulga East (R47/12-I, M 47/1621 and L45/380) and Mulga Well (E47/2117-I). Outside Development Envelope: **Area 3**: Hester Peak South-east (L45/316). **Area 6**: Hester Peak (E47/2044-I).	**Area 1**: 2021 Winter (Jun, Jul). **Area 3**: 2012 Winter (Aug). **Area 6**: 2012 Winter (Aug).	Environmental Factor Guideline: Flora and Vegetation (EPA 2016a). Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016d). Matters of National Environmental Significance Significant Impact Guidelines 1.1 (DoE 2013).
	Mulga Downs Iron Ore Project, Mine and Borefield Study Area Detailed Flora and Vegetation Assessment 2019-2022	Baseline flora and vegetation (multi-Phase) Within Development Envelope (refer to **Figure 9-1**):**Area 1**: Mulga East (R47/12-I, M 47/1621 and L45/380) and Mulga Well (E47/2117-I). **Area 5**: Two Mile Well (E47/4264). **Area 6**: Hester Peak (E47/2044-I). **Area 7**: Hester Peak East (L45/384 and E47/2044-I) (see also JBS&G 2023 below). Outside Development Envelope: **Area 2**: Mulga West (E47/1315-I). **Area 3**: Hester Peak South-east (L45/316). **Area 4**: Mulga West to Mulga East linking corridor.	**Area 1**: 2019 Winter (Aug), Spring (Sep), Autumn (May), and 2021 Winter (Jul), Autumn (May), Spring (Sep). **Area 2**: 2022 Autumn (Mar). **Area 3**: 2022 Autumn (Mar). **Area 4**: 2022 Autumn (Mar). **Area 5**: 2022 Autumn (Mar). **Area 6**: 2022 Autumn (Mar). **Area 7**: Assessed in this report via desktop study (field surveys undertaken over this area are discussed in JBS&G 2023). The above multi-phase surveys resulted in 249 quadrats across the entire survey area.	
	Mulga Downs West Flora and Vegetation Desktop Study	Outside Development Envelope:	2012 to 2015: targeted flora surveys over an area of 538 ha;	

Reference	Report	Description		Guidance
		Survey Type & Area	**Survey Month**	
		Phase 1 (E47/1315-I)Mulga West Borefield. Targeted flora surveys to support exploration activity	2018 to 2020: targeted flora surveys over an area of 3,245 ha. Vegetation mapping: 2021	
Spectrum (2024) **(Appendix 10a.2)**	Memo: Data reconciliation. S. Hitchcock to HanRoy.18March2024	Memo to address the discrepancies between Maia 2022 and IBSA data package for 2019 – 2022 survey (Maia 2022)	Not applicable.	Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016d).
JBS&G (2023) **(Appendix 10c)**	Memorandum: Mulga Downs Rail and Hub – Flora and Vegetation Surveys – Supplementary memorandum to Attexo (2022a,b). JBS&G 65318: 153,027.	Supplement to Attexo (2022a; b) reports. Detailed Survey (Quadrats and Targeted searches) Discusses surveys undertaken over **Area 7**: **L45/384 and E47/2044-I** which is inside the Development Envelope and common to the Mulga Downs Hub and Rail Proposal.	Phase 1 and 2 Detailed: 18 March 2022 (Autumn) 21 July 2022 (Winter)	Environmental Factor Guideline: Flora and Vegetation (EPA 2016a). Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016d). Matters of National Environmental Significance Significant Impact Guidelines 1.1 (DoE 2013).
Maia (2023) **(Appendix 10b)**	Strategen-JBS&G: Mulga Downs Iron Ore Mine, Additional Survey Areas, Flora and Vegetation Assessment, February 2023	Detailed flora and vegetation assessment Targeted Flora and Vegetation Survey over a 241.6 ha survey area. Within Development Envelope (refer to **Figure 9-1**): (E 47/2044-I) Solar Farm, Road Deviation Area Outside Development Envelope: Re-aligned water pipeline route (E47/1315-1 to Mulga East)	Detailed flora and vegetation assessment and targeted flora survey Summer - Autumn (Mar 2023).	Environmental Factor Guideline: Flora and Vegetation (EPA 2016a). Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016d).
AQ2 (2025) **(Appendix 5)**	Mulga Downs Groundwater, Surface Water &	Ecohydrological assessment across Mulga East (R47/12, E47/2117)	Two site reconnaissance visits: **Mulga East:** 2019 (March) **Mulga West:** 2021 (October)	Not applicable.

Reference	Report	Description		Guidance
		Survey Type & Area	**Survey Month**	
	Ecohydrological studies – Baseline Assessment (171X_492b)	Also includes assessment across Mulga West (E47/1315) which is outside the Development Envelope.	Four field work campaigns: • **Wet Season**: 2019 (May) • **Dry Season**: 2019 (October) • **Dry Season**: 2021 (October) • **Dry Season**: 2022 (October)	
Spectrum (2024c) **(Appendix 10d)**	Memo - Targeted flora and vegetation survey – portion of the Northern Haul Road.	Targeted flora and vegetation survey across a 55 km length within the Northern Haul Road within the Development Envelope.	A dry season survey targeting conservation significant flora and ecological communities	The survey was conducted in accordance with the relevant State and Commonwealth legislative, regulatory and survey guidance
Spectrum (2025) (**Appendix 10e**)	Report – Mulga Downs Iron Ore Mine – Targeted Hibiscus Survey (report pending)	Targeted Hibiscus sp. Mulga Downs (S. Hitchcock SH 638) survey over mapped occurrences of the Jamindie Land System, away from the Development Area. Traverses between 25 m and 50 m spacing within suitable habitat of selected Jamindie Land system mapped polygons.	July 2025 (supplementary dry season)	The assessment is compliant with guidelines, as outlined in: • EPA Environmental Factor Guideline: Flora and Vegetation (Environmental Protection Authority; and • EPA Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment

Figure 9-1: Flora and Vegetation Surveys Effort

590000 600000 610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000 720000

7610000 7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000 7520000 7510000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Survey areas

- Area 1 (Mulga East and Malay Well)
- Area 2 (Mulga West)
- Area 3 (Hester Peak SE)
- Area 4 (Mulga West - Mulga East Linking Corridor)
- Area 5 (Two Mile Well)
- Area 6 (Hester Peak)
- Area 7 (Hester Peak East)
- Proposed haul road diversion single phase detailed survey
- Proposed solar farm single phase detailed survey (Maia,2023)
- Water supply pipeline single phase targeted survey (Maia,2023)
- Targeted Hibiscus Survey Area (Spectrum 2025)
- Targeted Hibiscus Survey Traverses (Spectrum 2025)

Site Type

- Groundwater Dependent Vegetation Notes
- Quadrat
- Relevé

Roads (LGATE-195)

- Highway

JBS&G

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Client: Hancock Prospecting Pty Ltd

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Drawn By: jcrute	Checked By: VC

Scale 1:400,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

FLORA AND VEGETATION SURVEYS EFFORT

FIGURE 9.1 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Survey areas

- Area 1 (Mulga East and Malay Well)
- Area 5 (Two Mile Well)
- Area 6 (Hester Peak)
- Proposed haul road diversion single phase detailed survey
- Targeted Hibiscus Survey Area (Spectrum 2025)

Site Type

- Quadrat

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Scale 1:55,000 at A3

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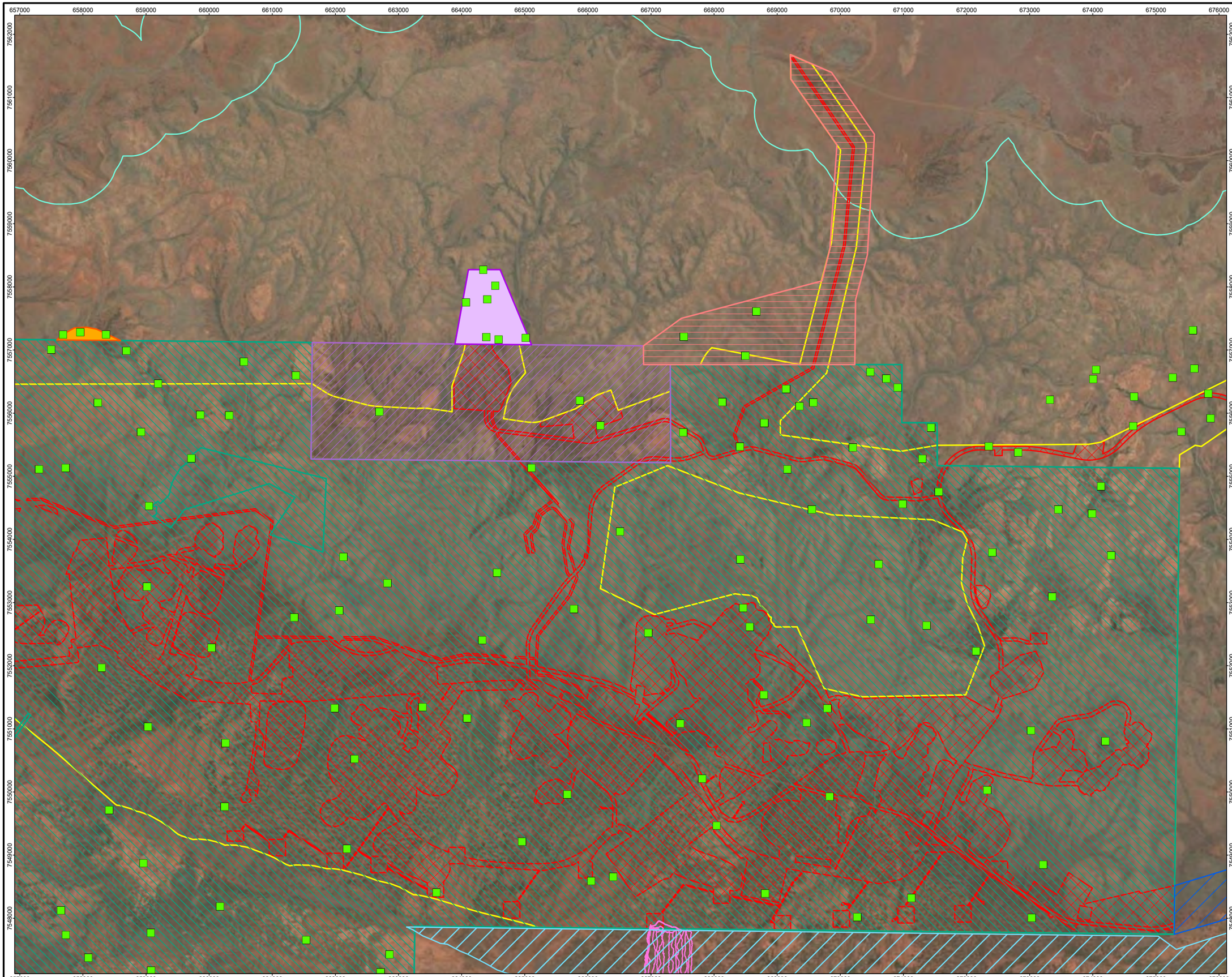
Coord. Sys. GDA2020 MGA Zone 50

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FLORA AND VEGETATION SURVEYS EFFORT

FIGURE 9.1 Map 2 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Survey areas

- Area 1 (Mulga East and Malay Well)
- Area 3 (Hester Peak SE)
- Area 6 (Hester Peak)
- Area 7 (Hester Peak East)
- Proposed haul road diversion single phase detailed survey
- Proposed solar farm single phase detailed survey (Maia,2023)
- Targeted Hibiscus Survey Area (Spectrum 2025)
- Targeted Hibiscus Survey Traverses (Spectrum 2025)

Site Type

- Quadrat

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Scale 1:55,000 at A3

0 1 2
Kilometers

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FLORA AND VEGETATION SURVEYS EFFORT

FIGURE 9.1 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

671000 672000 673000 674000 675000 676000 677000 678000 679000 680000 681000 682000 683000 684000 685000 686000 687000 688000 689000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Survey areas

- Area 1 (Mulga East and Malay Well)
- Area 3 (Hester Peak SE)
- Area 7 (Hester Peak East)
- Targeted Hibiscus Survey Area (Spectrum 2025)

Site Type

- Quadrat
- Relevé

Roads (LGATE-195)

- Highway

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 27-Aug-2025

Drawn By: jcrute | Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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FLORA AND VEGETATION SURVEYS EFFORT

FIGURE 9.1 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

9.3.2 Pre-European Vegetation Associations

Vegetation at a regional scale has been described by Beard (1975). These vegetation units (vegetation associations) are broad scale and are aligned with landform, soil and topography. The Development Envelope comprises four broad Beard structural vegetation associations (Beard 1975) as outlined in **Section 3.2**.

Currently, more than 99.8% of the four vegetation associations remain in the Pilbara bioregion and the relevant subregions (Maia, 2022).

9.3.3 Vegetation Types

A total of 15 vegetation types have been mapped within the Development Envelope during surveys undertaken for the Proposal (**Figure 9-2**; **Table 9-3**). Six of the 15 vegetation types were considered by Maia (2022) as locally significant (shown in bold in **Figure 9-3** and discussed in **Section 9.3.5**). With the exception of AWL (1) (33.56% of the Development Envelope), each locally significant vegetation type is a small percentage of the Development Envelope (less than 8.18%).

Table 9-3: Vegetation Types within the Development Envelope

Vegetation Type	Vegetation Description	Total Mapped Survey extent (Table 9.2)*	Extent within the Development Envelope	
			Area (ha)	Proportion (%)
AaAxSL	Tall Sparse Shrubland of *Acacia aneura* (alliance) and *A. xiphophylla* with a Low Sparse Shrubland of *Eremaea cuneifolia* and a Sparse Hummock Grassland of *Triodia epactia* and/or *T. basedowii*. Potential sheet-flow dependent vegetation.	3,628.68	814.09	4.83
AdEvWL	**Low Open Woodland to Low Woodland of *Acacia distans* and *Eucalyptus victrix* sometimes with a Tall Sparse Shrubland of *Acacia stenophylla* or *A. tetragonophylla* and a Shrubland to a Sparse Shrubland of *Duma florulenta.***	**12,051.30**	**4.96**	**0.03**
ASL (1)	Tall Sparse to Open mixed Shrubland mainly *of Acacia synchronicia, A. tetragonophylla, A. xiphophylla* with a mixed Sparse Chenopod Shrubland mainly of *Sclerolaena densiflora, S. cuneata* and *S. costata* and Isolated mixed Tussock Grasses mainly of *Sporobolus australasicus, Enneapogon polyphyllus* and *Dactyloctenium radulans.*	1,854.75	359.51	2.13
ASL (2)	**Mixed Tall Acacia Shrubland mainly of *Acacia tumida var. pilbarensis, A. pyrifolia* and *A. maitlandii* with a Sparse Tussock Grassland of *Themeda triandra* and Low Isolated Trees of *Corymbia hamersleyana* and / or *Eucalyptus victrix.***	**4,283.22**	**1,378.13**	**8.18**
AWL (1)	**Low Woodland / Tall Shrubland to Low Isolated Trees / Shrubs of *Acacia aneura* (complex) with a mixed Low Sparse Shrubland mainly of *Dodonaea petiolaris, Eremophila forrestii* and *Abutilon otocarpum* and Isolated Low Trees of *A. pruinocarpa.***	**14,111.52**	**5,654.28**	**33.56**

Vegetation Type	Vegetation Description	Total Mapped Survey extent (Table 9.2)*	Extent within the Development Envelope	
			Area (ha)	Proportion (%)
AWL (2)	**Low Woodland / Tall Shrubland to Low Isolated Trees / Tall Shrubs of *Acacia aneura* (complex) *A. synchronicia* and *A. tetragonophylla* with a mixed Low Sparse Shrubland mainly of *Solanum lasiophyllum, Abutilon otocarpum* and *Sida platycalyx* and a Sparse Tussock Grassland to Isolated Tussock Grasses mainly of *Sporobolus australasicus, Enneapogon cylindricus* and *Aristida contorta.***	**7,240.06**	**105.67**	**0.63**
AWL (3)	**Low Woodland of *Acacia aneura* (complex) mainly *Acacia aptaneura, A. aneura* and *A. incurvaneura* with a mixed Tall Shrubland mainly of *A. synchronicia, A. tetragonophylla* and *Hakea lorea subsp. lorea* with a Sparse Tussock Grassland to Isolated Tussock Grasses mainly of *Sporobolus australasicus, Enneapogon cylindricus* and *Aristida contorta*.**	**4,066.26**	**32.12**	**0.19**
AxAsSL	Tall Sparse Shrubland of *Acacia xiphophylla* and / or *A. synchronicia* with a mixed Sparse Chenopod Shrubland mainly of *Sclerolaena cuneata, S. bicornis, S. cornishiana* and a Sparse Tussock Grassland of *Eragrostis xerophila.*	9,779.72	1,381.93	8.20
MSW	Mixed Shrublands and Woodland of Drainage Lines. Shrublands and woodlands of *Eucalyptus spp., Atalaya hemiglauca, Melaleuca* and *Acacia* species associated with drainage lines. Potential Groundwater Dependent Vegetation.	2,433.38	141.97	0.84
MTG (1)	Mixed Tussock Grassland mainly of *Eragrostis xerophila, Eulalia aurea* and **Cenchrus setiger* with a mixed Tall Sparse Shrubland mainly of Acacia coriacea subsp. pendens, *A. tetragonophylla* and *A. synchronicia* with a Low mixed Sparse Shrubland mainly of *Pluchea rubelliflora, Pterocaulon sphacelatum* and *Salsola australis.*	576.38	241.96	1.44
MTGW	Tussock grasslands and shrublands of the 'Four plant assemblages of the Wona Land System' P1 (PEC) Mixed tussock grasslands of *Eragrostis xerophila, Aristida latifolia* and *Astrebla pectinate*, with patches of *Triodia spp*. and sparse mixed shrubs.	3,162.29	403.50	2.39
THG (1)	Mixed Hummock Grassland mainly of *Triodia basedowii, Triodia brizoides* and *T. vanleeuwenii* with a Tall Sparse Shrubland of mixed Acacia species mainly *Acacia atkinsiana*, *A. maitlandii*, *A. ancistrocarpa* with Low Isolated Trees of *Eucalyptus leucophloia*.	21,015.77	5,236.74	31.08
THG (2)	Mixed Hummock Grassland mainly of *Triodia basedowii, Triodia brizoides* and *T. vanleeuwenii* with a Tall Sparse Shrubland of mixed Acacia species mainly *Acacia atkinsiana*, *A. maitlandii*, *A. ancistrocarpa* with Low Isolated Trees of *Eucalyptus leucophloia*.	5,732.79	707.14	4.20

Vegetation Type	Vegetation Description	Total Mapped Survey extent (Table 9.2)*	Extent within the Development Envelope	
			Area (ha)	Proportion (%)
THGB	*Triodia* Hummock Grassland on Basaltic Terrain *Triodia epactia* and *T. brizoides* hummock grassland with sparse *Acacia inaequilatera* and *Grevillea pyramidalis* subsp. *leucadendron*	4,697.16	197.03	1.17
TvHG	**Hummock Grassland of *Triodia veniciae* with Isolated Shrubs of *Acacia marramamba* and *A. atkinsiana.***	**122.15**	**24.85**	**0.15**
Cleared / Disturbed		1,412.89	164.63	0.98
Total		**96,168.32**	**16,848.53**	**100**

*Note: area calculations are based on multiple surveys with some overlap and as a result some figures may be an overestimate.

Figure 9-2: Mapped Vegetation Types within the Development Envelope

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation type

- AaAxSL
- AdEvWL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MSW
- MTG (1)
- MTGW
- THG (1)
- THG (2)
- THGB
- TvHG
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

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Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.2 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation type

- AaAxSL
- AdEvWL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MTG (1)
- THG (1)
- THG (2)
- Cleared/Disturbed

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 06-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

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MAPPED VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.2 Map 2 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

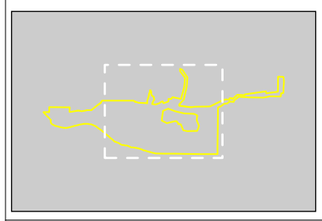
- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation type

- AaAxSL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MSW
- MTGW
- THG (1)
- THG (2)
- TvHG
- Cleared/Disturbed

Roads (LGATE-195)

- Minor Road



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Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.2 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

671000 672000 673000 674000 675000 676000 677000 678000 679000 680000 681000 682000 683000 684000 685000 686000 687000 688000 689000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation type

- AaAxSL
- ASL (2)
- AWL (1)
- MSW
- MTGW
- THG (1)
- THG (2)
- THGB
- TvHG
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

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Job No: 67751

Client: Hancock Prospecting Pty Ltd

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0 1 2
Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.2 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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9.3.4 Vegetation Condition

The condition of each vegetation type was assessed using the vegetation condition scale for the Eremaean and Northern Botanical Provinces recommended in EPA (2016d). The majority (99.01%) of vegetation in the Development Envelope is considered to be in 'Good' to 'Excellent' condition based on Keighery's (1994) vegetation condition scale (**Figure 9-3; Table 9-4**). Areas cleared for drill lines, access tracks, fence lines and existing infrastructure were mapped as Cleared, Completely Degraded or Disturbed' (Maia, 2022).

Vegetation mapped as 'Excellent' condition showed little to no disturbance from exploration or cattle grazing. Vegetation mapped as 'Very Good' condition showed impacts from current and historical grazing pressures and exploration activities, with numerous weed populations throughout. Vegetation mapped as 'Good' condition was mostly confined to an area close to the homestead and cattle yards and contained large numbers of weeds present with little to no understorey plants. Vegetation mapped as 'Degraded' is associated with areas cleared for exploration and small borrow areas (Maia, 2022). It should be noted that HPPL maintains an active exploration programme across the Mulga tenements. These activities are excluded from the current Proposal and are approved under relevant approval processes by DEMIRS under the Mining Act (e.g. programme of works) as noted in **Section 2.2.5**. Station tracks and some of clearing for exploration drilling have been digitised (Maia (2022); however, numerous drill lines have since been cleared. The area mapped as Degraded (**Figure 9-3; Table 9-4**) is therefore an underestimate of these areas. The nature of these exploration activities are low impact and temporary, with rehabilitation of the impacted areas required within six to twelve months depending on permit conditions.

Evidence of fire was noted in some areas, mainly on the low rolling hills and plains adjacent to Roebourne – Wittenoom Road. The condition of the vegetation within the floodplains is mostly rated as 'Very Good' to 'Good', as large numbers of cattle tend to graze in these areas. A number of weed species (**Malvastrum americanum*, **Cenchrus ciliaris*, **C. setiger* and **Vachellia farnesiana*) have been recorded in high numbers in vegetation types associated with the Fortescue River including its smaller tributaries and adjacent floodplains.

Table 9-4: Vegetation Condition within the Development Envelope (Maia, 2022).

Vegetation Condition	Extent in Development Envelope (ha)	Proportion of Development Envelope (%)
Excellent	6337.25	37.61
Very Good	8,363.23	49.64
Good	1,981.71	11.76
Sub-Total (Good to Excellent)	*16,682.19*	*99.01*
Degraded	158.91	0.94
Completely Degraded	7.43	0.04
Total	**16,848.53**	**100**

Figure 9-3: Vegetation Condition Mapped within the Development Envelope (Maia, 2022)

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation condition

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

Roads (LGATE-195)

- Highway
- Minor Road

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Drawn By: droberts	Checked By: VC

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0 1 2
Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

VEGETATION CONDITION MAPPED WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.3 Map 1 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

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Legend

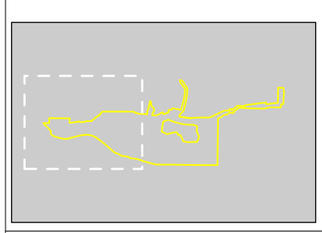
- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation condition

- Excellent
- Very Good
- Good
- Degraded

Roads (LGATE-195)

- Minor Road



JBS&G

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Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

VEGETATION CONDITION MAPPED WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.3 Map 2 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

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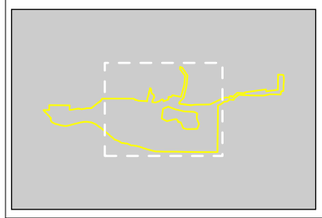
- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation condition

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

Roads (LGATE-195)

- Minor Road



JBS&G

Job No: 67751	
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Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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VEGETATION CONDITION MAPPED WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.3 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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GREAT NORTHERN HWY

Legend

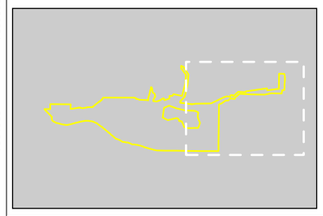
- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem (Priority 1)

Vegetation condition

- Excellent
- Very Good
- Degraded
- Completely Degraded

Roads (LGATE-195)

- Highway
- Minor Road



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0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

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VEGETATION CONDITION MAPPED WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.3 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

9.3.5 Significant Vegetation

For the purpose of EIA, significant vegetation is defined as vegetation which:

- Is identified as a threatened or priority ecological communities (TEC; or PEC);
- Has a restricted distribution;
- Has a degree of historical impact from threatening processes;
- Has a role as a refuge; or
- Provides an important function which is required to maintain ecological integrity of a significant ecosystem (EPA, 2016d).

The remaining extent of the pre-European vegetation associations within the Development Envelope and within the Pilbara bioregion is greater than 99% (refer to **Section 9.3.2**). Based on the remaining extent, the regional significance of the pre-European vegetation associations present is considered low.

9.3.5.1 Threatened Ecological Communities

There are no TECs listed under the BC Act within the Development Envelope or within 20 km of the Development Envelope

9.3.5.2 Priority Ecological Communities

Freshwater Claypans of the Fortescue Valley (Priority 1)

The Freshwater claypans of the Fortescue Valley PEC (Priority 1) includes a series of claypans in the Fortescue Valley and include the Gnalka Gnoona Claypan and the Koodjeepindarranna Claypans.

The Development Envelope does not intersect the DBCA designated buffer of the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC (**Figure 9-4**). While the Proposal will not result in direct impacts to this PEC, potential indirect impacts have been considered and are discussed in **Section 9.4.2**.

Four plant assemblages of the Wona Land System (Priority 1-Priority 3)

Within the Development Envelope the vegetation type MTGW has been mapped and described as Mixed Tussock Grasslands of *Eragrostis xerophila, Aristida latifolia* and *Astrebla pectinate*, with patches of *Triodia spp*. and sparse mixed shrublands (Maia 2022). This habitat/vegetation type lacks shrubs and has very little vegetative cover during the dry season. During the wet season, an array of ephemeral/annuals and short-lived perennials emerge, many of which are poorly known and range-end taxa (DBCA, 2021b). A total of 403.50 ha of MTGW occurs within the Development Envelope and is mapped as the 'Four plant assemblages of the Wona Land System' PEC (**Figure 9-4**). Of this, 69.98 ha occurs within the Indicative Footprint.

Vegetation type ASL(2) shares similar species to MTGW and may also be associated with the PEC so has been conservatively considered for the purpose of this assessment. A total of 4.00 ha of ASL (2) is mapped within the 'Four plant assemblages of the Wona Land System' PEC buffer (**Figure 9-4**). Of this, 0.33 ha occurs within the Indicative Footprint.

This system was previously known as the 'Cracking clays of the Chichester and Mungaroona Range' PEC. This PEC is a system of basalt upland gilgai plains with tussock grasslands which occurs throughout the Chichester Range into the Chichester-Millstream National Park and the Mungaroona Range Nature Reserve. There are a series of community types identified within the Wona Land System gilgai plains which are considered susceptible to known threats such as grazing or have constituent rare/restricted species.

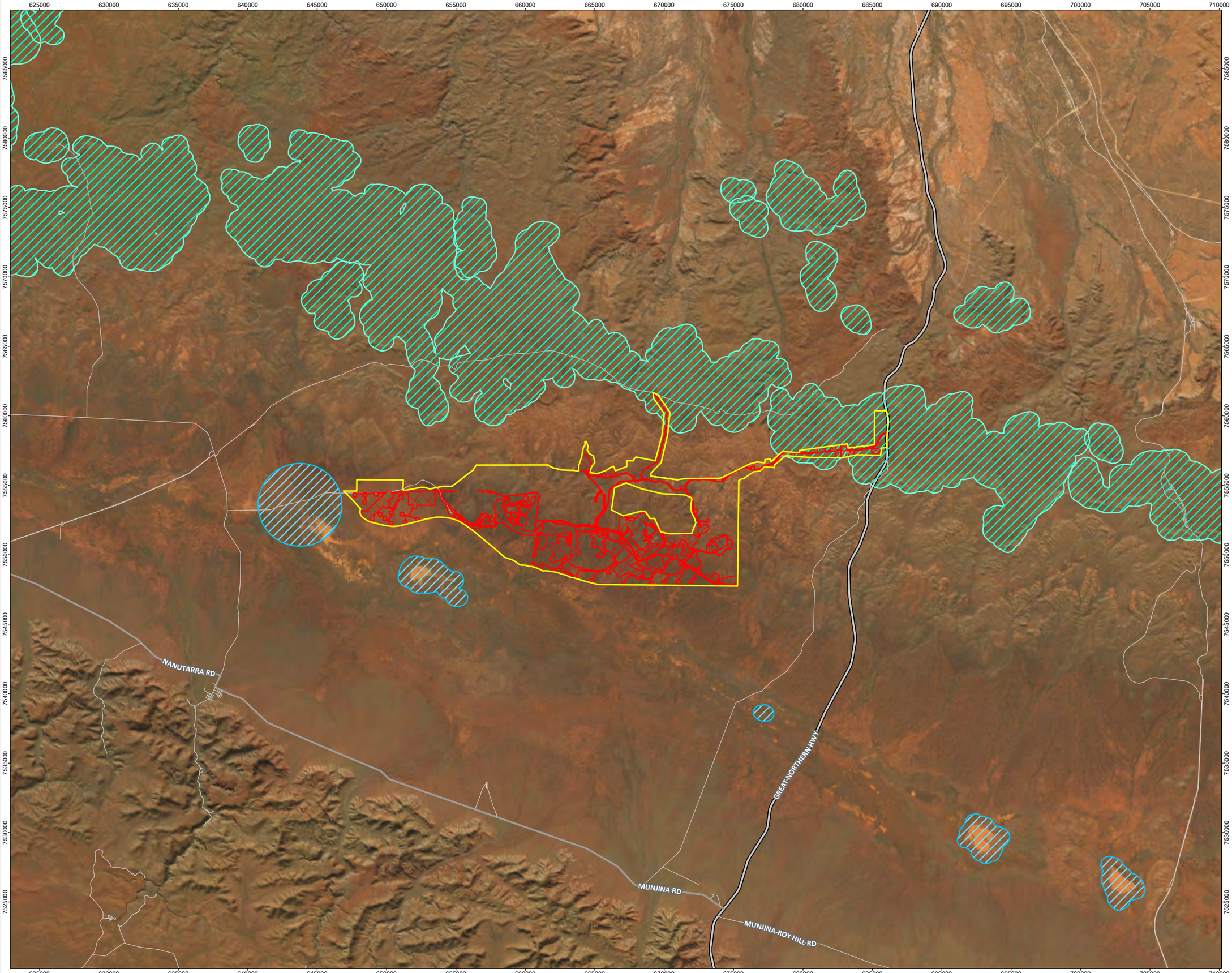
Table 9-5: Four plant assemblages of the Wona Land System PEC

Vegetation Type	Extent in Development Envelope (ha)	Extent in Indicative Footprint
MTGW	403.50	69.98
ASL(2)	4.00	0.33
Total	**407.50**	**70.31**

Coolibah-lignum flats: *Eucalyptus victrix* over lignum community in the Pilbara (Priority 1-Priority 3)

One vegetation community mapped within the Development Envelope AdEvWL (4.96 ha occurs within the Development Envelope) appears to have affinities with the PEC, 'Coolibah-lignum flats: *Eucalyptus victrix* over lignum community in the Pilbara' PEC (Priority 1 or Priority 3 depending on location; Maia 2022). Quadrat data from within this mapped area was sent to DBCA (Species and Communities Branch) for comparison and analysis against reference quadrats from known PEC occurrences. Based on the analysis, the presence of two different *Acacia* species (*Acacia distans* and A. *stenophylla*) signifies different communities from the sub-types described for the PEC (pers. comm. Jill Pryde A/Senior Ecologist, DBCA Species and Communities Branch, November, 2012). The nearest mapped location of this PEC is approximately 45 km south-southwest of the Development Envelope within Karijini National Park. This PEC is therefore not considered to be present within the Development Envelope. DBCA has advised that it is likely that the vegetation type is still not considered part of the Coolibah lignum flats of the Pilbara Region PEC (pers comms Robyn Luu 2/9/24).

Figure 9-4: Conservation Significant Ecological Communities based on DBCA designated buffers



Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA-038)

- Four plant assemblages of the Wona Landsystem PEC buffer (P1)
- Freshwater claypans downstream of the Fortescue Marsh PEC buffer (P1)
- Highway
- Major road
- Minor Road

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0 2 4
Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT ECOLOGICAL COMMUNITIES BASED ON DBCA DESIGNATED BUFFERS

FIGURE 9.4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

According to Maia (2022) six of the 15 vegetation types mapped within the Development Envelope may be locally significant due to being restricted locally, associated with significant ecological processes and landforms, and supporting conservation-significant species as outlined in (**Table 9-6**).

Table 9-6: Key attributes of locally significant vegetation within the Development Envelope (Maia, 2022)

Locally Significant Vegetation Type	Reason
ASL (2)	Drainage lines associated with ASL (2) harvest water from the surrounding hills and feed it to Mulga and other vegetation downslope; therefore, any changes to water flow into these drainage lines may affect the health of vegetation types dependent on water shedding off the hills.
AWL (1) AWL (2) AWL (3)	These vegetation types contain areas of banded and non-banded mulga and are likely to be susceptible to changes in surface water flow.
TvHG	Vegetation type TvHG occurs in the Jeerinah Formation stratigraphic unit which contains the geological characters of shale. The Priority 1 species Triodia venciae is the dominant and indicator species of this vegetation type.
AdEvWL	This riparian vegetation type is habitat specific as it is restricted to the Fortescue River and associated habitats.

9.3.5.3 Sheetflow Dependant Vegetation

Vegetation potentially dependent on sheet flow (overland/surface water flow) is present within the Development Envelope.

Acacia aneura and closely related co-occurring species are commonly referred to as Mulga vegetation (Mulga) (Page and Grierson, 2010). Mulga has been found to be highly dependent on sheet flow (Winkworth, 1973; Tongway and Hindley, 2004; cited in Maia, 2022)) and sensitive to any changes to sheet flow. The changes can be natural, such as following rainfall events where the natural fluvial channels may be altered from erosional processes.

Across the Pilbara, sheetflow vegetation typically comprises banded Mulga and non-banded Mulga that is most commonly associated with the Jamindie land system.

Vegetation types listed in **Table 9-7** which may represent sheetflow dependent vegetation types have been mapped within and surrounding the Development Envelope. They are identified as potential sheetflow vegetation solely due to the dominant presence of Mulga species, such as *Acacia aneura*, within these vegetation types (Maia 2022). Soil type and gradient has not been considered in the identification of these potential sheetflow dependent communities.

A total of 44,964.20 ha of these vegetation types have been mapped during surveys associated with the Proposal (refer to **Table 9-3**) of which 9,725.43 ha occurs within the Development Envelope and 2,973.51 ha occurs within the Indicative Footprint (**Figure 9-5**).

Table 9-7: Potential Sheet Flow Vegetation

Potential Sheetflow Vegetation	Known mapped Extent (refer to Figure 9-3)*	Extent in Development Envelope (ha)	Extent in Indicative Footprint (ha)
AaAxSL - tall sparse shrubland of *Acacia aneura* (alliance)	3,628.68	814.09	68.53
ASL (1) - *Acacia* tall shrubland	1,854.75	359.51	64.95
ASL (2) - *Acacia* tall shrubland	4,283.22	1378.13	253.47
AWL (1) - *Acacia* low woodland or tall shrubland	14,111.52	5654.28	2087.41
AWL (2) - *Acacia* low woodland or tall shrubland	7,240.06	105.67	35.98
AWL (3) - *Acacia* low woodland or tall shrubland	4,066.26	32.12	8.83
AxAsSL - *Acacia* tall sparse shrubland	9,779.72	1381.63	454.33
Total	**44,964.21**	**9,725.43**	**2,973.51**

*Note: area calculations are based on multiple surveys with some overlap and as a result some figures may be an overestimate.

Figure 9-5: Potential Sheetflow Dependent Vegetation within the Development Envelope (Maia, 2022)

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Sheetflow vegetation type

- AaAxSL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL

Roads (LGATE-195)

- Highway
- Minor Road

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Client: Hancock Prospecting Pty Ltd	
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Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

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Central Pilbara, Western Australia

POTENTIAL SHEETFLOW VEGETATION WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.5 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

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Legend

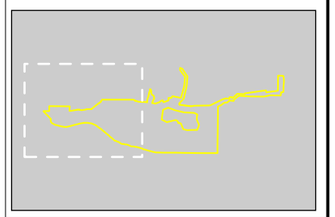
- Development Envelope
- Indicative Footprint

Sheetflow vegetation type

- AaAxSL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL

Roads (LGATE-195)

- Minor Road



JBS&G

Job No: 67751

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0 1 2
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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

POTENTIAL SHEETFLOW VEGETATION WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.5 Map 2 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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Legend

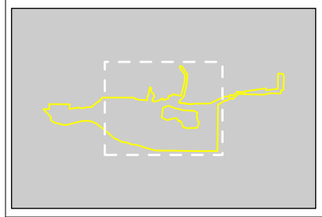
- Development Envelope
- Indicative Footprint

Sheetflow vegetation type

- AaAxSL
- ASL (1)
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- AWL (1)
- AWL (2)
- AWL (3)
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Roads (LGATE-195)

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JBS&G

Job No: 67751

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POTENTIAL SHEETFLOW VEGETATION WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.5 Map 3 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

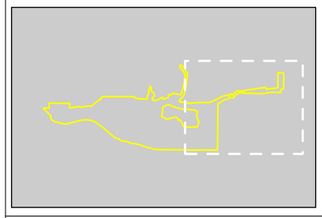
- Development Envelope
- Indicative Footprint

Sheetflow vegetation type

- AaAxSL
- ASL (2)
- AWL (1)

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

POTENTIAL SHEETFLOW VEGETATION WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.5 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

9.3.5.4 Groundwater Dependant Vegetation

Based on the detailed assessment of vegetation using remote sensing methods and other ecophysiological studies completed by AQ2 it is considered highly unlikely that groundwater dependent vegetation occurs within or in proximity to the Development Envelope (AQ2 2025).

Riparian species in the Pilbara represent the mesic or wet- end of an ecological gradient of decreasing water availability. Although vegetation higher in the ecological gradient may draw upon groundwater at times, riparian vegetation is considered the main groundwater-dependent vegetation of the Pilbara. It is also likely to be the most sensitive and least tolerant to decreased water availability (Loomes 2010, cited in Maia 2021). Dominant riparian Pilbara species are often widespread and common to other Pilbara systems (e.g. floodplains, springs, river pools) (Maia 2022).

Groundwater Dependent Ecosystems (GDE) and the related Groundwater Dependent Vegetation (GDV) may be separated into the following phreatophytes (a plant with deep root systems that draws its water supply from near the water table) types:

- Obligate - obtains all of its water from the water table; and
- Facultative - able to source water from other sources than groundwater, for example surface water (i.e. rainfall).

The following dominant Pilbara riparian tree and shrub species have been identified in an assessment of water level ranges of Pilbara riparian species (Loomes 2010 cited in Maia 2021):

- *Eucalyptus camaldulensis;*
- *Melaleuca argentea;*
- *Eucalyptus victrix;*
- *Sesbania Formosa;*
- *Atalaya hemiglauca;*
- *Melaleuca glomerata;*
- *M. bracteate;*
- *Livistona alfredii;*
- *Lysiphyllum cunninghamii;*
- *Ficus opposite;*
- *Hakea lorea; and*
- *Acacia ampliceps.*

Of these, the desktop flora and vegetation survey undertaken by Maia (2022) identified that the following species have the potential to occur within the Development Envelope and across associated areas of riparian vegetation and known drainage lines:

- *Eucalyptus victrix;*
- *Melaleuca glomerata;*

- *Ficus braccypoda;*
- *Atalaya hemiglauca; and*
- *Hakea lorea.*

To date, biological field surveys indicate no records of *Melaleuca argentea* or *Eucalyptus camaldulensis* (both obligate phreatophytes) occur within the Development Envelope. The dominant eucalypt species recorded by the biological field surveys was *Eucalyptus victrix*, a facultative phreatophyte (Maia, 2018 and 2020).

Eucalyptus victrix is considered a potential GDE indicator species (Maia 2022) and was recorded in four vegetation types mapped within the Development Envelope, including AdEvWL, ASL (2), AWL (2) and MTG (1) . The most notable aspects of these vegetation types are:

- *E. victrix* occurs in low, open woodland to low woodland formations in vegetation types AdEvWL. In all other vegetation types, *E. victrix* occurs as scattered or isolated trees. These trees may be regarded as outliers from the core woodland populations, with recruitment presumably facilitated by a combination of specific hydrological regimes (e.g., major floods providing seed dispersal) and micro niche habitat characteristics.
- The Acacia woodland/shrubland vegetation types (i.e. ASL (2) and AWL (2)), and tussock grass dominate types (i.e. MTG (1)) are all upgradient of the *E. victrix* woodland units.

The mapped vegetation types within the Development Envelope and their ecohydrological characteristics are listed in **Table 9-8.**

Table 9-8: Mapped Vegetation Types in the Development Envelope and their Ecohydrological Characteristics (AQ2 2024a)

Vegetation Community	Key Ecohydrological Characteristics
AaAxSL	Occurs in upland areas. Dominant species include members of the *Acacia aneura* (complex) and *A. xiphophylla*, with Low Sparse Shrubland of *Eremophila cuneifolia* and a Sparse Hummock Grassland of *Triodia epactia* and/or *T. basedowii*. These are generally regarded as shallow rooted, drought tolerant species.
AdEvWL	Occurs in valley areas adjacent to claypans where surface water inflows accumulate. *Eucalyptus victrix* open woodland to woodland formations, with little to no understorey to a dense overstorey of *Acacia distans*. Other notable shrub species can include *A. stenophylla, A. tetragonophylla* and *Duma florulenta*. Maia (2022) noted that in some areas the understorey is impacted by current and historical grazing.
ASL (1)	Associated with Jamindie Land System, at the base of alluvial fans on hardpan plains dissected by throughflow drainages. Water sources include direct rainfall and redistributed runoff. Tall sparse to open mixed Shrubland mainly of *Acacia synchronicia, A. tetragonophylla, A. xiphophylla* with a mixed Sparse Chenopod Shrubland and occasional patched of mixed Tussock Grasses. These are generally regarded as shallow rooted, drought tolerant species.
ASL (2)	Associated with creek banks, minor drainage channels and floodplains. *E. victrix* is present as scattered trees (low density). Other notable species include *Corymbia hamersleyana, A. tumida* var. *pilbarensis, A. pyrifolia* and *A. maitlandii* and the understorey tussock grass *Themeda triandra*. Drainage inflows augment rainfall with soil water storage controlled by alluvium depth.

Vegetation Community	Key Ecohydrological Characteristics
AWL (1)	A spatially extensive vegetation types that occurs on stony, washout flats with indistinct drainage on the northern side of the Fortescue Valley. Distinct banded vegetation formations supported by localised surface water redistribution processes. Dominated by *Acacia aneura* (complex) – shallow rooted, drought tolerant species.
AWL (2)	Similar to AWL (1), but mostly occurs on the southern side of the Fortescue Valley on better developed alluvial fans. Vegetation banding is evident but less distinct than AWL (1). Major species include *Acacia aneura* (complex), *Acacia synchronicia* and *A. tetragonphylla*, *E. victrix* present as scattered trees (low density).
AWL (3)	Functionally similar to AWL (1) and AWL (2). Occurs on broad drainage lines, drainage basins and hardpan and stony plains.
AxAsSL	Principally associated with the Hooley Land System (west of the proposed mining areas), occurs mainly on hardpan and stony plains. Characterised by fine textured (clayey) soil types. Water sources include direct rainfall and redistributed runoff. Tall Sparse Shrubland of *A. xiphophylla* and / or *A. synchronicia* with a mixed Sparse Chenopod Shrubland. These are generally regarded as shallow rooted, drought tolerant species.
MSW	Mixed shrublands and woodlands of drainage lines, contained the following species which have the potential to be groundwater dependent species: • *Eucalyptus camaldulensis;* and • *Eucalyptus victrix* or *Melaleuca argentea*.
MTG (1)	Occur in alluvial plains adjacent to major drainages feeding into the Fortescue Valley. Characterised by the fine textured soils. *E. victrix* present as scattered trees (low density) in MTG (1) and MTG (2).
MTGW	Four plant assemblages of the Wona Land System PEC
THG (1)	Occur on hillslopes in the Chichester Range, Rainfed, shallow rooted vegetation growing on stony soils.
THG (2)	
TvHG	Has restricted distribution on low rolling hills and undulating stony plains with a surface layer of shale in the Chichester Range. Rainfed, shallow rooted vegetation growing on stony soils.
THGB	Scattered spinifex hummock grasslands which occur in interfluvial areas, characteristic of skeletal soils and xerophytic conditions.

An ecohydrological study (AQ2 2025; **Appendix 4**) was completed to investigate the claypan flats and associated stands of mesic trees comprising *Eucalyptus victrix* with a midstorey and understorey of predominately *Acacia sp.* and *Meuhlenbeckia florulenta*.

An ecohydrological water model (EWB) was developed and predicted groundwater did not contribute to tree water demand at any of the measured sites (AQ2 2025). The model included several climatic scenarios. The objective of the model was to determine the frequency and magnitude of drought stress on the woodland trees over extended periods. The information from the assessment provides a basis for evaluating the necessity of

groundwater to augment rainfall at key times over the different climatic periods (i.e. after prolonged soil-drying). The EWB evaluated water transfer in *E. victrix* woodlands that are representative of the on-ground tree measurement locations in the Development Envelope.

No GDEs were identified within the Development Envelope during the ecohydrology assessment. The study area also considered the areas proximal to the Proposal including the Goodiadarrie Swamp. The focus areas for the assessment included the Koodjeepindarranna and Gnalka Goona Claypans, which are also outside of the Development Envelope.

The ecohydrological assessment concluded that groundwater dependent vegetation is unlikely to occur within and in the area surrounding the Proposal, based on the following evidence:

- Groundwater underlying the Fortescue Valley environs is generally brackish/saline and therefore does not constitute a favourable water source for the vegetation.
- In most areas, plant roots cannot readily access groundwater as there is calcrete or dense impermeable clay beneath the soil, and above the groundwater table, which plants roots cannot easily penetrate.
- There are no areas of persistently high greenness as measured by time series NDVI imagery in the relevant area. Greenness reflects photosynthetic activity, which relies on water availability. In order to maintain persistently high greenness, vegetation would likely need a persistent water source even during dry seasons, such as groundwater.
- Time series pre-dawn leaf water potentials indicate the tree-root zones are in unsaturated media. Also taking into consideration the potential influence of brackish groundwater, this precludes the roots being in groundwater or at the capillary fringe.
- Water balance modelling supported by on-ground vegetation measurements, used to estimate tree water use relative to water availability estimated that surface water inputs are sufficient to support the density of trees occurring in the Fortescue Valley *E. victrix* woodland communities. The denser woodland stands are associated with better structured soils with relatively higher plant-available water storage capacity. This provides further support to the conclusion that the vegetation is unlikely to be reliant on groundwater.

9.3.5.5 Riparian Vegetation

One mapped riparian vegetation type (AdEvWL) (**Figure 9-7**) was identified within the Development Envelope which is restricted to the Fortescue River and associated habitats (Maia 2022). Vegetation type AdEvWL supports species that only occur in seasonally inundated habitats (Maia 2022). AdEvWL was mapped within 4.96 ha (0.03 %) of the Development Envelope (**Table 9-3**).

9.3.6 Flora

9.3.6.1 Desktop Assessment

Maia (2022) completed a desktop assessment over an area approximately 235 km by 112 km referred to as the desktop study area. Searches were requested of DBCA's Threatened and Priority Flora List (TPFL) and WA Herbarium (WAH) databases in 2018 and 2020 (DBCA search references #31-0818FL, #55-0820FL and #41-1120FL) to gather information on conservation significant flora species that could potentially occur in the desktop study area.

9.3.6.2 Threatened Flora

Threatened flora is the species of flora that are listed under the BC Act as critically endangered, endangered or vulnerable threatened species (DBCA 2023).

Four Threatened flora species under the BC Act which currently have records in the Pilbara bioregion (WAH, 1998-):

- *Aluta quadrata* (Endangered); found in three geographically separated locations in the Hamersley Range, approximately 225 km south west of the Proposal;
- *Quoya zonalis* (Endangered) previously known as *Pityrodia sp. Marble Bar* (G. Woodman & D. Coultas GWDC Opp 4). Found in Chichester subregion approximately 130 km north west;
- *Thryptomene wittweri* (Vulnerable, BC Act). Records are from the Hamersley;
- *Synostemon hamersleyensis* (Endangered). This species was listed as Priority species (DBCA) at the time of referral of this Proposal in 2021). It was delisted in October 2023 and upgraded to Endangered under the BC Act. This species is restricted to the Hamersley subregion (Telford and Naaykens, 2015).

All four species occur some distance from the Proposal with very different habitat preferences to those were mapped in the Development Envelope. With the exception of *Q. zonalis,* with records in the Chichester*,* the other three taxa occur within the Hamersley subregion. Searches in extensive surveys did not yield any records of these taxa (Maia 2022).

9.3.6.3 Priority Flora

Priority 1 species are known from one or a few locations (generally five or less) and are species which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, for example, agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under immediate threat from known threatening processes (DBCA 2023).

Priority 2 (poorly-known species) are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes (DBCA 2023).

Priority 3 (poorly-known species) are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them (DBCA 2023).

Species that are adequately known, meet criteria for near threatened, or are rare but not threatened, or that have been recently removed from the threatened species list or conservation dependent or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4 (DBCA 2023).

The desktop assessment identified 108 Priority (classified by DBCA) flora species in the desktop study area. This includes 21 Priority 1 (P1), 19 Priority 2 (P2), 59 Priority 3 (P3) species and 9 Priority 4 (P4) species (See Table A3.3 of Maia 2022 for full species list; **Appendix 10a.1**).

Of these, 16 Priority flora species were previously recorded by surveys within the desktop study area:

- *Calotis squamigera* (Priority 1);
- *Helichrysum oligochaetum* (Priority 1);
- *Josephinia* sp. Woodstock (A.A. Mitchell PRP 989) (Priority 1);
- *Rhodanthe ascendens* (Priority 1);
- *Triodia veniciae* (Priority 1);
- *Teucrium pilbaranum* (Priority 2);
- *Eragrostis crateriformis* (Priority 3);
- *Eragrostis* sp. Erect spikelets (P.K. Latz 2122) (Priority 3);
- *Euphorbia australis* var. *glabra* (Priority 3);
- *Glycine falcata* (Priority 3);
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (Priority 3);
- *Lotasperma sessilifolium* (Priority 3);
- *Rostellularia adscendens* var. *latifolia* (Priority 3);
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3);
- *Triodia basitricha* (Priority 3); and
- *Bulbostylis burbidgeae* (Priority 4).

One queried Priority flora species has also been recorded: *Rostellularia adscendens* ? var. *latifolia* (potential P3), along with one other potential Priority flora species, *Bulbostylis burbidgeae* – atypical form (? P4).

At the time of referral Goodenia nuda was listed as Priority 4. This species was downgraded and no longer listed under DBCA or BC Act.

9.3.6.4 Field Surveys

A total of 749 taxa from 60 families and 206 genera were recorded during field surveys by Maia (2022). Maia (2022) recorded 88% of the estimated flora taxa within the Survey Area as determined by species accumulation analysis. This is greater than most other studies recorded within the local area (Maia 2022) and highlights the large survey effort undertaken by Maia. This demonstrates that an adequate level of survey has been undertaken throughout the Development Envelope with respect to flora species detection.

The plant families most frequently recorded were:

- Fabaceae: 130 taxa;
- Poaceae: 127 taxa;
- Malvaceae: 81 taxa;

- Asteraceae: 53 taxa; and
- Amaranthaceae: 35 taxa.

The findings are generally consistent with the flora assemblages expected for the Chichester and Fortescue Plains subregions (DBCA, 2022).

Following completion of the Maia (2022) survey, two additional survey areas (ASA) within the Development Envelope were identified, being the Road Deviation Area (RDA), the Solar Farm and the Water Pipeline (WP) covering a total area of 241.6 ha (**Figure 9-1**). A targeted flora and vegetation assessment of the ASA was subsequently undertaken by Maia in February 2023 (Maia 2023; **Appendix 10b**).

In total, 79 taxa from 45 genera and 22 families were recorded from the ASA; comprising 97% perennial taxa and 3% annual taxa. The families with the highest number of tax recorded were, similar to the Maia (2022) Survey Area:

- Fabaceae: 29 taxa;
- Poaceae: 10 taxa; and
- Malvaceae: 9 taxa.

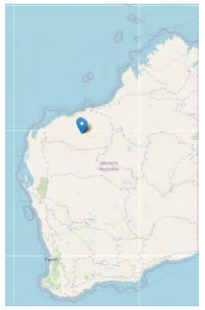
9.3.6.5 Conservation Significant Flora

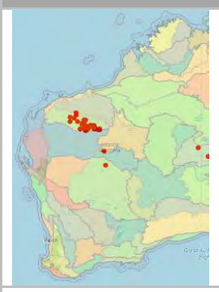
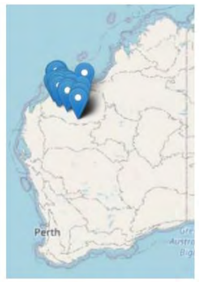
Conservation significant flora are species listed under the BC Act or Threatened or Priority species identified by DBCA as requiring further protection as described in **Section 9.3.6.2** and **9.3.6.3**, respectively.

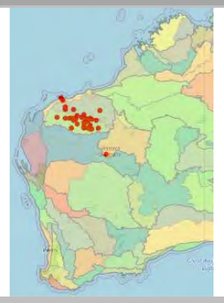
No Threatened flora species listed under the BC Act have been recorded within the Development Envelope (Maia 2022; 2023).

Ten confirmed 'Priority' flora species have been identified in the Development Envelope (**Table 9-9**; **Figure 9-6**). Of these, two species were initially considered unresolved, *Hibiscus* sp.? Nov. and *Bulbostylis burbidgeae*-like (atypical form); however, subsequent taxonomic identification has determined these species to be; *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) (now Priority 1); and an atypical form of *Bulbostylis burbidgeae*-(Priority 4).

Table 9-9: Conservation Significant Flora Recorded in the Development Envelope

Species	Description/Habitat/Known Range and Extent (Maia 2022; WAH 1998-)	Distribution (from Maia 2022; WAH 1998-)	Vegetation Types	Total Extent of Potential Habitat in Development Envelope (ha)	Total Extent of Potential Habitat in Indicative Footprint (ha)	Total number of individuals mapped during surveys (Table 9-2)	No. of known individuals in the Development Envelope	No. of known Individuals in the Indicative Footprint
Priority 1								
Dipteracanthus chichesterensis	*Dipteracanthus chichesterensis* (Acanthaceae: Ruellieae),a new geographically and edaphically restricted species from the Pilbara bioregion of Western Australia. Nuytsia 25: 161–170 (2015). *Dipteracanthus chichesterensis* Trudgen & de Kock is described as a new species of Acanthaceae (tribe Ruellieae Dumort.) restricted to the Chichester Plateau in the Pilbara bioregion of Western Australia. Spreading, glabrescent, perennial subshrubs to 30 cm tall, with short-lived, quadrangular stems from a perennial rootstock; hairs simple, soft, eglandular, septate, (2–)3–7-celled. Older stems with light grey bark; young stems light green or grey-green. The new species is known from five localities and is considered poorly known and of conservation significance.		MTGW	403.50	69.98	55	14	0
Hibiscus sp. Mulga Downs (S. Hitchcock SH 638) (includes resolved records)	*Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) is a sub-shrub, that has been recorded growing form 12 cm to 20cm in height, with purple flowers and grows on stony plain with red clay-load over ironstone (Western Australian Herbarium 1998-). Records associated with surveys undertaken in connection with this Proposal are the only records of this species. AWL (1) and AWL (2) are also the primary vegetation types in which this taxon has been recorded. Both vegetation types are sheetflow dependent.		AWL (1) AWL (2)	5,759.95	2,123.39	4,226	1,427	622
Triodia veniciae	Spinifex species located on shale slopes and tops of low hills. *T. veniciae* has 26 records on Florabase and 22 records on ALA. The ALA records appear to be mostly in the Fortescue subregion, with one record in the Chichester subregion of the Pilbara bioregion. This species has been recorded across the broader MDIOM and Hub and Rail Spur.		AaAxSL THG (1) THG (2) TvHG	6,782.81	1,192.97	3,994	1,278	574
Priority 3								

Species	Description/Habitat/Known Range and Extent (Maia 2022; WAH 1998-)	Distribution (from Maia 2022; WAH 1998-)	Vegetation Types	Total Extent of Potential Habitat in Development Envelope (ha)	Total Extent of Potential Habitat in Indicative Footprint (ha)	Total number of individuals mapped during surveys (Table 9-2)	No. of known individuals in the Development Envelope	No. of known Individuals in the Indicative Footprint
Aristida jerichoensis var. subspinulifera	*A. jerichoensis* var. *subspinulifera* has 42 records on Florabase and 36 records ALA in WA (2,105 records for all of Australia). The ALA records are in the Gascoyne, Murchison and Pilbara bioregions and five subregions – Hamersley, Fortescue, Augustus, Carnegie and Eastern Murchison.		ASL (2) AWL (1) THG (2)	7,739.54	2,525.78	14	5	0
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (includes *Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)*	Prostrate annual herb, growing up to 0.01 m tall. Blue-mauve flowers. Gentle slope, plains, in claypan, red-brown sandy clay. *D.* sp. Hamersley Station (A.A. Mitchell PRP 1479) has 38 2 records on Florabase. The Florabase records are all in the Pilbara bioregion (in the four subregions) but it is restricted to heavy clay soils.		AWL (1) THG (1)	10,891.02	3,026.64	180,220	29	2
Euphorbia australis var. glabra	Prostrate annual herb. Typically occurs on cracking clay and clay plains. Flowers in April to September. It is distributed widely in the central Pilbara. E. *australis* var. *glabra* has 23 records on Florabase and 25 records on ALA, with records are in the Pilbara bioregion and in the Chichester, Fortescue and Hamersley subregions.		AdEvWL	4.95	4.31	3,346	1	0
Rostellularia adscendens var. latifolia	Herb or shrub to 0.3 m high. Creeks, rocky hills. Flowers are blue-purple-violet in April to May. *Rostellularia adscendens* var. *latifolia* is an erect, perennial herb to 0.3 m high, which occurs near creeks or on rocky hills (Western Australian Herbarium 1998-). This taxon occurs over a range of approximately 420 km in Western Australia, from Warrawagine Station in the north-east, to near Hamersley Station in the south-west (DBCA 2007-). It also occurs in the Northern Territory, South Australia, Queensland and New South Wales (Council of Heads of Australasian Herbaria 2016). *R. adscendens* var. *latifolia* has 47 records on Florabase and 49 records on ALA in WA.The WA records are only in the Pilbara bioregion in three of the four subregions – Hamersley, Fortescue and Chichester.		AdEvWL	814.09	4.31	2,841	4	0

Species	Description/Habitat/Known Range and Extent (Maia 2022; WAH 1998-)	Distribution (from Maia 2022; WAH 1998-)	Vegetation Types	Total Extent of Potential Habitat in Development Envelope (ha)	Total Extent of Potential Habitat in Indicative Footprint (ha)	Total number of individuals mapped during surveys (Table 9-2)	No. of known individuals in the Development Envelope	No. of known Individuals in the Indicative Footprint
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	*Themeda* sp. Hamersley Station (M.E. Trudgen 11431) has 55 records on Florabase and 55 records on ALA. Almost all of the records are in the Pilbara bioregion, in all 4 subregions, while one record is in the Trainor subregion of the Little Sandy Desert bioregion.		AaAxSL MTG (1)	1,056.06	109.14	522	0	0
Priority 4								
Bulbostylis burbidgeae (includes count of 'atypical' taxa)	A tufted, erect to spreading annual, grass like or herb (sedge) growing 0.03-0.25m high, with brown flowers (March or June to August), on granitic soils, granite outcrops and cliff bases. The WA records of *Bulbostylis burbidgeae* are only in the Pilbara bioregion in three of the four subregions - Chichester, Fortescue, Roebourne. (WAH 1998-). The atypical form was recorded within the DE from 4 records (20 individuals each).		TGH (1)	5,236.74	939.23	80	20	0
Rhynchosia bungarensis	*R. bungarensis* has 87 records on Florabase and 91 records on ALA. While they are in the Carnarvon, Gascoyne and Pilbara bioregions most records are in the Pilbara. The records are in 5 subregions including the Chichester, Hamersley and Roebourne in the Pilbara. ALA shows one record in the Dampierland bioregion, Pindanland subregion, which is not on Florabase		ASL (1)	359.51	64.95	1	1	0

9.3.6.6 Other Significant Flora

According to EPA guidance (EPA, 2016f), flora species may be considered significant if they are considered possible new species, have atypical characteristics or are range extensions.

Using a distance of 100 km as the minimum distance from an existing record to define range extension, nine range extension species have been collected within the Survey Area:

- *Acacia doreta;*
- *Aristida anthoxanthoides;*
- *Abildgaardia oxystachya;*
- *Goodenia occidentalis;*
- *Maireana aphylla;*
- *Olearia muelleri;*
- *Roepera iodocarpa;*
- *Stemodia linophylla;* and
- *Vittadinia ertici*.

Two *Acacia sp. nov* individuals were collected from an *Acacia* with miniritchie bark growing in shaley areas. The shrubs were sterile when the surveys were carried out; however, one specimen was submitted to the WA Herbarium for identification, and it was indicated to be a potential new species (Maia 2022; **Appendix 10a.1**). The specimen did not clearly fit any currently recognised taxon or hybrid. More specimens were collected during a follow-up targeted flora survey in 2021, and they were submitted to the WA Herbarium for identification. The sample was subsequently determined likely to be *Acacia doreta*, with the WA Herbarium reasonably confident with the identification, and was noted that it would be good to see fruiting material to confirm. This is a northerly range extension for the species. *A. doreta* is not listed as conservation significant.

Species have a typical range which is indicated by their known distribution records. Sometimes species are recorded during a survey and their distribution records show that they have not been located in the area previously. The new records can either extend the range of a species out from its known distribution or fill a gap in the distribution records. The new distribution records can be a result of few surveys having been carried out in an area; of the degree of coverage achieved previously and of the habitats surveyed; or the time of year of survey with respect to season and rainfall. However, range extensions and gap fillers can also reflect a lack of submission of flora records to the WA Herbarium, as relatively common species or those not classified as significant are not often submitted.

An additional flora of significance, Sandalwood (*Santalum spicatum)* has also been recorded in the Survey Area but occurs outside the Development Envelope. This species is defined and controlled as a native species by the BC Act and *Biodiversity Regulations 2018*. It cannot be taken from private land or from Crown land without a license (flora taking (sandalwood license) (DBCA, 2025)), unless an exemption applies. It may also be lawfully taken (or cleared) in Western Australia under Parts IV and V of the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.* Three individual *S. spicatum* trees were identified within the Study Area (**Figure 9-6**).

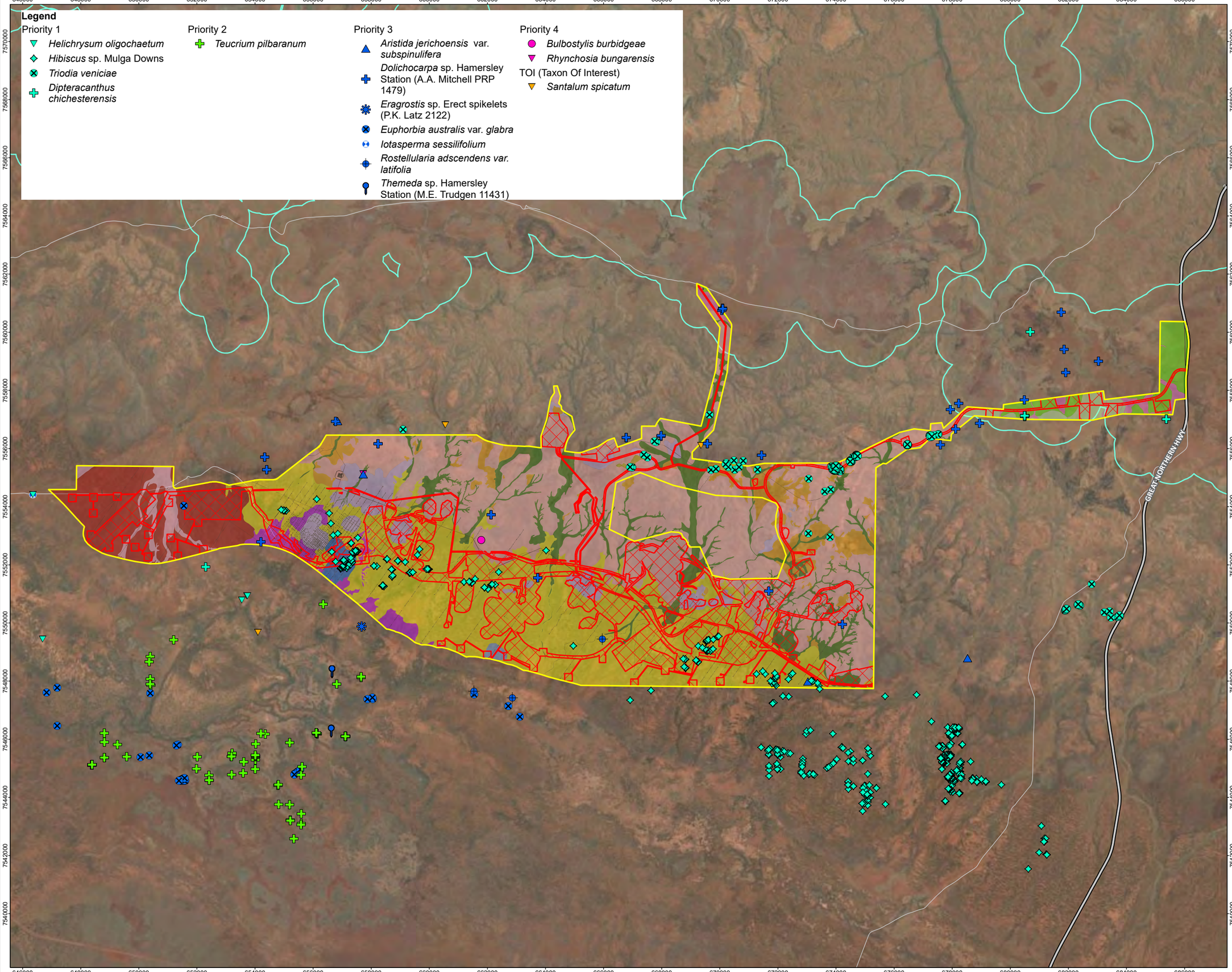
Some of these species could have been dispersed into the area by cattle if transported to the Survey Area from other regions. None of the range extension / range gap filling species is listed as conservation significant (Maia 2022). None of these other significant flora occur in the Development Envelope and are not considered further.

9.3.7 Introduced Flora

A total of 19 introduced flora taxa (weeds) have been recorded during surveys (Maia 2022; **Appendix 10a.1**) of which 13 are present within the Development Envelope. None of the introduced flora taxa are listed as Weeds of National Significance (WoNS). Introduced flora taxa recorded within the Development Envelope include:

- *Aerva javanica* (Kapok Bush)
- *Bidens bipinnata* (Bipinnate Begger's Tick)
- *Cenchrus ciliaris* (Buffel Grass)
- *Cenchrus setiger* (Birdwood Grass)
- *Chloris virgata* (Feathertop Rhodes Grass)
- *Citrullus amarus* (Pie Melon)
- *Citrullus colocynthis* (Colocynth)
- *Flaveria trinervia* (Speedy Weed)
- *Malvastrum americanum* (Spiked Malvastrum).
- *Rumex vesicarius* (Ruby Dock)
- *Setaria verticillata* (Whorled Pigeon Grass).
- *Tribulus terrestris* (Caltrop)
- *Vachellia farnesiana* (Mimosa Bush).

Figure 9-6: Conservation Significant Flora in relation to the Proposal



Legend

Development Envelope

Indicative Footprint

Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- AdEvWL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MSW
- MTG (1)
- MTGW
- THG (1)
- THG (2)
- THGB
- TvHG
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
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Scale 1:120,000 at A3

0 1 2
Kilometers

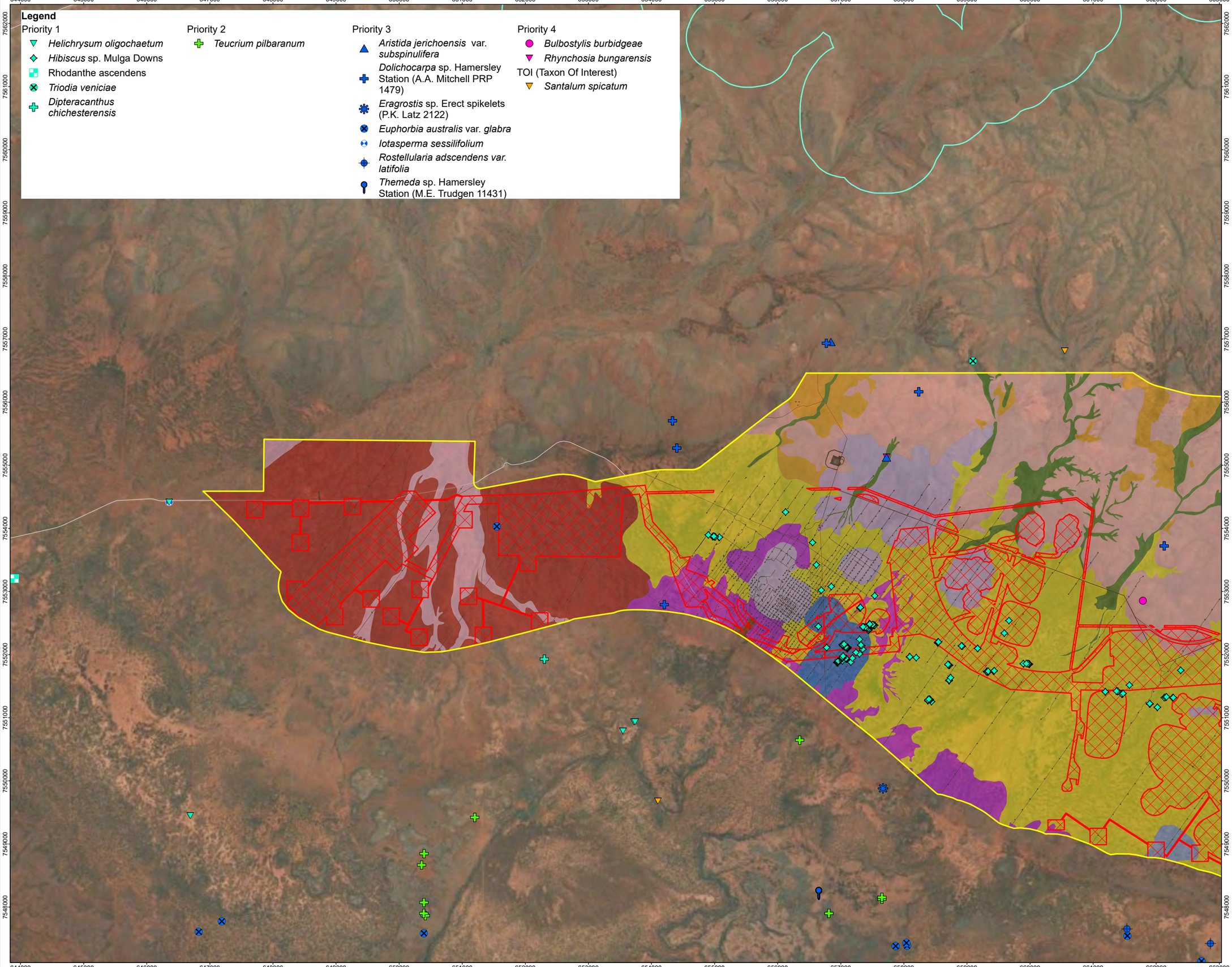
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FLORA IN RELATION TO THE PROPOSAL

FIGURE 9.6 Map 1 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
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Legend

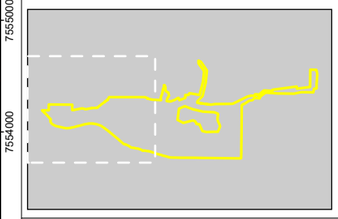
- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- AdEvWL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MTG (1)
- THG (1)
- THG (2)
- Cleared/Disturbed

Roads (LGATE-195)

- Minor Road



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Mulga Downs Iron Ore Mine
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CONSERVATION SIGNIFICANT FLORA IN RELATION TO THE PROPOSAL

FIGURE 9.6 Map 2 of 4

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Image Reference: World Imagery: Earthstar Geographics

Legend

Priority 1
- *Hibiscus* sp. Mulga Downs
- *Triodia veniciae*

Priority 2
- *Teucrium pilbaranum*

Priority 3
- *Aristida jerichoensis* var. *subspinulifera*
- *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)
- *Eragrostis* sp. Erect spikelets (P.K. Latz 2122)
- *Euphorbia australis* var. *glabra*
- *Rostellularia adscendens var. latifolia*

Priority 4
- *Bulbostylis burbidgeae*
- *Rhynchosia bungarensis*

TOI (Taxon Of Interest)
- *Santalum spicatum*

Legend
- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type
- AaAxSL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MSW
- MTGW
- THG (1)
- THG (2)
- TvHG
- Cleared/Disturbed

Roads (LGATE-195)
- Minor Road

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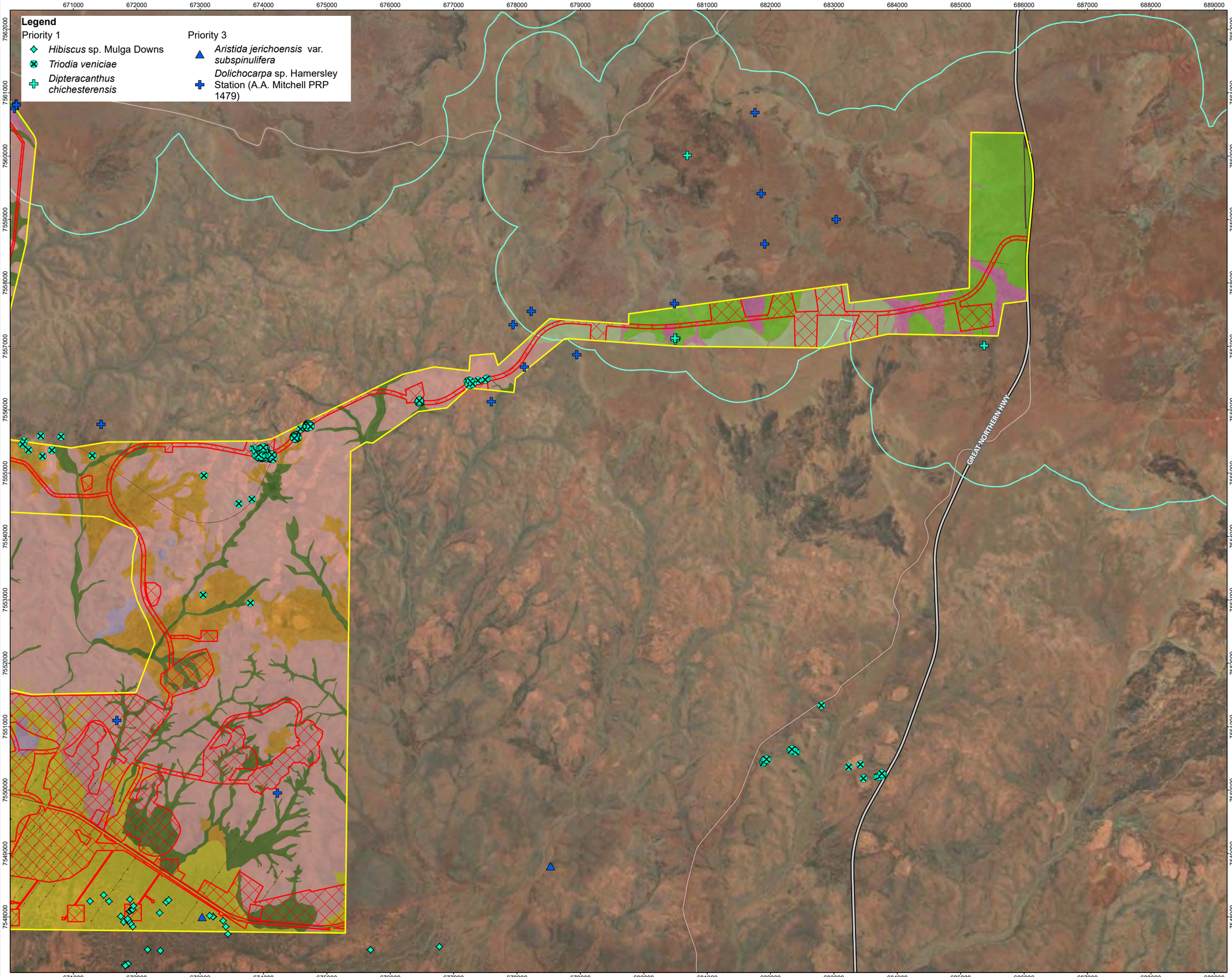
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Mulga Downs Iron Ore Mine
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CONSERVATION SIGNIFICANT FLORA IN RELATION TO THE PROPOSAL

FIGURE 9.6 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
Image Reference: World Imagery: Earthstar Geographics



Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- ASL (2)
- AWL (1)
- MSW
- MTGW
- THG (1)
- THG (2)
- THGB
- TvHG
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road



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Coord. Sys. GDA2020 MGA Zone 50

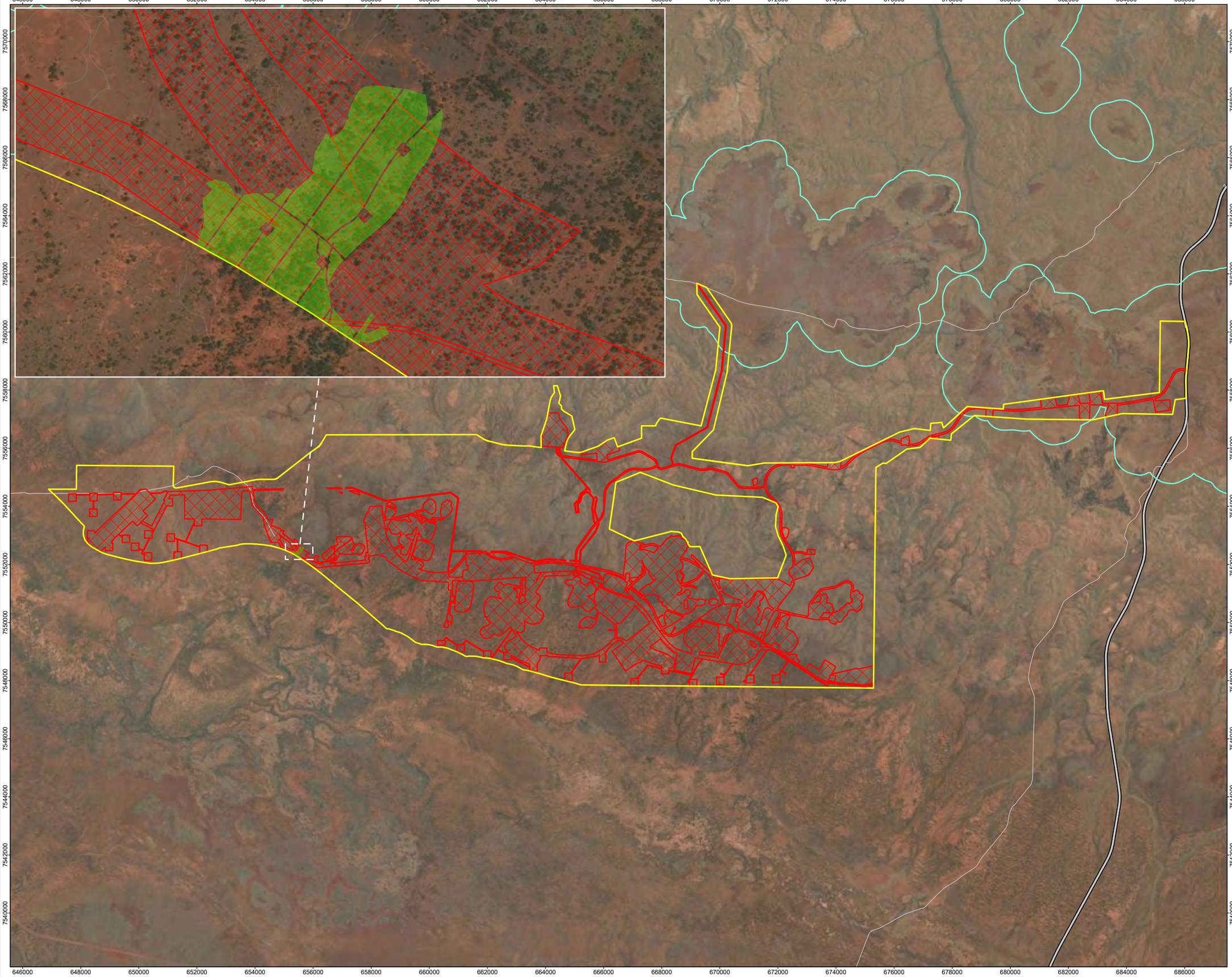
Mulga Downs Iron Ore Mine
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CONSERVATION SIGNIFICANT FLORA IN RELATION TO THE PROPOSAL

FIGURE 9.6 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics

Figure 9-7: Mapped Riparian vegetation Types within the Development Envelope



Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Riparian vegetation

- AdEvWL

Roads (LGATE-195)

- Highway
- Minor Road

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED RIPARIAN VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.7 Map 1 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Riparian vegetation

- AdEvWL

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 06-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

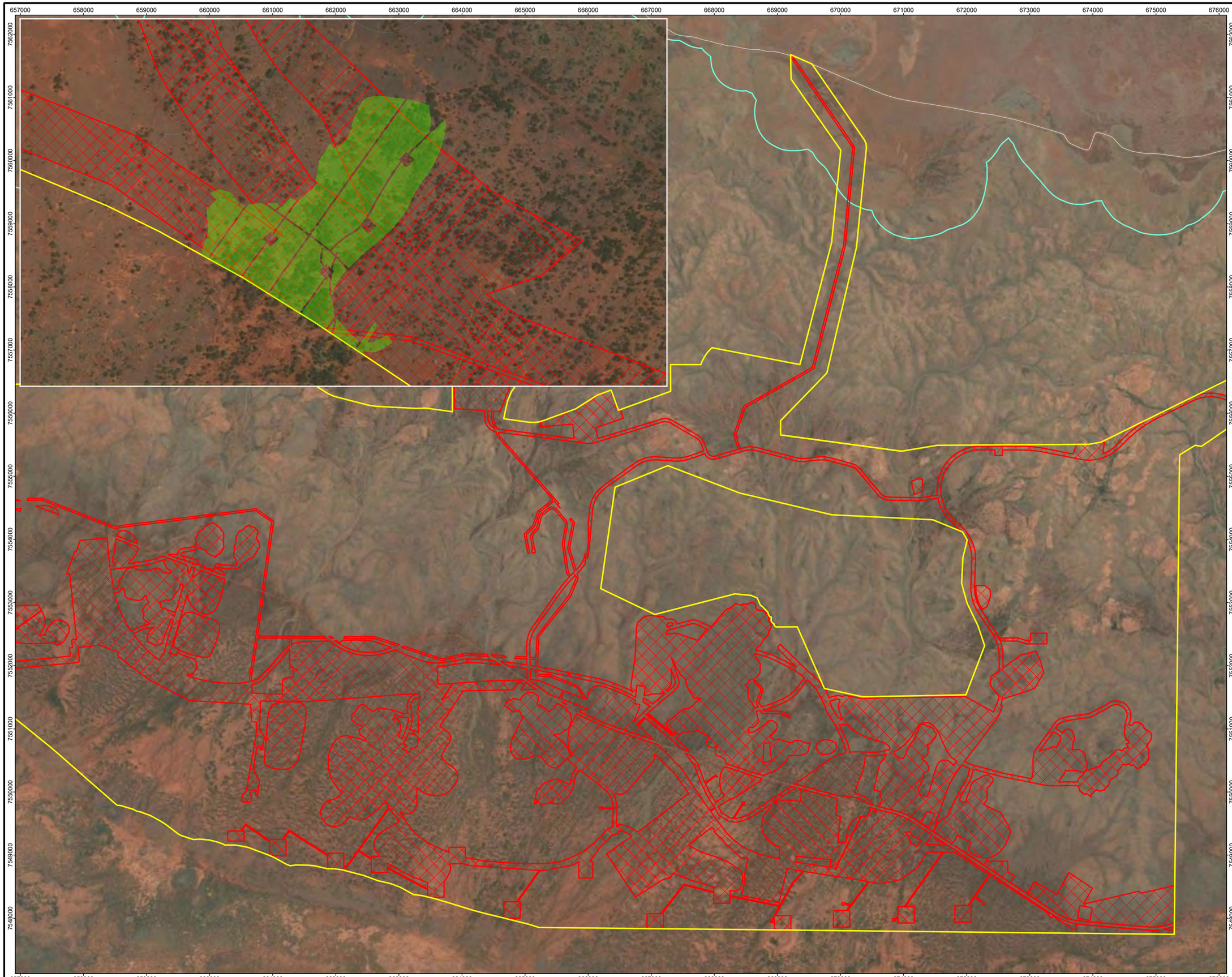
Coord. Sys. GDA2020 MGA Zone 50

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MAPPED RIPARIAN VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.17 Map 2 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
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Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 06-Nov-2024
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Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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MAPPED RIPARIAN VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.17 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 06-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED RIPARIAN VEGETATION TYPES WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 9.7 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

9.4 Potential Impacts

9.4.1 Direct Impacts

The direct impact to flora and vegetation from the Proposal will be from clearing. The impacts include the:

- Loss of native vegetation;
- Loss of conservation significant vegetation communities; and
- Loss of conservation significant flora.

9.4.1.1 Loss of Native Vegetation

This section presents the indicative loss of vegetation based on the Indicative Footprint; however, the final location of Proposal elements within the Development Envelope may change through the detailed design phase.

The maximum amount of native vegetation clearing as a result of the Proposal will not exceed 4,339.16 ha within the 16,848.53 ha Development Envelope. The majority (16,682.19 ha) of the vegetation in the Development Envelope is in 'Good to Excellent' condition. There are four vegetation associations within the Development Envelope. All are found within the Indicative Footprint and therefore are expected to be impacted (**Table 9-10**).

Less than 1% of the Pilbara extent of any of the vegetation associations mapped within the Indicative Footprint will be cleared.

Table 9-10: Loss of Pre-European Vegetation Associations

Vegetation Association	Description	Extent in Pilbara Bioregion (ha)	Extent in Development Envelope (ha)	Pre-European Vegetation within the Development Envelope (%)	Extent within Indicative Footprint (ha)	Pre-European Vegetation impacted by the Indicative Footprint (%)
29	Low woodland, open low woodland or sparse woodland. Mulga *Acacia aneura* and associated species.	1,131,712.01	9,194.77	0.81	3,195.44	0.28
173	Shrub-steppe. Flora: Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp.	1,747,677.63	1,220.52	0.07	183.15	0.01
175	Grasslands, short bunch-grass savanna. Flora: Annual grasses *Enneapogon* spp. *Aristida* spp. etc on dry plains and saltwater grasses *Sporobolus virginicus* on the coast	507,466.80	466.42	0.09	57.77	0.01
562	Low tree-steppe. Flora: Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp.,	103,606.82	5,966.82	5.76	902.80	0.87

Vegetation Association	Description	Extent in Pilbara Bioregion (ha)	Extent in Development Envelope (ha)	Pre-European Vegetation within the Development Envelope (%)	Extent within Indicative Footprint (ha)	Pre-European Vegetation impacted by the Indicative Footprint (%)
	Corymbia dichromophloia and *Eucalyptus leucophloia*					
TOTAL			**16,848.53**		**4,339.16**	

At a local scale, 15 vegetation types have been mapped within the Development Envelope and the Indicative Footprint (**Table 9-11; Figure 9-2**). The known extent of each community mapped through the surveys undertaken in relation to the Proposal (as outlined in **Table 9-2**) is also presented in **Table 9-11** to provide additional local context.

Table 9-11: Impacts to Vegetation Types (shaded cells represent locally significant vegetation types).

Vegetation Type	Total Mapped Extent of Surveys (Table 9-2)	Extent within the Development Envelope (ha)	Extent within Indicative Footprint (ha)	Approximate % impact within Development Envelope	Remaining extent in Development Envelope (%)	Impact on total Mapped Extent of Surveys (Table 9.2) (%)
AaAxSL	3,682.68	814.09	68.53	8.42	91.58	1.89
AdEvWL	12,051.30	4.96	4.31	86.90	13.13	0.04
ASL (1)	1,854.75	359.51	64.95	18.07	81.93	3.50
ASL (2)	4,283.22	1,378.13	253.47	18.39	81.61	5.92
AWL (1)	14,111.52	5,654.28	2087.41	36.92	63.08	14.79
AWL (2)	7,240.06	105.67	35.98	34.05	65.95	0.50
AWL (3)	4,066.26	32.12	8.83	27.49	72.51	0.22
AxAsSL	9,779.72	1,381.93	454.33	32.88	67.12	4.65
MSW	2433.38	141.97	12.96	9.13	90.87	0.53
MTG (1)	576.38	241.96	40.61	16.78	83.22	7.05
MTGW	3,162.29	403.50	69.98	17.34	82.66	2.21
THG (1)	21,015.77	5,236.74	939.23	17.94	82.06	4.47
THG (2)	5,732.79	707.14	184.90	26.15	73.85	3.23
THGB	4697.16	197.03	71.13	36.10	69.90	1.51
TvHG	122.15	24.85	0.31	1.25	98.76	0.25
Cleared/Degraded	1,412.89	164.63	42.23	25.65	74.35	2.99
Total	**96,222.32**	**16,848.53**	**4,339.16**	-	-	-

Vegetation within the Indicative Footprint is considered to be in predominantly 'Good' or better condition, the majority of which occurs in the Fortescue IBRA subregion (**Table 9-12; Figure 9-3**). Of the vegetation to be removed, the majority (99.01%) is classified as being in a 'Good' or better condition.

Table 9-12: The extent of proposed vegetation clearing per IBRA subregion within the Development Envelope and Indicative Footprint

Vegetation Condition	Extent within Development Envelope (ha)			Extent within Indicative Footprint (ha)			Impact (% vegetation of this condition lost)
	Chichester Subregion	Fortescue Subregion	Total	Chichester Subregion	Fortescue Subregion	Total Cleared (ha)	
Good	0.00	1,981.22	1,981.71	0.00	559.89	559.89	28.25
Very Good	639.98	7,723.26	8,363.23	90.20	2,563.26	2,653.46	31.73
Excellent	1,054.60	5,282.65	6,337.25	152.92	930.66	1,083.57	17.10
Sub-total (Good to Excellent)	*1,694.58*	*14,987.13*	*16,682.19*	*243.12*	*4,053.80*	*4,296.93*	
Degraded	0.99	157.92	158.91	0.02	41.84	41.87	26.35
Completely Degraded	7.43	0.00	7.43	0.36	0.00	0.36	4.85
TOTAL	**1,703.00**	**15,145.04**	**16,848.53**	**243.51**	**4095.65**	**4,339.16**	

9.4.1.2 Loss of Conservation Significant Vegetation Communities

Implementation of the Proposal will result in the loss of conservation significant vegetation including:

- Four Plant Assemblages of the Wona Land System' Priority 1 PEC;
- Sheetflow dependent vegetation communities; and
- Riparian vegetation.

As noted in **Section 9.3.5.2**, 407.50 ha of the Four Plant Assemblages of the Wona Land System' Priority 1 PEC occurs within the Development Envelope, of which 70.31 ha (i.e. 17.25% of the mapped extent in the Development Envelope) will be impacted by the Proposal through clearing.

The impacts of clearing on potential sheetflow dependent vegetation communities and riparian vegetation within the Development Envelope are outlined in **Table 9-13**. The known extent of each community mapped through the surveys undertaken in relation to the Proposal (as outlined in **Table 9-3**) is also presented to provide additional local context. Only the mapped extent of MTGW and ASL (2) within the boundary of the Four Plant Assemblages of the Wona Land System' Priority 1 PEC are considered part of the PEC. Both vegetation types are also mapped outside the PEC boundary. The significant residual impacts of native vegetation clearing on significant vegetation communities is assessed in **Section 9.4.1.2**.

Table 9-13: Loss of Conservation Significant Vegetation within the Development Envelope

Conservation Significant Vegetation	Total Mapped Extent of Surveys (Table 9-3)	Extent within Development Envelope (ha)	Extent within Indicative Footprint (ha)	% Impact within the Development Envelope	% Impact of mapped extent of surveys
Sheetflow dependent vegetation communities					
AaAxSL	3,628.68	814.09	68.53	8.42	1.89
ASL (1)	1,854.75	359.51	64.95	18.07	3.50
ASL (2)	4,283.22	1,378.13	253.47	18.39	5.92
AWL (1)	14,111.52	5654.28	2,087.41	36.92	14.79
AWL (2)	7,240.06	105.67	35.98	34.05	0.50
AWL (3)	4,066.26	32.12	8.83	27.49	0.22
AxAsSL	9,779.72	1,381.93	454.33	32.88	4.65
Sub Total	*44,964.21*	*9725.73*	*2973.50*	30.57	6.61
Riparian					
AdEvWL	12,051.30	4.96	4.31	86.90	0.04
TOTAL (Conservation Significant Vegetation)	**57,015.51**	**9,730.69**	**2,977.81**	**30.60**	**5.22**

9.4.1.3 Loss of Conservation Significant Flora and Habitat

No Threatened flora species will be impacted by the Proposal.

Of the ten Priority flora taxa recorded within the Development Envelope, three taxa occur within the Indicative Footprint (shaded orange) in **Table 9-14**.

Table 9-14: Impacts to Conservation Significant Species and their Habitat (coloured cells = taxa in Indicative Footprint)

Species	Vegetation Types	Total Extent of Potential Habitat in Development Envelope (ha)	Total Extent of Habitat in Indicative Footprint (ha)	% impact of Indicative Footprint on known habitat within Development Envelope	Total mapped individuals from survey effort	No. of known individuals in the Development Envelope	No. of known Individuals in the Indicative Footprint	% Impact (loss of individuals in Indicative Footprint compared to Development Envelope)
Priority 1								
Dipteracanthus chichesterensis	MTGW	403.50	69.98	17.34	55	14	0	0
Hibiscus sp. Mulga Downs (S. Hitchcock SH 638)	AWL (1)	5,759.95	2,123.39	36.86	4,226	1427	622	43.59
	AWL (2)							
Triodia veniciae	AaAxSL	6,782.81	1,192.97	17.59	3,994	1,278	574	44.9
	THG (1)							
	THG (2)							
	TvHG							
Priority 3								
Aristida jerichoensis var. subspinulifera	ASL(2)	7,739.54	2,525.78	32.63	14	5	0	0
	AWL (1)							
	THG (2)							
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479)	AWL (1)	10,891.02	3,026.64	27.79	180,220	29	2	6.89
	<THG (1)							
Euphorbia australis var. abragl	AdEvWL	712.10	4.31	0.61		1	0	0
	MSL (2)				3346			
	MTG (2)							
Rostellularia adscendens var. latifolia	AdEvWL	814.09	4.31	0.53	2841	4	0	0
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	AaAxSL	1,056.06	109.14	10.33	522	0	0	0
	MTG (1)							
Priority 4								

Species	Vegetation Types	Total Extent of Potential Habitat in Development Envelope (ha)	Total Extent of Habitat in Indicative Footprint (ha)	% impact of Indicative Footprint on known habitat within Development Envelope	Total mapped individuals from survey effort	No. of known individuals in the Development Envelope	No. of known Individuals in the Indicative Footprint	% Impact (loss of individuals in Indicative Footprint compared to Development Envelope)
Bulbostylis burbidgeae	TGH (1)	5,236.74	939.23	17.94	80	20	0	0
Rhynchosia bungarensis	ASL (1)	359.51	64.95	18.07	1	1	0	0

9.4.1.4 Loss of Other Significant Flora and Habitat

As discussed in **Section 9.3.6.6**, nine taxa with previously known ranges greater than 100 km from their recorded location were collected within the Survey Area (Maia 2022), however none of these occur within the Development Envelope.

As described in **Section 9.3.6.6**, three individual *Santalum. spicatum* trees (Sandalwood) were identified within the Study Area; however, these records are located outside the Development Envelope and will not be directly impacted by the Proposal (**Figure 9-6**).

9.4.2 Indirect Impacts

Indirect impacts which will result in the decline of vegetation health are:

- Altered fire regimes and increased risk of fire;
- Dust deposition and management with saline water;
- Introduction and spread of weed species;
- Altered hydrological regimes; and
- Fragmentation and/or isolation of populations/occurrences.

9.4.2.1 Altered Fire Regimes and Increased Fire Risk

The Proposal has the potential to increase the risk of fires with the introduction of ignition sources such as machinery, vehicles and equipment. Altered fire regimes can result in the loss of species during critical seeding phases or during recruitment. Fires too early in the year can prevent the establishment of resilient seed banks which are resistant to periods of fire, characteristic of the Pilbara and other arid zones. Fires out of season can also remove the ability of a species to set seed, reducing the successive generations of a population. Frequent fires also lead to an increase of some weeds species, which can result in the vegetation becoming more bushfire prone.

9.4.2.2 Dust and Use of Saline Water for Dust Suppression

The Proposal has the potential to impact on the health of flora and vegetation resulting from generation of dust and deposition onto the surfaces of leaves. This includes the clearing of vegetation, construction of roads, vehicle movement and the transport and handling of ore during operation. There is also the potential of impacts to flora and vegetation from the use of saline water for dust suppression during the construction and operation of the Proposal. Although unlikely to result in vegetation mortality, an increase in soil salinity can lead to a decline in vegetation /flora health.

9.4.2.3 Introduced Weeds

Clearing, and vehicle and machinery movements have the potential to increase the spread and/or introduce weed species. Weeds are often able to rapidly invade locations due to disturbance, land clearing and/or altered hydrological regimes resulting in degradation of vegetation condition and competition with native flora species. There is a risk that weeds will be spread into environmentally sensitive areas in the Development Envelope. These areas include the Four Plant assemblages of the Wona Land System PEC.

As noted in **Section 9.3.7**, a total of 19 introduced flora taxa (weeds) have been recorded during surveys (Maia 2022) of which 13 are present within the Development Envelope. None of the introduced flora taxa are listed as Weeds of National Significance (WoNS). Eight of the introduced flora taxa recorded within the Development Envelope are listed as environmental weeds.

9.4.2.4 Altered Hydrological Regimes

Diversion of surface water flows, abstraction of groundwater and the reinjection of mine dewater via MAR will result in changes to the natural hydrological regime. Relevant mechanisms which will cause these changes are:

- Surface catchment modifications, in particular reduced or redirected inflows and increased sedimentation to portions of the valley environment.
- Modifications which impede or disrupt surface flow to sheetflow dependent vegetation outside the Development Envelope.
- Groundwater drawdown from mine dewatering.
- Groundwater mounding from management of surplus mine dewater via MAR.

Surface Water

The presence of water within the drainage lines in the Pilbara is characteristically temporary and flows only in response to rainfall events. Surface water flows can be diverted/disrupted as a result of mine pits, waste rock dumps, borrow pits, airport, haul and access roads, pipelines, and other infrastructure associated with the Proposal. This can have impacts both immediately downstream of disturbance area footprints and surface water diversions, and further downstream as an accumulation of impacts from multiple disturbance areas. These changes can be detrimental to the vegetation downstream. The receptors which may potentially be impacted by the Proposal are local vegetation (in particular, sheetflow vegetation which is reliant on a particular pattern) and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools.

The Proposal will cause a reduction in surface water flows to the environment on the downstream side of the Proposal, particularly around the Fridge Hill mining area, due to a reduction in contributing catchment areas. This particularly applies to the development of the pits, waste rock dumps, borrow pits and stockpiles as they are proposed to extend across large areas draining towards the Fortescue Valley and will therefore prevent surface water from draining through those areas. Additionally, where mine development areas block drainage paths, there is a risk of increased inundation on the upstream side of the development area. The increased inundation may lead to vegetation death due to water logging and changes to vegetation composition with more water tolerant vegetation species (including weeds) potentially taking over in these areas (AQ2 2025).

Mulga (*Acacia aneura*) and other closely related co-occurring species, is sensitive to changes to sheet flow (Maia 2020). Six vegetation types within the Development Envelope were mapped as potential sheetflow dependent vegetation communities. These communities are:

- AaAxSL – tall sparse shrubland of *Acacia aneura* (alliance);
- ASL (1 and 2)– Acacia tall shrubland; and
- AWL (1, 2 and 3) - Acacia low woodland or tall shrubland.

A total of 44,964.20 ha of these vegetation types have been mapped during surveys associated with the Proposal (refer to **Table 9-3**) of which 9,725.43 ha occurs within the Development Envelope and 2,973.51 ha occurs within the Indicative Footprint and will therefore be impacted through clearing. Potential surface water dependent vegetation extends beyond the Development Envelope. Changes to sheetflow can cause a shadow effect down gradient of the Proposal and result in indirect impacts to vegetation downstream of disturbance areas.

In addition, there are six conservation significant flora within the surface water dependent vegetation types present in the Development Envelope:

- *Triodia veniciae* (Priority 1) occurring within AaAxSL;
- *Hibiscus* sp. Mulga Downs (Priority 1) - occurring within AWL (1) and (2);
- *Aristida jerichoensis* var. *subspinulifera* (Priority 3) – occurring within ASL (2); and
- *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3)- occurring within AWL (1)
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3) – occurring within AaAxSL; and
- *Rhynchosia bungarensis* (Priority 4) – occurring within ASL (1).

While individually these taxa are not necessarily surface water dependant, they may be indirectly impacted by degradation / loss of habitat that supports them. Freshwater claypans of the Fortescue Valley PEC (Priority 1) includes the Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan, both of which are located south of the Development Envelope. The key characteristics of the claypans which may be impacted are changes to the inundation depths, ponding duration (hydroperiod) and water quality (TDS) of ponded water as a result of changes in water availability and quality downstream of the Proposal.

Groundwater

Given that the vegetation is inferred to be disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment, inclusive of vegetation (AQ2 2025). An ecohydrological assessment found no GDV within the Development Envelope and surrounds or in the valley to the south.

The principal change risk is groundwater mounding as a result of MAR. As dewatering exceeds water demands, excess water will be disposed of by MAR within the Development Envelope. MAR is proposed on the slopes of the valley (i.e. in and around the proposed mining areas). Initially, MAR is proposed via reinjection bores, with the potential for using repurposed dewatering bores and / or in-pit infiltration, once mining of a pit is complete. Without management practices in place, there is the potential for detrimental environmental impacts resulting from changes to groundwater levels and / or quality as a result of MAR.

Mounding of groundwater can result in the following impacts (AQ2 2025):

- Tree roots that become inundated for more than a few weeks to months will senesce, due to oxygen deficiency, effectively pruning the deeper roots. If sustained over long periods, this could result in vegetation leaf area index adjustments (either increased or decreased) based on the net effect of interactions between climate (droughts or floods) and soil water replenishment processes. In the extreme case of prolonged saturation of the entire root system, tree deaths could occur.

- Waterlogging associated with flood events may be more spatially extensive and of longer duration, causing increased exposure of vegetation to this stress agent relative to baseline conditions.
- Salt may accumulate in the upper soil profile resulting from the combined effects of increased evaporative concentration and/or reduced salt leaching into the deeper profile. If sustained over long periods, this could have adverse impacts on vegetation health by reducing soil water extractability.
- Claypan water quality could also be affected by increased salt loads.

9.4.2.5 Fragmentation

Fragmentation of vegetation occurs when pockets of vegetation become isolated through clearing for mining and associated infrastructure, creating islands of vegetation. These areas of vegetation are at increased risk of degradation as a result of 'edge effect' where cleared areas become vectors for weeds and changes to surface drainage.

Where there is sufficient isolation of islands of vegetation, there may be a reduction of corridors for pollinators to travel between these areas, with resultant reduction in flora reproduction and genetic diversity.

9.4.3 Cumulative Impacts

The Proposal and other projects in the region including the Mulga Downs Hub and Rail Spur and Murray's Hill, will have a cumulative impact on flora and vegetation at a regional scale through:

- The loss and fragmentation of native vegetation from clearing; and
- The loss of conservation significant species and communities as a result of clearing.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in **Section 17**.

9.5 Mitigation

The Proponent has applied the mitigation hierarchy (avoid, minimise and rehabilitate) during Proposal design to reduce the potential direct and indirect impacts to flora and vegetation.

The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since its referral in 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal on flora and vegetation. Overall, there has been a total reduction in the Development Envelope and Indicative Footprint of 23,804.97 ha and 5,288.84 ha respectively. In addition, impacts to the following have also been avoided or reduced:

- Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided;
- Impacts to DBCA Priority (P) listed species have been avoided / reduced;
- Impacts to seven vegetation types, including riparian vegetation, are avoided and / or reduced;
- Impacts to five vegetation types that support *Eucalyptus victrix* are avoided and / or reduced;
- The extent of impacts to vegetation within the Fortescue IBRA subregion are significantly reduced; and
- The extent of direct impacts to mapped potential sheetflow vegetation is reduced.

A summary of mitigation measures applied to address the key potential impacts on flora and vegetation are provided in **Table 9-15.**

Table 9-15: Mitigation Measures for Flora and Vegetation

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts			
Loss of native vegetation	• Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of native vegetation and a FHEZ corridor which avoids impacts within an additional 991.45 ha area. • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided.	• The Development Envelope and Indicative Footprint has been revised and reduced through iterative mine planning to reduce the extent of clearing required where possible resulting in a 5,288.84 ha reduction in impacts to native vegetation. • Utilise areas of existing disturbance before clearing of new ground where possible. • Proposal elements have been located to minimise impacts on environmental factors. • Phase the works to enable progressive clearing and where possible progressive rehabilitation. • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • Ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal Ground Disturbance Permit (GDP).	• Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout life of mine. • Decommissioning and rehabilitation of disturbed areas at the end of LoM. • Topsoil will be collected in windrows and stored for rehabilitation of temporary construction areas. • Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation. • Topsoil will be progressively re-spread over temporary construction areas or utilised for future rehabilitation. • Rehabilitation will occur with vegetation comprised of native species of provenance local to the Chichester and Fortescue bioregions in accordance with a DEMIRS approved MCP. • Consultation with Banjima to inform the seed mix so that it includes culturally significant species.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
Loss of conservation significant flora and communities from clearing	• Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of native vegetation and a FHEZ Corridor which contains an additional 991.45 ha area. • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided.	• The final location of non-fixed Proposal elements (i.e. linear / supporting infrastructure) will be designed to minimise impacts to Priority flora species. • Located Proposal elements to minimise impacts on locally significant vegetation communities. • Implement induction and education of the workforce with respect to flora and vegetation protection and management. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal GDP).	• Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout life of mine. • Decommissioning and rehabilitating of Development Envelope at end of life of mine. Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation. • Rehabilitation will occur with vegetation comprised of native species of provenance local to the Chichester and Fortescue bioregions in accordance with a DEMIRS approved MCP. • Consultation with Banjima to inform the seed mix so that it includes culturally significant species.
Indirect Impacts			
Altered fire regimes and increase of risk of fires.	Minimisation measures are considered to be the key mitigation for this impact.	• An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire. • Ensure compliance with the *Bushfire Act 1954*. • Compliance with internal Hot Works Procedures. • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous	If saline water (> 5000 mg/L TDS) is required for firefighting purposes, then potential impacts to vegetation will be monitored and managed through the implementation of the Water Management Plan (**Appendix 6**).

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		material storage areas, hot works job sites, service trucks. • An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment.	
Deposition of dust during clearing and operational activities and use of saline water for dust suppression.	Sealing of the Northern Haul Road will avoid dust emissions generated along the approx. 36 km haulage route to the Great Northern Hwy. Minimisation measures are considered to be the key mitigation for this impact as complete avoidance of dust is not possible.	• Dust control measures will be implemented throughout the life of the Proposal and will include: ○ Saline water (> 5000 mg/L TDS) shall not be used for dust suppression. ○ Dust suppression techniques (e.g. water trucks) shall be used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; ○ Vehicle speeds on haul roads, work and camp sites shall be reduced where necessary to minimise dust emissions; ○ Vegetation clearing and earthworks during high winds (>50 km/hr) shall be avoided; and ○ Clearing activities will be staged to minimise areas of exposed surfaces. ○ • Vegetation health monitoring (which will include dust as a criteria) as described in the WMP (Appendix 6).	• Progressive rehabilitation will be undertaken as areas become available. • Topsoil stockpiles will not exceed 2 m in height.
Introduction and spread of weed species.	Minimisation measures are considered to be the key mitigation for this impact as	• Implement and comply with internal hygiene and weed management measures to prevent the	• Ongoing monitoring and management of weeds within the Development Envelope.

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
	complete avoidance of weeds is not possible.	spread or introduction of weeds as a result of Proposal activities. • Weed controls will be implemented including: • All machinery and vehicles shall be cleaned down of all soil and vegetation material prior to arriving or entering on site. Any soil and vegetation removed from machinery or vehicles during clean down upon arrival, but prior to entry on site shall be collected and disposed of offsite; • All vehicles and machinery mobilised to site shall be inspected prior to entry to site and issued with a Weed & Soil Hygiene Certificates; • Imported fill or other potential weed mediums to be certified by the supplier as being free from weed free sources prior to arrival on site; • Areas of known weed-infestation will be identified and managed separately to weed free areas; • Where areas of weed-infestation are to be disturbed or cleared, material will be stockpiled/placed in windrows separately from weed-free material; and • Targeted control of infestations.	• The MCP will detail specific weed management measures in rehabilitation areas.
Altered hydrological regimes.	Minimisation measures are considered to be the key mitigation for this impact, as complete avoidance of altered hydrological regimes is not possible for the Proposal.	• The Proposal has been designed to minimise interactions with, and disturbance to, watercourses, riparian vegetation and flood plains. • Implementation of the Water Management Plan (**Appendix 6**).	• Impacts to vegetation as a result of altered hydrological regimes will be managed through the implementation of the Water Management Plan (**Appendix 6).**

Mitigation			
Potential Impacts	**Avoid**	**Minimise**	**Rehabilitate / Monitor**
		• Adherence to permit requirements under the RiWI Act (i.e. 5C water abstraction and Bed and Banks Permits).	
Fragmentation	Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of native vegetation and a FHEZ corridor which avoids impacts within an additional 991.45 ha area, both of which include drainage lines to avoid fragmentation in that area of the Development Envelope.	• Implement weed hygiene measures (refer above) to minimise introduction of weeds caused by edge effects • Phase the works to enable progressive clearing and where possible progressive rehabilitation.	• Conduct rehabilitation in accordance with the DEMIRS approved MCP. • Weed monitoring.

9.6 Assessment and Significance of Residual Impacts

9.6.1 Direct Impacts

9.6.1.1 Loss of Native Vegetation

As discussed in **Section 9.5**, the Proposal's Development Envelope and Indicative Footprint have been significantly reduced following updates to the mine design, an increasing understanding of the existing environmental values gained from recent surveys and studies, and continuing efforts to apply the mitigation hierarchy and reduce potential environmental impacts from the Proposal.

The Proposal will result in the clearing of up to 4,339.16 ha of native vegetation. This represents approximately 25.75% of the total amount of native vegetation mapped within the Development Envelope. Most of this clearing area,4,296.93 ha, is in 'Good' or better condition made up of, 559.89 ha of vegetation in 'Good' condition, 2,653.46 ha in 'Very Good' condition and 1,083.57 ha 'Excellent' condition. The remaining area (42.23 ha) is in 'Degraded to Completely Degraded 'condition.

Fifteen vegetation types have been mapped within the Development Envelope, six of which are considered locally significant. With the exception of AdEvWL, more than 63% of the mapped extent of each vegetation type will be retained within the Development Envelope. Each vegetation type is also known to extend outside of the Development Envelope. The Proposal will impact 0.04% of the total known extent of vegetation type AdEvWL mapped in the Survey Area (both within and outside the Development Envelope).

At a regional scale, the Development Envelope contains four mapped Pre-European vegetation associations. At present, the Pilbara bioregion, the relevant subregions (Chichester and Fortescue IBRA), and the Shire of Ashburton all retain more than 99.8% of Pre-European extents of those vegetation associations. The Indicative Footprint will impact a small proportion of each of the vegetation associations; three are impacted by less than 0.8%, and one will lose 5.76%.

In terms of vegetation of the IBRA subregions, the Proposal will result in the loss of 243.12 ha of Chichester IBRA subregion vegetation in 'Very Good' to 'Excellent'. Of the vegetation which lies within the Fortescue IBRA subregion, 4,053.80 ha of 'Good' to 'Excellent' condition vegetation will be cleared.

Based on the above, the impacts to native vegetation from the Proposal are not considered significant on their own. However, the EPA recognises the cumulative loss of native vegetation in the Pilbara bioregion is a significant residual impact. Consistent with the Western Australian offset framework, any clearing of native vegetation in 'Good' to 'Excellent' condition in the Fortescue and Chichester subregions (**Figure 3-1**) associated with the Proposal will be offset in accordance with EPA requirements (refer to **Section 16**).

9.6.1.2 Loss of Conservation Significant Vegetation

Freshwater Claypans of the Fortescue Valley (Priority 1)

As a result of revised mine design and continual efforts to apply the mitigation hierarchy, the Proposal will have no direct impact on the DBCA designated buffer of the 'Freshwater claypan of the Fortescue Valley' (Priority 1) PEC'. While the PEC extends across the Fortescue Valley in the vicinity of the Proposal, it is no longer intersected

by the Development Envelope. Potential indirect impacts arising from altered hydrological regimes are discussed in **Section 9.6.2**.

'Four Plant Assemblages of the Wona Land System' Priority 1 PEC

A total of 407.5 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC occurs within the Development Envelope, of which 83% will be retained. Up to 70.31 ha of the PEC is present within the Indicative Footprint. This PEC is extensive and occurs across the Chichester Ranges as shown in **Figure 9-4.** There are approximately 127,050 ha of this PEC within the Pilbara, therefore the Proposal is not expected to significantly impact the PEC on a regional scale, with a loss of 0.05% of the Pilbara extent. However, given its conservation status, the direct loss of 70.31 ha of this PEC is considered a significant residual impact and is further considered in **Section 16** (Offsets) and will be offset.

Sheetflow Dependent Vegetation

Up to 2,973.51 ha of seven vegetation types representing potential sheet flow dependent communities (ASL (1) (2), AWL (1) (2) (3), AxAsSL and AaAxSL) may be impacted. This equates to 30.57% of the known mapped extent of potential sheet flow dependent vegetation types within the Development Envelope. A total of 44,964.20 ha has been mapped during surveys associated with the Proposal. The Proposal impacts 6.6% of this total mapped extent. The direct loss of sheetflow vegetation is considered a significant residual impact and is further considered in **Section 16** (Offsets).

Loss of Riparian Vegetation

One mapped riparian vegetation type was identified within the Development Envelope; AdEvWL. A total of 4.96 ha of this vegetation type has been mapped within the Development Envelope of which 4.31 ha occurs within the Indicative Footprint. A total of 12,051.30 ha has been mapped during surveys associated with the Proposal, of which the Proposal will impact 0.04%. The direct loss of riparian vegetation is considered a significant residual impact and is further considered in **Section 16** (Offsets).

9.6.1.3 Loss of Conservation Significant Flora

Based on the Indicative Footprint, the Proposal will directly impact three DBCA-listed Priority listed species as outlined in **Table 9-14**. An assessment of residual impacts on each of those species is provided below.

***Hibiscus* sp. Mulga Downs (Priority 1)**

An undescribed *Hibiscus* sp. ?nov. specimen was collected from the Survey Area (Area 1, Mulga East) in 2012. While appropriate areas were searched by botanists during subsequent years, it was not located again. However, in 2021 targeted flora surveys recorded the taxon at multiple locations in May, July and September 2021. Specimens were submitted to the WA Herbarium for determination, and they were identified as a new species and were given the phrase name of *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638). Current records associated with surveys undertaken for this Proposal are the only records of this species; however, surveys have recorded individuals outside the Development Envelope within the banded mulga formations which continue to the south east of the Development Envelope. This taxon is a Priority 1 listed flora species (DBCA 2024).

A total of 4,226 individuals have been recorded during surveys undertaken for the Proposal, of which 1,427 occur within the Development Envelope (**Table 9-3**).

Based on the Indicative Footprint, the Proposal will result in the loss of 622 individuals. The loss of individuals resulting from the Proposal represents 14.72% of the mapped extent (both within and outside the Development Envelope) and 43.59% of the mapped extent within the Development Envelope.

This taxa is known from two vegetation types (AWL(1); AWL(2)) within the Development Envelope of which 3,521.89 ha (61.24%) of the mapped habitat will remain. **Figure 9-8** shows that the banded mulga formation extends well outside the Development Envelope (approximately 21,351.58 ha has been mapped through surveys undertaken in the local area) and this species has been recorded along these areas. The Proposal will directly impact 9.9% of the total surveyed extent of potential habitat for this species. Potential indirect impacts to this species from altered hydrological regimes are discussed further in **Section 9.6.2.4**.

Table 9-16: Loss of habitat for ***Hibiscus* sp. Mulga Downs (Priority 1)**

Vegetation Type	Total Mapped Extent of Surveys (Table 9-3)	Extent within Development Envelope (ha)	Extent within Indicative Footprint (ha)	% Impact within the Development Envelope	% Impact of mapped extent of surveys
AWL (1)	14,111.52	5,654.28	2087.41	36.92	14.79
AWL (2)	7,240.06	105.67	35.98	34.05	0.50
Total	**21,351.58**	**5,759.95**	**2,123.39**	**38.86**	**9.90**

Given this species is associated with sheet flow vegetation, management measures that ensure that sheetflow is maintained will minimise potential impacts on this species. Ongoing monitoring of vegetation health and condition will be undertaken as outlined in the WMP, (**Appendix 6**). The WMP also outlines trigger for groundwater levels associated with MAR. These trigger levels have been determined such that there is no surface expression of groundwater or water logging of vegetation. Indirect impacts resulting from changes to hydrology are discussed in **Section 9.6.2.4**. Other potential indirect impacts, including dust, are also considered in **Section 9.6.2**.

Figure 9-8: Records of *Hibiscus* sp. Mulga Downs

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- AdEvWL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MSW
- MTG (1)
- MTGW
- THG (1)
- THG (2)
- THGB
- TvHG
- Cleared/Disturbed
- *Hibiscus* sp. Mulga Downs

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Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RECORDS OF HIBISCUS SP. MULGA DOWNS

FIGURE 9.8 Map 1 of 4

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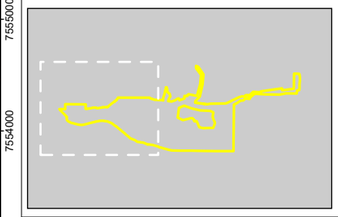
7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- AdEvWL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MTG (1)
- THG (1)
- THG (2)
- Cleared/Disturbed
- *Hibiscus* sp. Mulga Downs



JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 27-Aug-2025
Drawn By: jcrute	Checked By: MD

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RECORDS OF HIBISCUS SP. MULGA DOWNS

FIGURE 9.8 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
Image Reference: World Imagery: Earthstar Geographics

657000 658000 659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000 673000 674000 675000 676000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AxAsSL
- MSW
- MTGW
- THG (1)
- THG (2)
- TvHG
- Cleared/Disturbed
- *Hibiscus* sp. Mulga Downs

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Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RECORDS OF HIBISCUS SP.
MULGA DOWNS

FIGURE 9.8 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
Image Reference: World Imagery: Earthstar Geographics

671000 672000 673000 674000 675000 676000 677000 678000 679000 680000 681000 682000 683000 684000 685000 686000 687000 688000 689000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

Vegetation type

- AaAxSL
- ASL (2)
- AWL (1)
- MSW
- MTGW
- THG (1)
- THG (2)
- THGB
- TvHG
- Cleared/Disturbed
- *Hibiscus* sp. Mulga Downs

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 27-Aug-2025

Drawn By: jcrute | Checked By: MD

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

RECORDS OF HIBISCUS SP. MULGA DOWNS

FIGURE 9.8 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01 - Veg and Flora.aprx
Image Reference: World Imagery: Earthstar Geographics

***Triodia veniciae* (Priority 1)**

This Spinifex species located on shale slopes and tops of low hills. *T. veniciae* has 26 records on Florabase and 21 records on ALA. The ALA records appear to be mostly in the Fortescue subregion, with one record in the Chichester subregion of the Pilbara bioregion. This species has been recorded across the broader MDIOM and Hub & Rail Spur (**Figure 9-9**).

This species is known from four vegetation types (AaAxSL; THG(1); THG(2); TvHG). Within the Development Envelope, 1,192.97 ha (3.9%) of the mapped potential habitat will falls within the Indicative Footprint (**Table 9-17**). The Proposal will not impact 96.1% of the total surveyed extent of potential habitat for this species.

Table 9-17: Loss of habitat for ***Triodia veniciae* (Priority 1)**

Vegetation Type	Total Mapped Extent of Surveys (Table 9-3)	Extent within Development Envelope (ha)	Extent within Indicative Footprint (ha)	% Impact within the Development Envelope	% Impact of mapped extent of surveys
AaAxSL	3,628.68	814.09	68.53	8.41	1.89
THG (1)	21,015.77	5,236.74	939.23	17.94	4.47
THG (2)	5,732.79	707.14	184.90	26.15	3.23
TvHG	122.15	24.85	0.31	1.25	0.25
Total	**30,499.39**	**6,782.82**	**1,192.97**	**17.59**	**3.9**

A total of 2,359 individuals have been recorded during surveys undertaken for the Proposal, of which 1,099 individuals occur within the Development Envelope.

Based on the Indicative Footprint, the Proposal will result in the loss of 544 individuals recorded within the Development Envelope, representing a loss of 49.50% of the extent within the Development Envelope and 23.07% of the local mapped extent.

A loss of 23.07% of the local population is not considered likely to significantly impact the taxon given its known extent and the area of potential habitat remaining within the Development Envelope.

***Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3)**

A total of 180,220 individuals have been recorded during surveys undertaken for the Proposal, of which 29 occur within the Development Envelope (**Figure 9-10**).

Based on the Indicative Footprint, the Proposal will result in the loss of 2 individuals representing a loss of 6.89% of the extent within the Development Envelope and 0.001% of the local mapped extent. This taxa is known from two vegetation types (AWL(1); THG(1)) within the Development Envelope of which 7,864.38 ha (72%) of the mapped habitat within the Development Envelope will remain (**Table 9-18**).The Proposal will impact 0.09% of the total surveyed extent of potential habitat for this species.

Table 9-18: Loss of habitat for *Dolichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3)

Vegetation Type	Total Mapped Extent of Surveys (Table 9-3)	Extent within Development Envelope (ha)	Extent within Indicative Footprint (ha)	% Impact within the Development Envelope	% Impact of mapped extent of surveys
AWL (1)	14,111.52	5,654.28	2,087.41	36.92	14.79
THG (1)	21,015.77	5,236.74	939.23	17.93	4.47
Total	**35,127.29**	**10,891.02**	**3,026.64**	**27.79**	**8.62**

The WAH has 38 records distributed across the Pilbara region (WAH, 1988-). This species is broadly distributed across the Pilbara, from the Chichester, Hamersley, Fortescue and Roebourne subregions, but it is restricted to heavy clay soils. *Dolichocarpa* sp. Hamersley Station has been recorded in Millstream-Chichester National Park, Karijini National Park, Hamersley Range and Caoolawanyah Station (State of Western Australia, 2022; WAH, 2023).

A loss of 0.001% of the local population is not considered likely to significantly impact the taxon given its broad distribution and the protection of populations in Millstream-Chichester National Park and Karijini National Park and area of potential habitat remaining within the Development Envelope.

Figure 9-9: Records of ***Triodia veniciae***

610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000

7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000

NANUTARRA RD

MUNJINA RD

MUNJINA-ROY HILL RD

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Vegetation type

- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AaAxSL
- AdEvWL
- AxAsSL
- AxS
- BpoFL
- EfEbTG
- EvWL
- MSL (1)
- MSL (2)
- MSW
- MTG
- MTG (1)
- MTG (2)
- MTG (3)
- MTGW
- Mosaic of AdEvWL / *
- THG (1)
- THG (2)
- THGB
- THGG
- TbHG
- TvHG
- TwHG
- Restricted (Heritage)
- Cleared/Disturbed area

Priority 1

- *Triodia veniciae*

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

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Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:310,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACTS ON TRIODIA VENICIAE

FIGURE 9.9

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 9-10: Records of *Dolichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479)

610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000

7600000 7590000 7580000 7570000 7560000 7550000 7540000 7530000

NANUTARRA RD

MUNJINA RD

MUNJINA-ROY HILL RD

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Vegetation type

- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AaAxSL
- AdEvWL
- AxAsSL
- AxS
- BpoFL
- EfEbTG
- EvWL
- MSL (1)
- MSL (2)
- MSW
- MTG
- MTG (1)
- MTG (2)
- MTG (3)
- MTGW
- Mosaic of AdEvWL / *
- THG (1)
- THG (2)
- THGB
- THGG
- TbHG
- TvHG
- TwHG
- Restricted (Heritage)
- Cleared/Disturbed area

Priority 3

- *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:310,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACTS ON DOLICHOCARPA SP. HAMERSLEY STATION (A.A. MITCHELL PRP 1479)

FIGURE 9.10

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

9.6.1.4 Loss of Other Significant Flora and Habitat

As discussed in **Section 9.4.1.4** of the nine taxa with range extension collected within the Survey Area (Maia 2022), none of these occur within the Development Envelope.

The mapped *Santalum. spicatum* trees (Sandalwood) were also recorded outside the Development Envelope and will not be directly impacted by the Proposal (**Figure 9-6**).

9.6.2 Indirect Impacts

9.6.2.1 Altered Fire Regimes and Increased Fire Risk

Fire prevention and control measures will be in place during construction and operation of the Proposal. This will also provide additional fire management in the wider area through implementation of fire-fighting equipment, trained personnel and fire access. If a fire does occur, fire response procedures and equipment will ensure that the fire outbreak is kept to a minimum and effectively controlled. Therefore, the Proposal is not considered likely to increase fire regimes. Several mitigation measures will be implemented in relation to minimising bushfire risk (**Table 9-15**), which are expected to effectively mitigate fire risks during construction and operation of the Proposal.

9.6.2.2 Dust and Use of Water for Dust Suppression

The Proposal will result in dust emissions from vegetation clearing required for construction and operation of the Proposal, topsoil stripping, waste material movement, processing and other ancillary activities. In addition, dust emissions may result from the movement of vehicles and machinery along unsealed roads. Matsuki et al. (2016) conducted a study examining the impacts of dust on plant health in semi-arid environments. The results of the study indicated no evidence of negative impacts on plant health as a result of dust deposition. Plants in semi-arid environments are exposed to dust within the natural environment and are less likely to suffer from short-term impacts of dust.

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope and throughout the life of mine using well-established industry practices (such as water based dust suppression). The Proposal may result in a minor, temporary increase in localised dust deposition on vegetation but this is not expected to significantly impact vegetation, noting that the Pilbara is a naturally dusty environment.

Dust emissions will also be regulated under Part V of the EP Act (works approval and licence). As noted in **Table 4-3**, conditions are applied to works approvals and licences that are considered to be necessary or convenient for the prevention, control, abatement or mitigation of pollution or environmental harm. DWER will set conditions to give effect to determined regulatory controls in accordance with its regulatory guidance. It is expected that DWER will regulate dust emissions associated with construction and operation of the Proposal.

In addition, a Mining Proposal is required under the Mining Act. The Mining Proposal is required to include the main environmental threats that are relevant to the mining Proposal (e.g. dieback, pathogens, weeds, feral animals, wildfires) and relevant baseline data for those threats that are relevant to the environmental risk assessment. Where dust, noise or other atmospheric emissions will impact on environmental factors (biodiversity, water resources, land and soils and/or rehabilitation and mine closure), and the impacts not

directly regulated under the EP Act, such impacts are required to be considered in the environmental risk assessment, mitigation measures and environmental outcomes.

Dewatered mine water will be used to suppress dust. The water will be a blend of brackish water from dewatering bores. This water may be saline (TDS of >5,000) and therefore has the potential to impact on vegetation. Saline water (> 5000 mg/L TDS) will be limited to use in mine areas where vegetation has been cleared and therefore, the risk of vegetation health being impacted from use of saline water is low.

Ongoing monitoring and management of dust and the use of saline water for dust suppression will be implemented. In addition, one of the objectives of the WMP **(Appendix 6)** is to allow for the identification and management of impacts to vegetation health and vegetation resulting from the use of saline water for dust suppression associated with implementation of the Proposal.

On this basis, the Proposal is considered unlikely to significantly impact the condition of native vegetation through dust deposition and dust suppression activities. Any impacts are predicted to be localised to disturbed areas. Vegetation health and condition will be monitored annually in accordance with the WMP to ensure the environmental impacts to flora and vegetation values continue to be managed to within the acceptable levels. As a result, no significant residual impacts on vegetation condition is anticipated as a result of fugitive dust emissions.

9.6.2.3 Introduced Weeds

HPPL has a number of established weed and hygiene management measures to reduce the risk of existing weeds being spread or new weeds being introduced into the Development Envelope including:

- Environmental Compliance Standard (HNR-0000-EN-STD-0001);
- Significant Fauna, Flora and Weed Identification Manual (HNR-0000-EN-MAN-0001);
- Imported Materials Weed Hygiene Inspection Form (HNR-0000-EN-TEM-0004);
- Vehicle & Mobile Equipment Weed Hygiene Inspection Form (HNR-0000-EN-TEM-0014).

Weed control measures include:

- Targeted weed control (including in areas around the clearing front and in retained native vegetation adjacent to cleared areas);
- Implementation of measures as per HPPL's established weed and hygiene management documentation listed above; and
- Progressive clearing and rehabilitation to minimise the opportunity for weeds to become established.

On this basis, the Proposal is considered unlikely to significantly impact the condition of native vegetation through the spread or introduction of weed species. Any impacts are predicted to be localised to disturbed areas and vegetation will be monitored annually to ensure the environmental impacts to flora and vegetation values continue to be controlled to within triggers and thresholds established in the WMP.

As a result, no significant residual impacts on vegetation condition from spread of weeds are anticipated.

9.6.2.4 Altered Hydrological and Hydrogeological Regimes

Groundwater

Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be 2.0 mbgl (i.e. to within 2 m below ground). If water levels rise above this threshold for prolonged periods, vegetation stress is predicted.

The maximum extents of groundwater mounding have been predicted using the numerical groundwater model over the life of the Proposal. These model outputs, together with the regional depth to groundwater data, have been used to identify areas where there is a risk of maximum groundwater levels mounding to within 2.0 m of the ground surface (i.e., 2 mbgl). These areas occur down gradient from the Fridge / Horseshoe South MAR Borefield and the Murray's Hill / Anticline Hill MAR area, coinciding with the break of slope. With the recession of water table associated with decreased MAR, surviving tree root systems (i.e., above zone of prolonged saturation) would be expected to gradually recolonise the desaturated zone down to root impeding layers and salt flushing processes would be reinstated (AQ2 2024b).

In overall terms, potential impacts to from groundwater mounding are likely to be spatially restricted and transient over the life of the Proposal. However, given the level of uncertainty associated with predictive modelling of groundwater levels, and noting that the tolerance of vegetation to groundwater level change is site specific and not easily determined, a program of ongoing monitoring of groundwater levels and vegetation health and adaptive management will be undertaken. A detailed discussion of the proposed management and monitoring measures is provided in the Water Management Plan (**Appendix 6**). The key management measures are:

- Surplus water will be managed via MAR to:
    - limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater) and
    - limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.
- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality will be undertaken to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes. As the tolerance of vegetation to groundwater level change is site specific and not easily determined, baseline and operational monitoring of both groundwater levels and vegetation health is of particular importance for the areas identified as being at risk of exposure to shallow groundwater levels.
- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering rates if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes. The modelling indicates a rapid recovery of groundwater levels post-mining, with predicted groundwater levels

reported to recover to within 0.1 m of pre-mining levels within 10 years of the cessation of mining, at all mining areas, MAR areas and regional simulated observation points.

- Adaptive management will be undertaken to incorporate additional knowledge including higher resolution digital elevation to improve topographic representation as it comes to hand to address assumptions and uncertainties to gain increased understanding of vegetation and aquifer response.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

As such there is a low likelihood of vegetation impacts resulting from groundwater mounding.

Groundwater salinity will also change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 1,800 and 3,000 mg/L. The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM. As the intent is to avoid any water logging of the root zones, the salinity of the mounded groundwater and the tolerance of vegetation to salinity changes does not require further consideration.

The backfilling of the pits at the completion of mining eliminates any post-mining increases in groundwater salinity caused by evaporation from the pit lake surfaces, however, modelling of post-mining groundwater quality has not been conducted to date.

Surface water

To reduce the impact of the mine development on the hydrological regime of the downstream environment, surface water diversions are proposed to divert water around mine development areas and reduce the likelihood of ponding and contamination of runoff (i.e., surface water that has come in contact with pollutants such as chemicals or waste materials associated with the Proposal). Flood modelling undertaken for the Proposal predicts that the diversions convey the majority of flows around infrastructure footprints and minimise the upstream ponding that may be present otherwise. Where water is predicted to build up behind development areas the ponding is typically only temporary, with the model predicting ponds to recede as water drains to the south. In downstream locations where water level reductions are predicted, this is due to a reduction in catchment area as runoff is contained within the Surface Water Containment Areas. In some cases, the diversion of catchments upstream of the Surface Water Containment Areas is diverted into alternate catchments which also results in a reduction of flow (AQ2 2025).

Based on the water balance assessment of Fortescue Valley woodland vegetation communities completed by AQ2 (2025), the amount of time between effective rainfall events is the most important factor determining vegetation water supply, rather than the magnitude of these events. This also means that the vegetation communities are periodically exposed to drought and waterlogging stress under baseline conditions and have adaptations to cope with this (AQ2 2025). Importantly, the hydrological impact assessment identifies that all baseline hydrological processes will be maintained. The predicted hydrological change primarily relates to the magnitude and duration of flooding events AQ2 2025).

A total area of approximately 25 ha is predicted by the 2D flood model to be subject to increased flood levels (>5 cm increase maximum flood height) for a 63% AEP rainfall event (i.e., ~1 year average recurrence interval). Affected areas comprise a mix of Mulga dominated vegetation at the base of the alluvial fans and *Eucalyptus victrix* woodlands proximal to an area of outcropping basement near the valley fringe. The magnitude of predicted change however is modest. In the majority of cases, the dominant species in these vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change of increased surface water inputs. Vegetation types dominated by *Acacia aneura* complex are susceptible to increased waterlogging, which could cause a decline in tree health. Such areas are relatively small (circa tens of hectares) in the overall affected area. Although this area has also been identified as being at risk of exposure to shallow groundwater levels (from MAR), as mentioned above, prolonged periods of groundwater mounding can be avoided with a programme of ongoing monitoring and adaptive management (AQ2 2025). Monitoring and management is outlined within the WMP (**Appendix 6**). Given this, it is considered unlikely that significant impacts to vegetation will occur as a result of increased flood levels, however, these areas will be monitored to ensure any changes are detected and managed.

The 2D flood modelling predicts the containment of runoff within the mine development areas will cause a reduction in flood levels within the Fortescue Valley to the south of the Development Envelope. In particular, the areas of ponding within the Goodiadarrie Swamp immediately to the south of Anticline South, Fridge West, Fridge Central and Horseshoe South pits are predicted to have a reduction in flood levels of 0.2 m following a 63% AEP rainfall event. Water shadowing downstream of linear infrastructure (i.e., roads and the rail line) is minimal due to the preliminary locations selected for the proposed culverts as captured in the model, which allow flows to continue downstream of the infrastructure. The modelling predicts only localised impacts on surface water inundation depths upstream and downstream of roads.

Mulga (*Acacia aneura*) (and other closely related co-occurring species), is sensitive to changes to sheet flow (Maia 2020). Seven vegetation types within the Development Envelope were mapped as sheetflow dependent vegetation communities. These communities are:

- AaAxSL – tall sparse shrubland of *Acacia aneura* (alliance);
- ASL (1 and 2)– Acacia tall shrubland;
- AWL (1, 2 and 3) - Acacia low woodland or tall shrubland; and
- AxAsSL - *Acacia* tall sparse shrubland.

A total of 44,964.20 ha of these vegetation types have been mapped during surveys associated with the Proposal (refer to **Table 9-3**) of which 9,725.43 ha occurs within the Development Envelope and 2,973.51 ha occurs within the Indicative Footprint. Potential surface water dependent vegetation extends beyond the Development Envelope. Changes to sheet flow cause a shadow effect down gradient of the Proposal and result in indirect impacts to vegetation downstream of disturbance areas.

An area of approximately 310 ha is predicted to be subject to decreased flood levels (>5 cm decrease maximum flood height) for a 63% AEP rainfall event. These areas largely are blanketed in fine depositional sediments with patchy vegetation dominated Mulga and scattered *Eucalyptus victrix* in southern portions that transition into the Loamy Flats. The magnitude of predicted change is modest. Typically, vegetation types that support Mulga and scattered *Eucalyptus victrix* include AWL (1), (2) and (3) and AdEvWL. The dominant species in these

vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change of decreased flood levels. Denser patches with high percentage cover of *Eucalyptus victrix* (vegetation types AdEvWL and EvWL), have the greatest potential to experience soil water depletion and drought stress during prolonged interfloods. Although a channel pool is located within the area of predicted flood depth reduction, the LoM flood modelling for a 63% AEP rainfall event predicts that surface water flow to the pool is not interrupted (i.e., the pool will continue to be supported by surface water) (AQ2, 2024b).

There are six conservation significant flora within the surface water dependent vegetation types present in the Development Envelope:

- *Triodia veniciae* (Priority 1) occurring within AaAxSL;
- *Hibiscus* sp. Mulga Downs (Priority 1) - occurring within AWL (1) and (2);
- *Aristida jerichoensis* var. *subspinulifera* (Priority 3) – occurring within ASL (2);
- *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3)- occurring within AWL (1);
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3) – occurring within AaAxSL; and
- *Rhynchosia bungarensis* (Priority 4) – occurring within ASL (1).

While individually these taxa are not necessarily surface water dependant, they may also be indirectly impacted by degradation / loss of habitat that supports them. Current survey extent does not extend to areas south of the Development Envelope, however, baseline monitoring will be undertaken across these areas prior to implementation of the Proposal and a program of monitoring will be implemented during operation. Monitoring and management is outlined within the WMP (**Appendix 6**).

Freshwater claypans of the Fortescue Valley PEC (Priority 1) includes a series of claypans in the Fortescue Valley, distributed over a distance of about 70 km from near the western end of the Fortescue Marsh to the Roebourne – Wittenoom Rd. The two westernmost claypans, known as the Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan, are located south of the Development Envelope. The key characteristics of the claypans which may be impacted by the proposed development are changes to the inundation depths, ponding duration (hydroperiod) and water quality (TDS) of ponded water. Changes to inundation depth, ponding duration and water quality has the potential to impact fringing vegetation of the claypans associated with the Freshwater Claypans of the Fortescue Valley' Priority 1 PEC and fringing *Eucalyptus victrix.*

As discussed in Section 7.5, a water balance model for the claypans was created to quantify the impact due to the potential loss in catchment related to the proposed mine development. The proposed mine development represents a loss of surface water catchment of 21 km^2 which is a 10% reduction to the Gnalka Gnoona catchment and a 2% reduction to the combined claypan catchment areas. The catchment reduction estimated for Koodjeepindarranna is insignificant compared to Baseline (<0.5%) (AQ2 2025).

The claypan water balance assessment concluded the following (AQ2 2025):

- The loss of catchment has nil to minor impact on the ponded water levels. The changes to the water levels in the claypans should therefore not impact on their hydrological function.

- The reduction in the duration of water ponding within the claypans due to the loss of catchment associated with the proposed mine development is negligible for small inundation events (where total event duration approximately 2 weeks), and is in the order of days for medium to large inundation events (total event duration is between three months and a year). It is unlikely these reductions to ponding duration will have a significant impact on the hydrological ecosystem function provided by the claypans.
- A salt balance was completed in conjunction with the water balance model completed for Gnalka Gnoona and Koodjeepindarranna claypans to assess the potential impact of the Proposal on the water quality of the claypans. The results indicate the salinity will vary marginally between the Pre-Development and LoM model scenarios.
- Standard local runoff management practices will be deployed within plant and mining areas to reduce the risk of contaminated water being released to the downstream environment where it has the potential to impact on local waterways and the downstream Fortescue Valley and claypans. These measures are further discussed in the WMP.

The predicted changes to inundation depths, ponding duration (hydroperiod) and water quality (TDS) of ponded water associated with the claypans are therefore anticipated to be marginal (AQ2 2025). These changes would be within the range of tolerance of vegetation fringing the claypans and are therefore unlikely to have a significant impact.

The WMP aims to avoid and minimise impacts to vegetation through a monitoring program targeted at detecting adverse changes, and the implementation of clear response actions if such changes are detected. The monitoring approach is informed by the results of baseline surveys, hydrological models, and the Proposal parameters. Additionally, the WMP considers management measures to avoid and minimise impacts associated with potentially contaminated surface water. Details of proposed monitoring, mitigation and contingency actions are outlined in the WMP (**Appendix 6**).

9.6.2.5 Fragmentation

There may be fragments of vegetation created within the Development Envelope during construction and operation of the Proposal and a proportion of these fragments are likely to be small and may not continue to be representative of their original community structure.

It is not possible to quantify indirect impacts to flora and vegetation from fragmentation as, fragmentation by itself does not prevent native vegetation from existing. Fragmentation can however lead to secondary impacts such as the introduction and spread of weeds, reduced seed dispersal and dust.

As discussed in **Section 9.6.2.3**, HPPL has a number of established weed and hygiene management measures to reduce the risk of existing weeds being spread or new weeds being introduced into the Development Envelope.

Dust impacts will also be managed as outlined in **Section 9.6.2.2**. HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope and throughout the life of mine using well-established industry practices (such as the sealing of roads and the use of water based dust suppression). Remnant vegetation around mine areas will likely experience some levels of degradation from edge effects, however with the implementation of management measures to minimise impacts from those secondary impacts and implementation of mine closure activities, ecological linkage to some

areas will be restored, mitigating the impacts of fragmentation on vegetation. Impacts from fragmentation are likely to be localised and not regionally significant.

9.7 Significant Residual Impact

The significant residual impact of the Proposal to Flora and Vegetation, after the application of the mitigation hierarchy, is:

- Clearing of up to 4,296.93 ha of native vegetation in Good to Excellent condition;
- Loss of up to 2,973.51 ha of potential sheet flow dependent vegetation;
- Loss of up to 4.31 ha of riparian vegetation; and
- Loss of up to 70.31 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC.

Environmental offsets are proposed to mitigate the significant residual impacts of the Proposal and are discussed in **Section 16**. HPPL therefore considers the Proposal can be managed to meet the EPA's objective to protect flora and vegetation so that biological diversity and ecological integrity are maintained.

9.8 Environmental Outcome

Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with flora and vegetation meet the EPA's objective for this factor. The predicted environmental outcomes for flora and vegetation are summarised in **Table 9-19**.

Table 9-19: Flora and Vegetation Environmental Outcomes

Potential impact	Environmental Outcome
Direct impacts	
Loss of native vegetation	Loss of no more than 4,296.93 ha of native vegetation in Good to Excellent condition of which: • 243.12 ha occurs within the Chichester IBRA subregion. • 4,053.80 ha occurs within the Fortescue IBRA subregion. • Loss of native vegetation across 15 vegetation types, including five locally significant vegetation types.
Loss of Conservation Significant Vegetation	• Loss of up to 2,973.51 ha of potential sheet flow dependent vegetation. • Loss of up to 70.31 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC. • Loss of up to 4.31 ha of Riparian vegetation.
Loss of Conservation Significant Flora	No impact to Threatened Flora listed under the BC Act. Clearing of three DBCA-listed Priority flora species (based on the Indicative Footprint): • Up to 622 known *Hibiscus sp*. Mulga Downs (S. Hitchcock SH 638) (P1)) individuals of the 4,226 individuals recorded in total during the survey effort for the Proposal (representing 14.7% impact). • Up to 574 known *Triodia veniciae* (P1) individuals, of the 1,278 recorded in the Development Envelope. 2,359 individuals were recorded in total during the survey effort for the Proposal.

Potential impact	Environmental Outcome
	• Up to 2 known *Dolichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479) (P3) individuals of the 29 recorded in the Development Envelope. 180,220 individuals were recorded in total during the survey effort for the Proposal.
Indirect impacts	
Altered fire regimes and increased fire risk	No significant damage to vegetation and flora as a result of fires caused by the Proposal.
Dust and use of saline water for dust suppression	No significant decline in vegetation and flora health as a result of dust deposition and the use of saline water (up to 5,000 mg/L TDS) for dust suppression required for the Proposal.
Introduced weeds	No introduction of new environmental weed species within the Development Envelope as a result of Proposal activities.
Altered hydrological regime	No significant decline in health of potential sheet flow dependant vegetation or Freshwater claypans of the Fortescue Valley P1 Priority Ecological Community (Fortescue claypans) PEC as a result of altered hydrological regimes resulting from Proposal activities as determined through monitoring and adaptive management in accordance with the Water Management Plan (**Appendix 6**).

10 Terrestrial Fauna

10.1 EPA Objective

The EPA's objective for the environmental factor Terrestrial Fauna is:

> "To protect terrestrial fauna so that biological diversity and ecological integrity are maintained" (EPA 2016b).

10.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to the key environmental factor Terrestrial Fauna which have informed the planning for the Proposal, are listed in **Table 10-1**.

HPPL has specifically considered these guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and its significance;
- Identification of activities which may lead to impacts to terrestrial fauna; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 10-1: Terrestrial Fauna Policy and Guidance

Author	Title	How Policy has been considered
EPA 2016e	Environmental Factor Guideline – Terrestrial Fauna	Considered in design (methods and approach) of the terrestrial fauna surveys or previous guidance (if survey undertaken before current guidelines).
EPA 2020a	Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment	
EPA 2016f	Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna	
EPA 2016g	Technical guidance – sampling of short-range endemic invertebrate fauna	
EPA 2021g	Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans	
Government of Western Australia (GoWA), 2011	WA Environmental Offsets Policy	The offset policy and guidelines have been considered in relation to the definition of significant residual impacts and the proposed offset strategy.
GoWA 2014	WA Environmental Offsets Guidelines	

Specific additional work required for assessment of the Proposal, relating to Terrestrial Fauna, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

10.3 Receiving Environment

10.3.1 Relevant Studies

A summary of the terrestrial fauna surveys undertaken for the Proposal and surrounding area is provided in **Table 10-2**. Terrestrial fauna survey coverage is shown in **Figure 10-2** to **Figure 10-5**. The survey effort for Short Range Endemic (SRE) is shown in **Figure 10-6**.

Surveys for the Development Envelope and the surrounding Mulga Downs area date back to 2013; however, for this assessment only contemporary surveys from 2018 to 2024 have been included. Historic and recent fauna surveys and assessments have been undertaken at various survey levels including desktop, basic, detailed and targeted within the Development Envelope and surrounds (**Table 10-2**).

All surveys were undertaken in accordance with the *Technical Guidance - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2020a) and the *Technical Guidance – Sampling of Short-range Endemic Invertebrate Fauna* (EPA 2016g) or earlier technical guidance.

The entire Development Envelope has been surveyed (**Figure 10-1**). The areas which were surveyed are referred to as the Survey Area for the purpose of this assessment and are more extensive than the Development Envelope of the Proposal.

The terrestrial fauna surveys undertaken from 2019 to 2022 were consolidated into one report - Attexo (2023) *Consolidated Terrestrial Fauna Report* which is provided as **Appendix 11c**.

Surveys post 2022 have been collated into the final data set and are included in this ERD.

There are two proposed exclusion areas – the Fauna Habitat Exclusion Zone (FHEZ) which is not within the Development Envelope, however it is referred to and discussed as a mitigation measure and to confirm areas of occupancy for significant fauna. The second area is the FHEZ Corridor which is an exclusion area within the Development Envelope. These are discussed in the context of mitigation for terrestrial fauna and have been included in survey data.

The FHEZ will not support any proposed mining related activities with the exception of proposed monitoring. The FHEZ Corridor will remain within the Development Envelope and will accommodate minor, low impact activities such as a communications tower and light vehicle access road, and monitoring activities. An infrastructure corridor is also proposed within the FHEZ Corridor however this will only be developed if the related Mulga Downs Hub and Rail Spur Proposal is approved. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub and Spur Proposal.

Table 10-2: Terrestrial Fauna Surveys and Studies

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Terrestrial fauna survey effort - overview					
ecologia 2020 **Appendix 11d**	Baseline Terrestrial Invertebrate Fauna (SRE) Level 2 Assessment.	March 2020	• Level 2 SRE Invertebrate Survey	• 18 dry pitfall sites over 1,376 trap nights. • 31 active foraging sites over 104 hours of foraging. • 18 Leaf litter and soil sampling sites.	• Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g). • Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
ecologia 2021a **Appendix 11a.1**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019 (Wet Season)	• Detailed Phase 1 Vertebrate Fauna Survey • Mulga East - (R47/0012) • Malay Wells - (E47/2117) • Proposed Rail Corridor - (E45/380, L45/381, L45/382, L45/447, E47/2044, E45/3593)	• 18 Systematic Trap Sites, 5,652 trap nights. • 22 Avifauna survey sites. 23.3 hrs surveyed. • 21 Acoustic recording sites and 42 recording nights. • 12 hrs nocturnal surveyed sites.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Survey Guidelines for Australia's Threatened Bats (DEWHaH 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
		April 2020 (Dry Season)	• Detailed Phase 2 Vertebrate Fauna Survey • Mulga East - (R47/0012) • Malay Wells - (E47/2117) • Proposed Rail Corridor - (E45/380, L45/381, L45/382, L45/447, E47/2044, E45/3593)	• 18 Systematic Trap Sites, 6,160 trap nights. • 15 Avifauna survey sites. 12.3 hrs surveyed. • 25 Acoustic recording sites and 60 recording nights. • 36 hrs nocturnal surveyed sites.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Biologic 2022a **Appendix 11b.1**	Mulga East Iron Ore Project: Mulga West Borefield and Mulga East Corridors Terrestrial Fauna Survey.	November 2021 (Dry Season)	• Dry Season Basic Survey and targeted fauna survey • Mulga West Borefield – (E47/1315) • Mulga East Southern Corridor – (L45/316)	• 6 Avifauna survey sites. 2.3 hrs surveyed. • 2 Acoustic recording sites and 8 recording nights. • 2 hrs active foraging, 0.8 hrs surveyed.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017) • Survey Guidelines for Australia's Threatened Bats (DEWHaA 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
		March 2022 (Wet Season)	• Wet Season Detailed Survey, including targeted surveys • Mulga West Borefield – (E47/1315) • Mulga East Southern Corridor – (L45/316)	• 5 Systematic Trap Sites, 1,820 trap nights. • 6 Avifauna survey sites. 9.1 hrs surveyed. • 12 Acoustic recording sites and 65 recording nights. • 7 hrs nocturnal surveyed sites. • 12 hrs active foraging, 11.3 hrs surveyed.	
Biologic 2022b **Appendix 11b.2**	Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey	November 2021 (Dry Season)	• Dry Season Basic Survey and targeted fauna survey	• 6 Avifauna survey sites. 2.3 hrs surveyed. • 2 Acoustic recording sites and 8 recording nights. • 2 hrs active foraging, 0.8 hrs surveyed.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
		March 2022 (Wet Season)	• Wet Season Detailed Survey, including targeted surveys	• 5 Systematic Trap Sites, 1,820 trap nights. • 6 Avifauna survey sites. 9.1 hrs surveyed. • 12 Acoustic recording sites and 65 recording nights. • 7 hrs nocturnal surveyed sites. • 12 hrs active foraging, 11.3 hrs surveyed.	• Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017) • Survey Guidelines for Australia's Threatened Bats (DEWHaA 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline (ASA)	March 2023	• Area referred to as ASA. • Level 1 –Basic and targeted terrestrial vertebrate and SRE assessment • Mulga East - (E47/2044, L45/0687) • Pipeline – (E47/1729, E47/1315, R47/0014)	• 2 Systematic Trap Sites, 30 trap nights. • 5 Acoustic recording sites and 19 recording nights. • 9 Targeted survey and active forages over 9 hours searched.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia (DBCA, 2017); • Survey Guidelines for Australia's Threatened Bats (DEWHaA 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Attexo 2023 **Appendix 11c**	Consolidated Terrestrial Fauna Report	2023	Consolidated Report: consolidates reports completed up to 2021 for the MDIOM		• Statement of Environmental Principles, Factors, Objectives and Aims of EIA • Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g). • Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
Spectrum 2024a **Appendix 11e**	Targeted Bilby & Night Parrot Survey	March 2024 May 2024	Targeted Bilby and Night Parrot surveys at the MDIOM Development Envelope and surrounding tenements (Malay Well E47/2117-1, Mine Area M47/1621 and Murrays Hill L45/316 (the Survey Area)) within potential habitat.		
Spectrum 2024b **Appendix 11f**	Supplementary Targeted Fauna Survey	June 2024	The scope of this study was to undertake a single-phase, targeted terrestrial fauna survey, focusing on the potential occurrence of threatened species within the Survey Area (MDIOM 25,588.1 ha; FHEZ 793.6 ha) and where the MDIOM intersects with the Rail 8B Alignment		
Northern Quoll and Pilbara Olive Python Survey Effort					
ecologia 2021a **Appendix 11a.1**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• Motion sensor sites for 48 nights. • 20 hrs targeted searches	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
		July 2019	Phase 1 – Targeted significant fauna survey	• 42 motion sensor sites for 207 nights. • 45 cage traps over 315 trap nights • 20 hrs targeted searches, 12 hrs nocturnal searches.	
		April 2020	Detailed Phase 1 Vertebrate Fauna Survey	• 39 motion sensor sites. • 60 hrs targeted searches.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
		July 2020	Phase 2 – Targeted Significant Fauna Survey	• 39 motion sensor sites for 3,982 nights. • 100 hrs targeted searches, 36 hrs nocturnal searches. • 107 kms of UAV flight pathways.	
Biologic 2022b **Appendix 11b.2**	Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey	November 2021	Basic Survey	• 3 motion sensor sites for 10 nights. • 1.25 hrs targeted searches.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
		March 2022	Detailed Phase 1 Fauna Survey	• 13 motion sensor sites for 88 nights. • 5 cage trap sites for 70 nights • 9.6 hrs targeted searches, 7 hrs nocturnal searches.	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Level 1 –Basic and targeted terrestrial vertebrate and SRE assessment	• 2 motion sensor sites for 30 nights. • 11.25 hrs targeted searches.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2024b **Appendix 11f**	Supplementary Targeted Fauna Survey	June 2024	Supplementary Targeted fauna Survey	• 25 motion sensor cameras at 14 sites – total of 989 trap nights (Northern Quoll) • 14 unbounded targeted searches • 34.8km was traversed	• Environmental Factor Guidelines – Terrestrial Fauna (EPA, 2016a). • Environmental Protection Authority (EPA) Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020). • Survey guidelines for Australia's threatened mammals (DSEWPaC 2011a). • Survey guidelines for Australia's threatened bats (DEWHaA 2010). • Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b). • EPBC Act Significant impact guidelines 1.1 - Matters of National Environmental Significance (DotE 2013). • EPBC Act referral guideline for the endangered Northern Quoll Dasyurus hallucatus (DotE, 2016). •
Ghost Bat and Pilbara Leaf-nosed Bat Survey Effort					
ecologia 2021a **Appendix 11a.1**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• 31 acoustic recording sites over 59 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)
		July 2019	Phase 1 – Targeted Significant Fauna Survey	• 57 acoustic recording sites over 75 recording nights.	
		December 2019	Targeted Pilbara Leaf-nosed Bat Survey	• 70 acoustic recording sites over 70 recording nights.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
		March 2020	Long-term Pilbara Leaf-nosed Bat Survey	• 6 acoustic recording sites over 212 recording nights.	
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	• 18 acoustic recording sites over 18 recording nights. • 107km of UAV flight pathways.	
		July 2020	Phase 2 – Targeted Significant Fauna Survey	• 42 acoustic recording sites over 42 recording nights. • 81 Cave habitat assessments.	
		October 2020	Targeted Pilbara Leaf-nosed Bat Survey	• 28 acoustic recording sites over 28 recording nights. • 1 cave habitat assessment.	
ecologia 2021b **Appendix 11a.2**	Letter: Targeted Pilbara Leaf-nosed Bat Gap Analysis	March 2021	Targeted Pilbara Leaf-nosed Bat Gap Survey	• 16 acoustic recording sites over 16 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)
Biologic 2022b **Appendix 11b.2**	Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey	November 2021	Basic Survey	• 2 acoustic recording sites over 8 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)
		March 2022	Detailed Survey	• 12 acoustic recording sites over 65 recording nights.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment	• 5 acoustic recording sites over 19 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)
ecologia 2023a. **Appendix 11h**	Desktop Risk Assessment for the Pilbara Leaf-nosed Bat and Ghost Bat.	NA	A desktop review of the Pilbara Leaf-nosed Bat and Ghost Bat surveys undertaken as part of this assessment was completed by *ecologia* (2023a). The review consolidated all relevant survey work and was commissioned based on concerns surrounding the habitat usage by the two species. The review included an additional peer review by a specialist bat consultant on the work completed to date, in particular with respect to bat cave categories. This study is discussed in Section 13.3.5.		• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
Specialised Zoological 2021 (in *ecologia* 2021a)	Review of Pilbara leaf-nosed bat activity Mulga East Project.	NA	Peer review by a specialist bat consultant on the bat work completed to date, in particular with respect to bat cave categories. Included a comprehensive peer review of the long-term data collected at MEC016. This study is discussed in **Section 9.3.2.5**		
LGA, 2024 **Appendix 27**	Environmental Noise Assessment – Mulga Downs Mining Operations	N/A	An assessment of the potential noise and vibration impacts from the proposed Mulga Downs Iron Ore Mine (MDIOM, the Proposal) on surrounding noise sensitive receptors including the Youngaleena and Wirrilimarra communities, heritage sites and bat caves.		• Environmental Protection (Noise) Regulations 1997 (the Regulations) • Australian Standard AS2021 Acoustics – Aircraft Noise Intrusion - Building Siting and Construction • AS 2187.2-2006 Explosives – Storage and use – Use of explosives • State Planning Policy 5.4 Road and Rail Noise

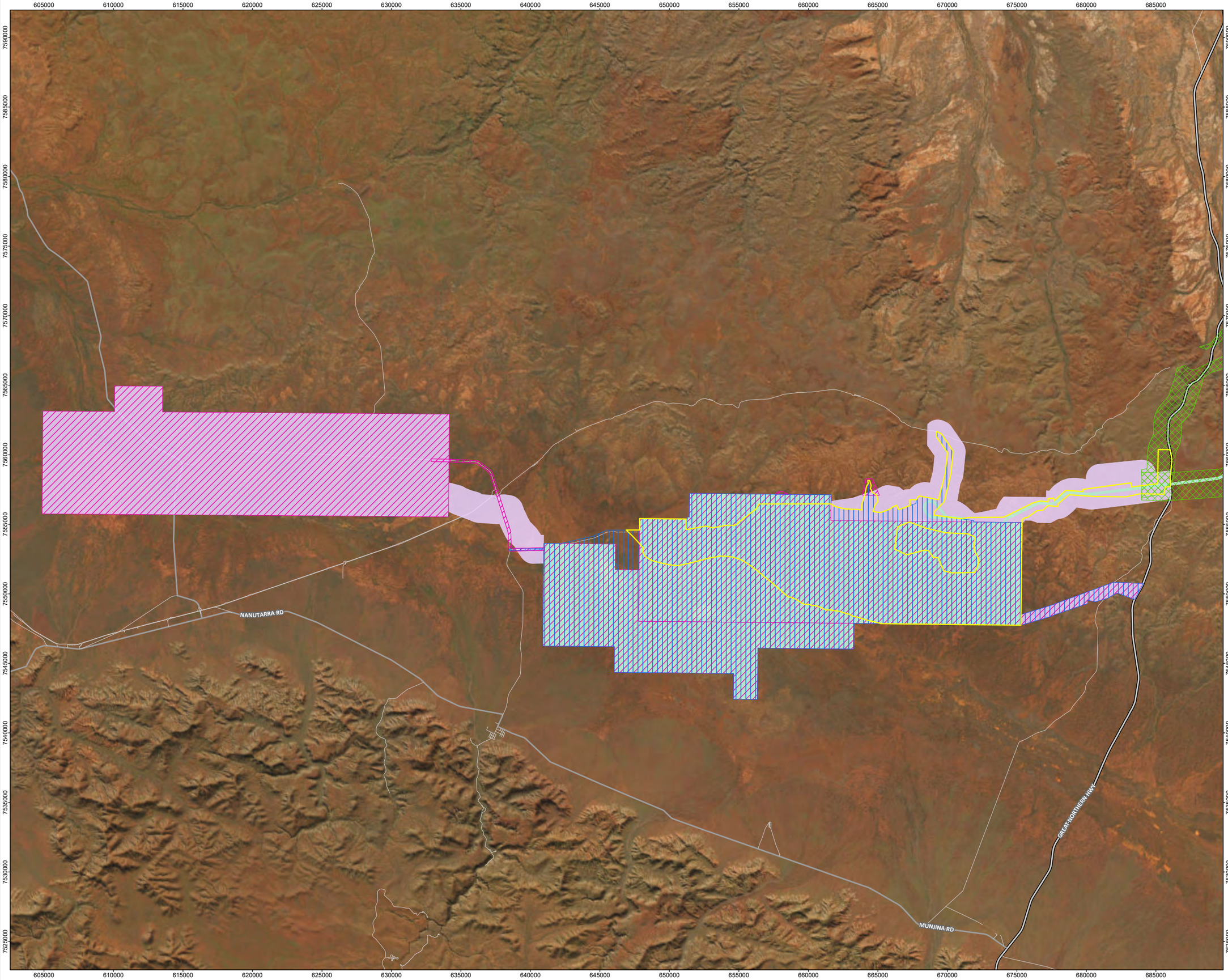
Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
PSM, 2024 **Appendix 28**	Geotechnical Assessment of Bat Caves, Mulga Downs Iron Ore Project	November 2023; January 2024	Geotechnical assessments of bat caves in the vicinity of the MDIOP. The primary objective of the assessments was to qualitatively assess geotechnical stability of the caves, with regards to the potential vibrations from the Proposal.		Not applicable
Night Parrot Survey Effort					
ecologia 2021a **(Appendix 11a.1)**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	3 acoustic recording sites over 24 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	• 7 acoustic recording sites over 42 recording nights. • 33km of UAV flight pathways.	
Biologic 2022a **(Appendix 11b.1)**	Mulga East Iron Ore Project: Mulga West Borefield and Mulga East Corridors Terrestrial Fauna Survey.	March 2022	Detailed Survey	• 7 acoustic recording sites over 40 recording nights.	
Spectrum 2023a **(Appendix 11g)**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment	2 acoustic recording sites over 12 recording nights.	• Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017)
Spectrum 2024a **Appendix 11e**	MDIOM Night Parrot and Bilby Targeted Survey	18-24 March 2024 (following heavy rain) May 2024	Targeted Night Parrot Survey in habitats identified as potential habitat.	• 12 Night Parrot recorders installed in areas of long unburnt spinifex, clay pans and near drainage lines • 30 Habitat assessments completed	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Greater Bilby Survey Effort					
Terrestrial Ecosystems 2013	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	2013	Level 2 Fauna Assessment	• 702 Habitat assessments and targeted searches • 500 camera trap nights at 100 sites	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) •
ecologia 2021a **(Appendix 11a.1)**		April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• 42 targeted habitat assessments undertaken. The targeted surveys involved surveying habitat known to support populations of the Bilby in Western Australia, including Acacia aneura (mulga) woodland/shrubland growing on ridges and rises which was surveyed extensively with a UAV during the survey.	
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	228 km of UAV flight pathways.	
Spectrum 2023a **(Appendix 11g)**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment ASA – solar farm, northern haul road and pipeline route to Mulga West	• 9 targeted searches within a total of 9 hours. Mulga Woodland habitat was targeted along the proposed pipeline route.	
Spectrum 2024a **(Appendix 11e)**	MDIOM Night Parrot and Bilby Targeted Survey 2024	18-24 March 2024 May 2024	Targeted Bilby Survey Mulga Woodland and Drainage Line / Floodplains habitat	• 14 targeted Bilby searches • 30 habitat assessments	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
SRE Survey Effort					
ecologia 2020 **Appendix 11d**	Mulga East Short-range Endemic Invertebrate Fauna Assessment.	March 2020	Level 2 SRE Invertebrate Fauna Survey	• 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights) • 22 active foraging sites; 44 hours of active foraging. • 10 Leaf litter and soil sampling sites.	• Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g)
Biologic 2022a **Appendix 11b.1**	Mulga East Iron Ore Project: Mulga West Borefield and Mulga East Corridors Terrestrial Fauna Survey.	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• 6 active foraging sites over 9 hours of foraging. • 6 Leaf litter and soil sampling sites.	
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	• 18 active foraging sites over 27 hours of foraging. • 18 Leaf litter and soil sampling sites.	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline.	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment	• 20 active foraging sites (10 hours of foraging). • 8 Leaf litter and soil sampling sites.	
Grey Falcon Survey Effort					

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
ecologia 2023b **Appendix 11i.1**	Mulga Downs Iron Ore Project – Desktop Risk Assessment for the Grey Falcon	NA	An additional desktop risk assessment was competed for the Grey Falcon (*Falco hypoleucos*) listed as Vulnerable (BC Act, EPBC Act) for the Proposal. The desktop reviewed the surveys undertaken for the Proposal and identified potential nesting habitat for the Grey Falcon.		EPA Environmental Factor Guideline: Terrestrial fauna (EPA 2016a) Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) Survey Guidelines for Australia's Threatened birds (DEWHA 2010) Conservation Advice – *Falco hypoleucos* Grey Falcon (TSSC, 2020)
Spectrum 2023b **Appendix 11i.2**	Memo: Mulga Downs Iron Ore Mine, Targeted Grey Falcon Survey	August 2023	A targeted Grey Falcon (*Falco hypoleucos*) survey including induvial searches and suitable nests within potential nesting habitat during the nesting/breeding season (June to November). Survey area across the MDIOM tenements E47/1315, E47/2117-1, M47/1621 and L45/316.		
Aquatic Fauna					
Biologic 2023 **Appendix 24**	Mulga Downs Iron Ore Mine, Freshwater Claypans Desktop Assessment	N/A	A desktop assessment of the aquatic ecosystems of freshwater claypans in the vicinity of the Mulga Downs Iron Ore Mine. The assessment included database searches and a literature review to summarise the aquatic biota assemblages of the freshwater claypans in the vicinity of the Development Envelope, including taxa of significance. The search area for the Desktop Assessment comprised a 40 km radius from the central point of the Development Envelope (the Desktop Assessment Search Area). Tolerance of sensitive receptors to salinity and turbidity was reviewed in the literature and threats to the claypans assessed.		• This Desktop Assessment was carried out in a manner consistent with the following, where applicable: • Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) • Assessing and Managing Water Quality in Temporary Waters (Smith et al., 2020) • Environmental Factor Guideline, Inland Waters. • Statement of Environmental Principles, Factors, Objectives and Aims of EIA • Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g). • Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)

Figure 10-1: Terrestrial Survey Extent



Legend

- Development Envelope

Fauna survey

- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).
- Biologic Environmental Survey (2022).
- ecologia Environment (2020 and 2021)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 06-Nov-2024
Drawn By: dmills	Checked By: VC

Scale 1:250,000 at A3

0 4 8
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

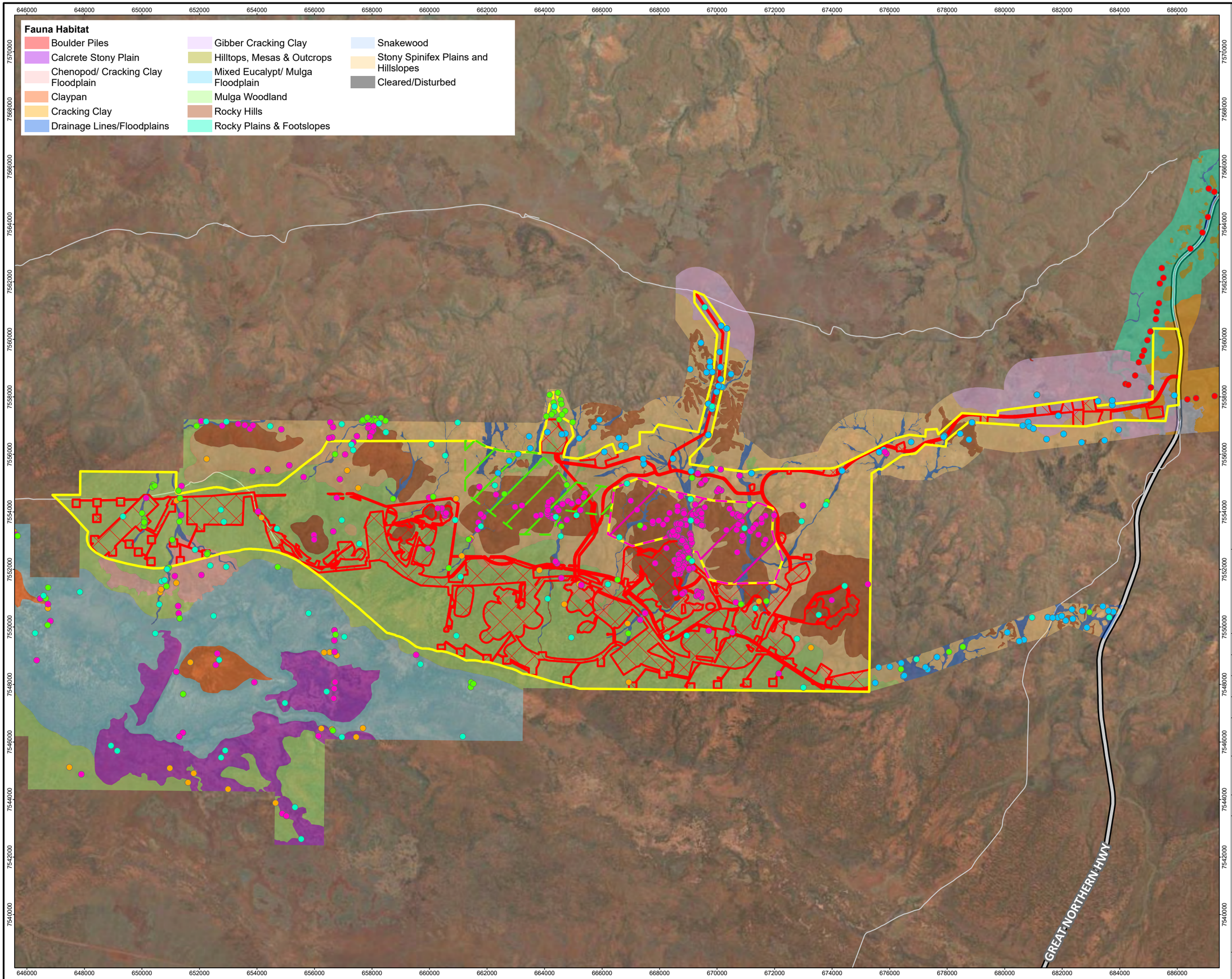
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EXTENT

FIGURE 10.1

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EPBC\02_MapProjects\67751_MDIOM_EPBC_s156a_PER_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-2: Terrestrial Fauna Survey area for the Proposal



Legend

- Development Envelope
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor
- Indicative Footprint

Sample site

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).
- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

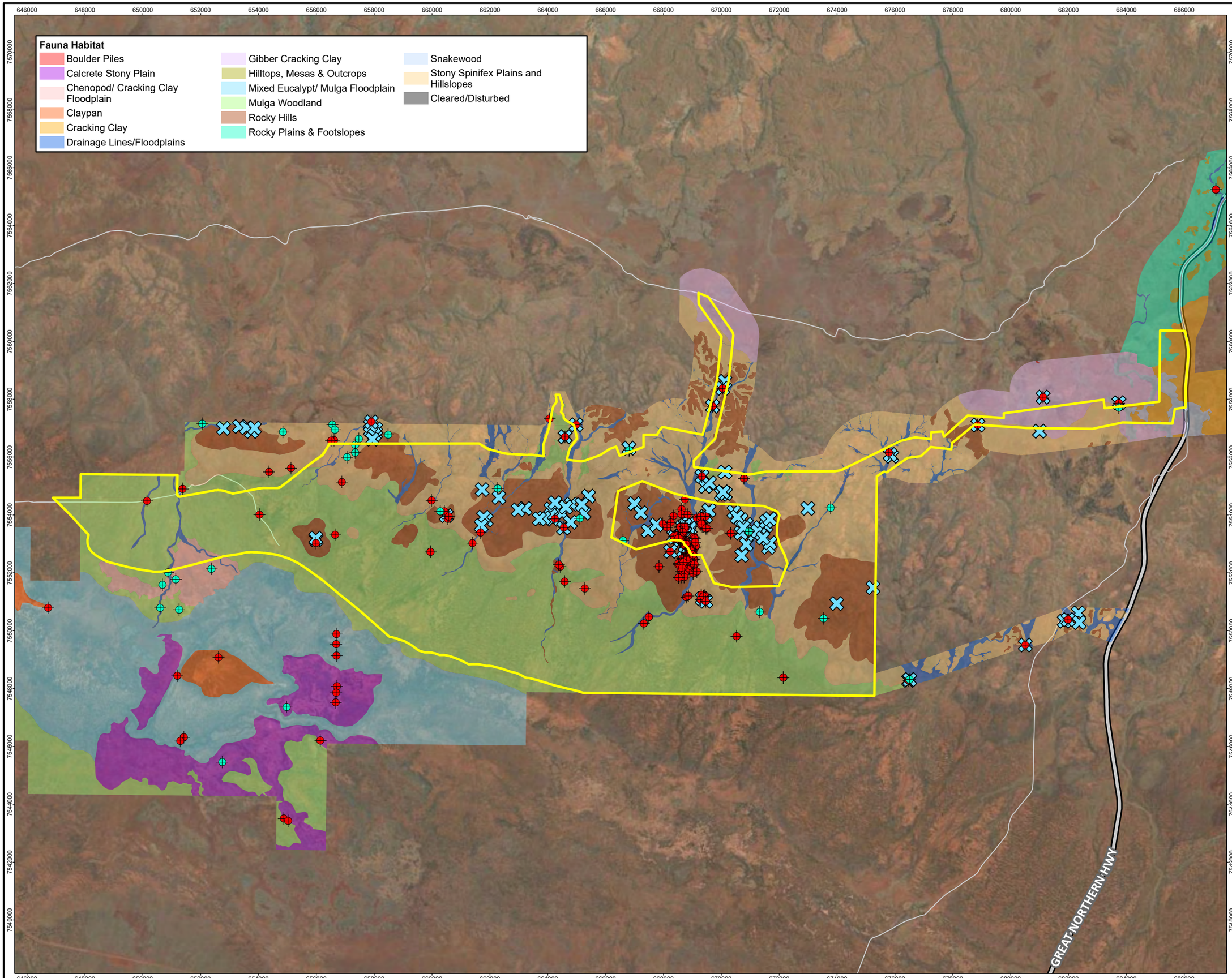
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT

FIGURE 10.2

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Figure 10-3: Terrestrial Fauna Survey Area for the Proposal (Acoustic, Avifauna and Nocturnal Survey Sites)



Legend

- Development Envelope
- Ultrasonic recording site
- Audio recording site
- Motion camera recording site

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY AREA FOR THE PROPOSAL (ACOUSTIC, AVIFAUNA AND NOCTURNAL SURVEY SITES).

FIGURE 10.3

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Figure 10-4: Terrestrial Fauna Survey area for the Proposal (UAV Survey Sites)

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Night Parrot flight path UAV effort
- Bilby flight path UAV effort

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

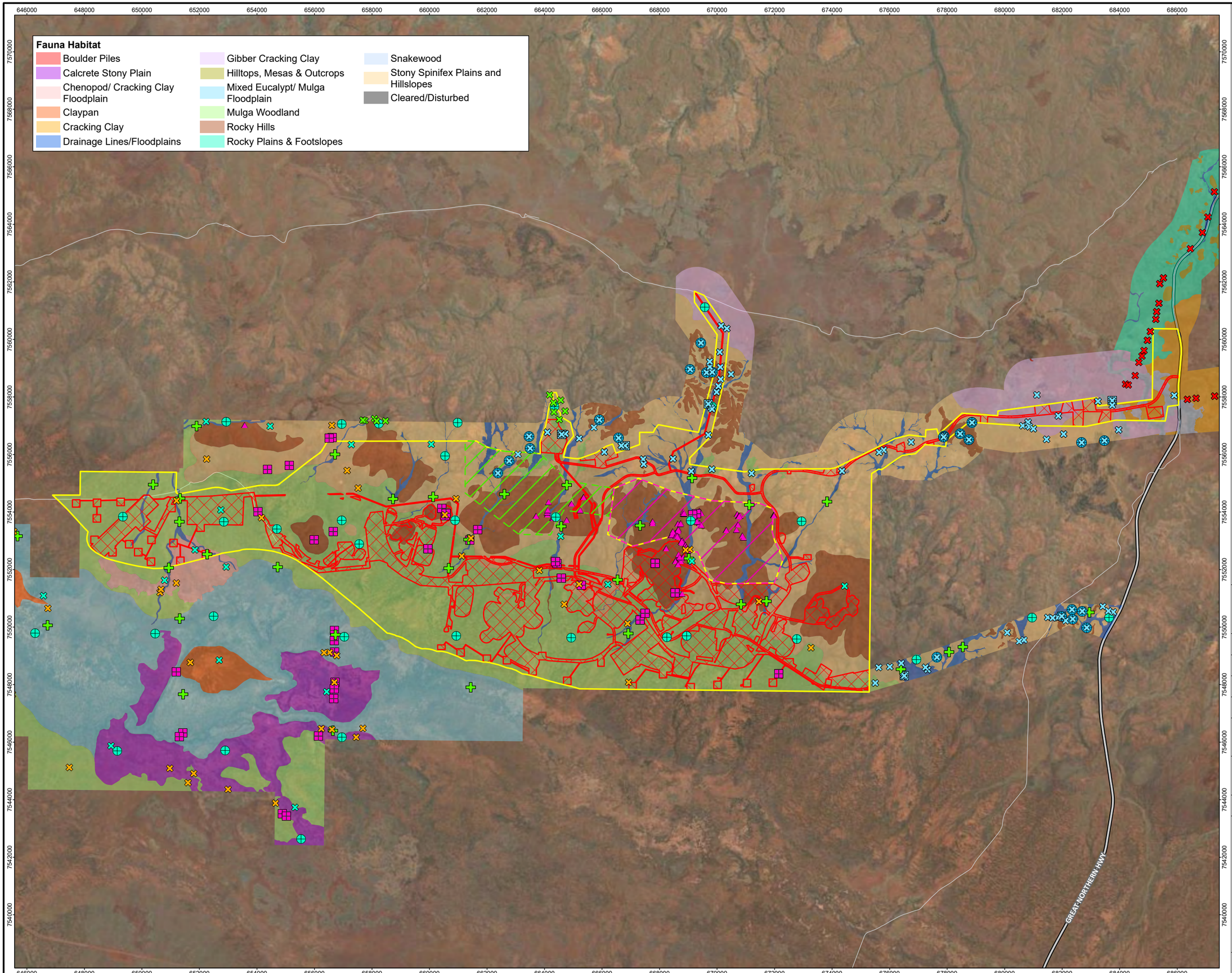
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT FOR THE PROPOSAL (UAV SURVEY SITES)

FIGURE 10.4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-5: Terrestrial Fauna Survey Effort (Habitat assessment, Cave assessment, Systematic Trapping and Targeted Survey)



Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor
- Fauna Habitat Exclusion Zone (FHEZ)

Habitat Assessment
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Targeted Survey
- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)
- Spectrum Ecology & Spatial (2023).

Systematic Trapping
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment
- ecologia Environment (2020).
- ecologia Environment (2021).

Roads (LGATE-195)
- Highway

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

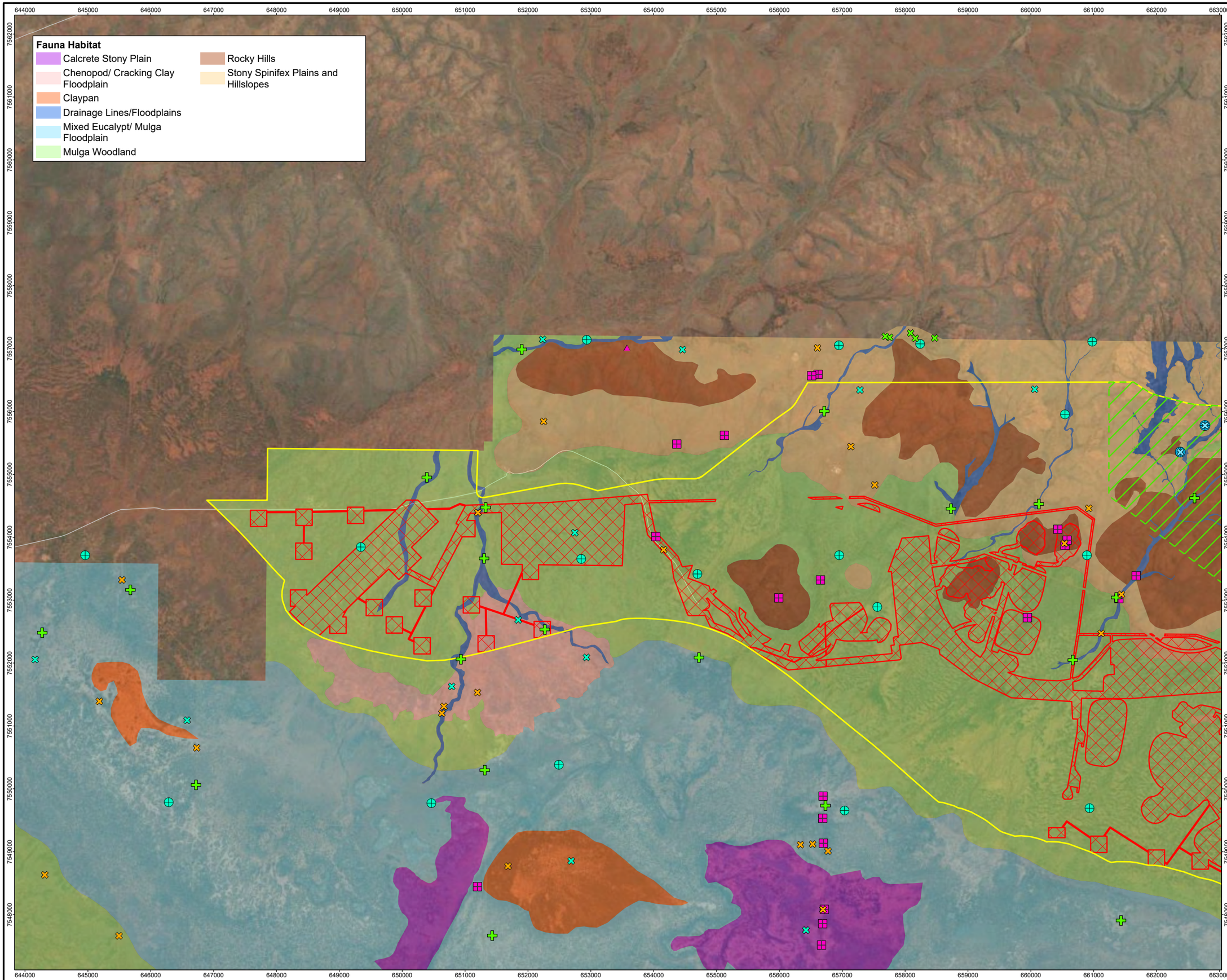
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 1 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Habitat Assessment

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Targeted Survey

- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)

- Spectrum Ecology & Spatial (2023).

Systematic Trapping

- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment

- ecologia Environment (2021).

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 2 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

Fauna Habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor
- Fauna Habitat Exclusion Zone (FHEZ)

Habitat Assessment

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Targeted Survey

- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)

- Spectrum Ecology & Spatial (2023).

Systematic Trapping

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment

- ecologia Environment (2020).
- ecologia Environment (2021).

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 3 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Habitat Assessment
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey
- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)
- Spectrum Ecology & Spatial (2023).

Systematic Trapping
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment
- ecologia Environment (2020).
- ecologia Environment (2021).

Roads (LGATE-195)
- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 01-Apr-2025

Drawn By: dmills | Checked By: VC

Scale 1:55,000 at A3

0 1 2 Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-6: Short Range Endemic Survey Effort for the Proposal

SRE Sample Sites

Biologic Environmental

- Phase 1 - 6 active foraging sites over 9 hours of foraging, 6 Leaf litter and soil sampling sites.
  Phase 2 - 18 active foraging sites over 27 hours of foraging, 18 Leaf litter and soil sampling sites.

ecologia Environment

- 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights), 22 active foraging sites; 44 hours of active foraging, 10 Leaf litter and soil sampling sites.

SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 1 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

SRE Sample Sites

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ecologia Environment

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SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 2 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

SRE Sample Sites

Biologic Environmental

- Phase 1 - 6 active foraging sites over 9 hours of foraging, 6 Leaf litter and soil sampling sites.
  Phase 2 - 18 active foraging sites over 27 hours of foraging, 18 Leaf litter and soil sampling sites.

ecologia Environment

- 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights), 22 active foraging sites; 44 hours of active foraging, 10 Leaf litter and soil sampling sites.

SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 3 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

SRE Sample Sites

Biologic Environmental

- Phase 1 - 6 active foraging sites over 9 hours of foraging, 6 Leaf litter and soil sampling sites.
  Phase 2 - 18 active foraging sites over 27 hours of foraging, 18 Leaf litter and soil sampling sites.

ecologia Environment

- 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights), 22 active foraging sites; 44 hours of active foraging, 10 Leaf litter and soil sampling sites.

SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.2 Vertebrate Fauna

10.3.2.1 Desktop Assessment

Each terrestrial fauna survey included comprehensive database searches (all surveys provided results within 40 km of the Proposal) and literature reviews consistent with EPA guidance (EPA 2020). As part of the Attexo (2023) consolidated report, contemporary searches (using a 40 km buffer) of mapping resources and databases were completed to identify any changes to records of conservation significant fauna (desktop study area).

Previously completed assessments within the desktop study area were reviewed for conservation significant fauna and SREs which may occur. From this desktop review, the following information was collated for each fauna species of known conservation significance with potential to occur:

- Conservation status (EPBC Act, BC Act, DBCA listing);
- Description of habitat requirements;
- Description of previous records; and
- Distance of record to the Proposal.

Conservation significant fauna with the potential to occur in the Development Envelope were assigned a likelihood of occurrence rating according to the criteria set (**Table 10-3**). While there was some variation between assessments, the criteria for the rating were similar and comparable. Criteria included assessing the distance of the record from the Proposal (historical database records considered not accurate were excluded if required), presence of appropriate habitats within the Survey Area (using geology, vegetation mapping, and/or aerial imagery), and time passed since a fauna record.

Table 10-3: Likelihood of Occurrence

Likelihood	Criteria
Recorded	The species has been recorded within the Development Envelope previously or during the current survey.
Likely	The species may occur within the Development Envelope as suitable habitat is known to be present and there are existing records within 10 km of the Development Envelope.
Possible	The species may occur within the Development Envelope as there are existing records in the vicinity of the Development Envelope, and suitable habitat is likely to be present, OR the species may occur within the Development Envelope as there is insufficient information available to exclude the possibility of occurrence.
Unlikely	The species is unlikely to occur within the Development Envelope as suitable habitat is not present or is not likely to be present, OR suitable habitat is present within the Development Envelope, but the taxon/community has not been recorded despite reasonable survey effort.

The consolidated desktop and literature assessments undertaken as part of the *ecologia* (2021), Biologic (2022a, b) and Spectrum (2023a) fauna assessments identified 384 species of vertebrate fauna, which have previously been recorded in, or have potential to occur within, the desktop study area. This comprised:

- 49 mammals (43 native species and six introduced species);
- 188 birds;
- 134 reptiles; and
- 13 amphibians.

Of these, 36 were considered conservation significant fauna and are listed in **Table 10-4.**

Table 10-4: Conservation Significant Species Identified from Desktop and Literature Assessments

Scientific Name	Common Name	BC Act Status[1]	DBCA Status[1]
Mammals			
Dasycercus blythi	Brush-tailed Mulgara	-	P4
Dasyurus hallucatus	Northern Quoll	EN	-
Leggadina lakedownensis	Northern Short-tailed Mouse	-	P4
Pseudomys chapmani	Western Pebble-mound Mouse	-	P4
Macrotis lagotis	Greater Bilby	VU	-
Macroderma gigas	Ghost Bat	VU	-
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	VU	-
Birds			
Apus pacificus	Fork-tailed Swift	MI	-
Calidris acuminata	Sharp-tailed Sandpiper	MI	-
Calidris ferruginea	Curlew Sandpiper	CR	-
Calidris melanotos	Pectoral Sandpiper	MI	-
Calidris ruficollis	Red-necked Stint	MI	-
Charadrius veredus	Oriental Plover	MI	-
Elanus scriptus	Letter-winged Kite	-	P4
Falco hypoleucos	Grey Falcon	VU	-
Falco peregrinus	Peregrine Falcon	OS	-
Gelochelidon nilotica	Gull-billed Tern	MI	-
Glareola maldivarum	Oriental Pratincole	MI	-
Hirundo rustica	Barn Swallow	MI	-
Hydroprogne caspia	Caspian Tern	MI	-
Motacilla cinerea	Grey Wagtail	MI	-
Motacilla flava	Yellow Wagtail	MI	-

Scientific Name	Common Name	BC Act Status[1]	DBCA Status[1]
Pandion haliaetus cristatus	Eastern Osprey	MI	-
Pezoporus occidentalis	Night Parrot	CR	-
Plegadis falcinellus	Glossy Ibis	MI	-
Rostratula australis	Australian Painted Snipe	EN	-
Sternula albifrons	Little Tern	MI	-
Tringa glareola	Wood Sandpiper	MI	-
Tringa nebularia	Common Greenshank	MI	-
Actitis hypoleucos	Common Sandpiper	MI	
Reptiles			
Anilios ganei	Gane's Blind Snake	-	P1
Liasis olivaceus barroni	Pilbara Olive Python	VU	-
Ctenotus nigrilineatus	Pin-striped Finesnout Ctenotus	-	P1
Ctenotus uber johnstonei	Spotted Ctenotus	-	P2
Notoscincus butleri	Lined Soil-crevice Skink	-	P4
Underwoodisaurus seorsus	Pilbara Barking Gecko	-	P2

[1] Biodiversity Conservation Act: P1: Priority One, P2: Priority Two, P3: Priority Three, P4: Priority Four, OS: Other specially protected species, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory.

10.3.2.2 Field Surveys

A total of 236 terrestrial fauna species were recorded cumulatively from surveys undertaken by *ecologia* (2021a), Biologic (2022a, b), Spectrum (2023a) and Spectrum (2024 a, b). Records included 28 mammals, 121birds, 84reptiles and two amphibians (Attexo, 2023; Spectrum, 2023a). Native taxa recorded account for 79% of the species identified during the desktop assessment as occurring within the vicinity of the Proposal.

The 28 mammal species recorded within the survey area included 13 species of native ground dwelling mammals, nine species of bat and five introduced mammals. Ground dwelling mammal species recorded account for 57% of regional mammal species identified in database searches. Bat species recorded account for 75% of regional bat species identified in database searches.

The 121 bird species recorded from the surveys represent 63% of the regional bird species identified from database searches as having the potential to occur. A total of 63 species were predominantly woodland/shrubland canopy species, 18 species were ground dwelling, 17 species were nocturnal birds of prey, and 22 species were wading birds. One species was introduced – Zebra Dove (*Geopelia striata*) (Attexo, 2023; Spectrum 2023a).

The 84 species of reptile recorded during the surveys represent 63% of regional reptile species identified from database searches as having the potential to occur.

Two amphibian species, Little Red Treefrog (*Litoria rubella*) and Sheep Frog (*Cyclrana maini*) were recorded from the surveys representing 15% of regional amphibian species identified in the database searches as having the potential to occur.

Five introduced terrestrial fauna species were recorded during the surveys. This includes the domestic mouse (*Mus musculus*), feral cat (*Felis catus*), feral dog/dingo (*Canis lupus*), domestic cattle (*Bos taurus*) and the European red fox (*Vulpes vulpes*). Introduced species occur broadly across the Pilbara region and are not restricted to specific habitat types. Cats and foxes are classed as declared pests under the *Biosecurity Agriculture Management Act 2007* (BAM Act). As the Development Envelope is located around active pastoral leases, cattle were regularly observed during surveys.

10.3.3 Conservation Significant Fauna

A total of 11 conservation significant fauna (as categorised by the BC Act and under DBCA classification) have been recorded within the Development Envelope (Attexo 2023; Spectrum 2023a). This includes four migratory birds, which were recorded within the Gnalka Gnoona and Koodjeepindarranna claypans. These claypans are part of the Freshwater Claypans of the Fortescue Valley P1 PEC. They are not located within the Development Envelope; however, the Proposal has the potential to alter to hydrological regimes of the claypans and therefore the fauna species associated with these features have been considered in the assessment. A Glossy Ibis was recorded within the previously proposed Mulga West Borefield area which is also now outside of the Development Envelope (refer to **Section 2.3.3**).

A further six species are considered likely to occur based on historical records, although two species were considered to have a low likelihood based on habitat type – the Night Parrot and the Greater Bilby (**Table 10-5**).

Table 10-5: Conservation Significant Fauna within the Development Envelope (recorded and likely to occur)

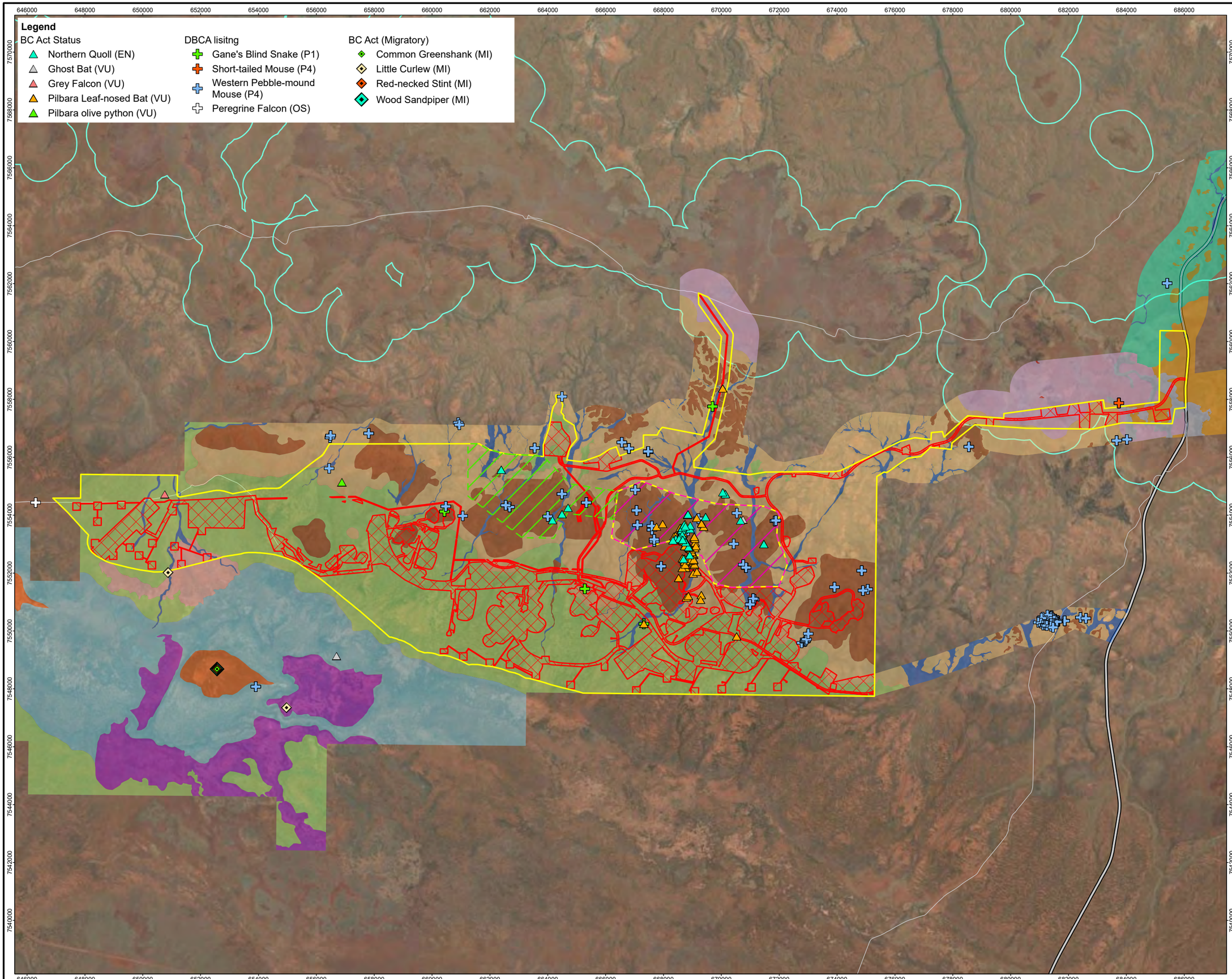
Species		**Conservation Status[1]**		**Occurrence**
Scientific Name	**Common Name**	**BC Act Status**	**DBCA Status**	
Mammals				
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	VU	-	Recorded
Macroderma gigas	Ghost Bat	VU	-	Recorded
Dasyurus hallucatus	Northern Quoll	EN	-	Recorded
Pseudomys chapmani	Western Pebble-mound Mouse	-	P4	Recorded
Dasycercus blythi	Brush-tailed Mulgara	-	P4	Likely
Leggandina lakedowensis	Northern Short-tailed Mouse	-	P4	Likely
Macrotis lagotis	Greater Bilby	VU	-	Likely (Low)
Birds				
Falco hypoleucos	Grey Falcon	VU	-	Recorded
Falco peregrinus	Peregrine Falcon	OS	-	Recorded
Calidris ruficollis	Red-necked Stint	MI	-	Recorded

Species		Conservation Status[1]		Occurrence
Scientific Name	**Common Name**	**BC Act Status**	**DBCA Status**	
Tringa glareola	Wood Sandpiper	MI	-	Recorded
Tringa nebularia	Common Greenshank	MI	-	Recorded
Plegadis falcinellus	Glossy Ibis	MI	-	Likely
Pezoporus occidentalis	Night Parrot	CR	-	Likely (Low)
Reptiles				
Anilios ganei	Gane's Blind Snake	-	P1	Recorded
Liasis olivaceus barroni	Pilbara Olive Python	VU	-	Recorded
Ctenotus uber johnstonei	Spotted Ctenotus	-	P2	Likely

[1] Biodiversity Conservation Act: P1: Priority One, P2: Priority Two, P3: Priority Three, P4: Priority Four, OS: Other specially protected species, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory.

The species of conservation significance which have been confirmed within the Development Envelope, are discussed in detail in the following sections.

Figure 10-7: Conservation Significant Fauna Recorded in Relation to the Proposal



Legend

Development Envelope
Indicative Footprint
Fauna Habitat Exclusion Zone (FHEZ)
FHEZ Corridor

Priority Ecological Communities (DBCA)

Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

Boulder Piles
Calcrete Stony Plain
Chenopod/ Cracking Clay Floodplain
Claypan
Cracking Clay
Drainage Lines/Floodplains
Gibber Cracking Clay
Hilltops, Mesas & Outcrops
Mixed Eucalypt/ Mulga Floodplain
Mulga Woodland
Rocky Hills
Rocky Plains & Footslopes
Snakewood
Stony Spinifex Plains and Hillslopes
Cleared/Disturbed

Roads (LGATE-195)

Highway
Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

BC Act Status
- Northern Quoll (EN)
- Ghost Bat (VU)
- Grey Falcon (VU)
- Pilbara olive python (VU)

DBCA lisitng
- Gane's Blind Snake (P1)
- Western Pebble-mound Mouse (P4)
- Peregrine Falcon (OS)

BC Act (Migratory)
- Common Greenshank (MI)
- Little Curlew (MI)
- Red-necked Stint (MI)
- Wood Sandpiper (MI)

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communties (DBCA)
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

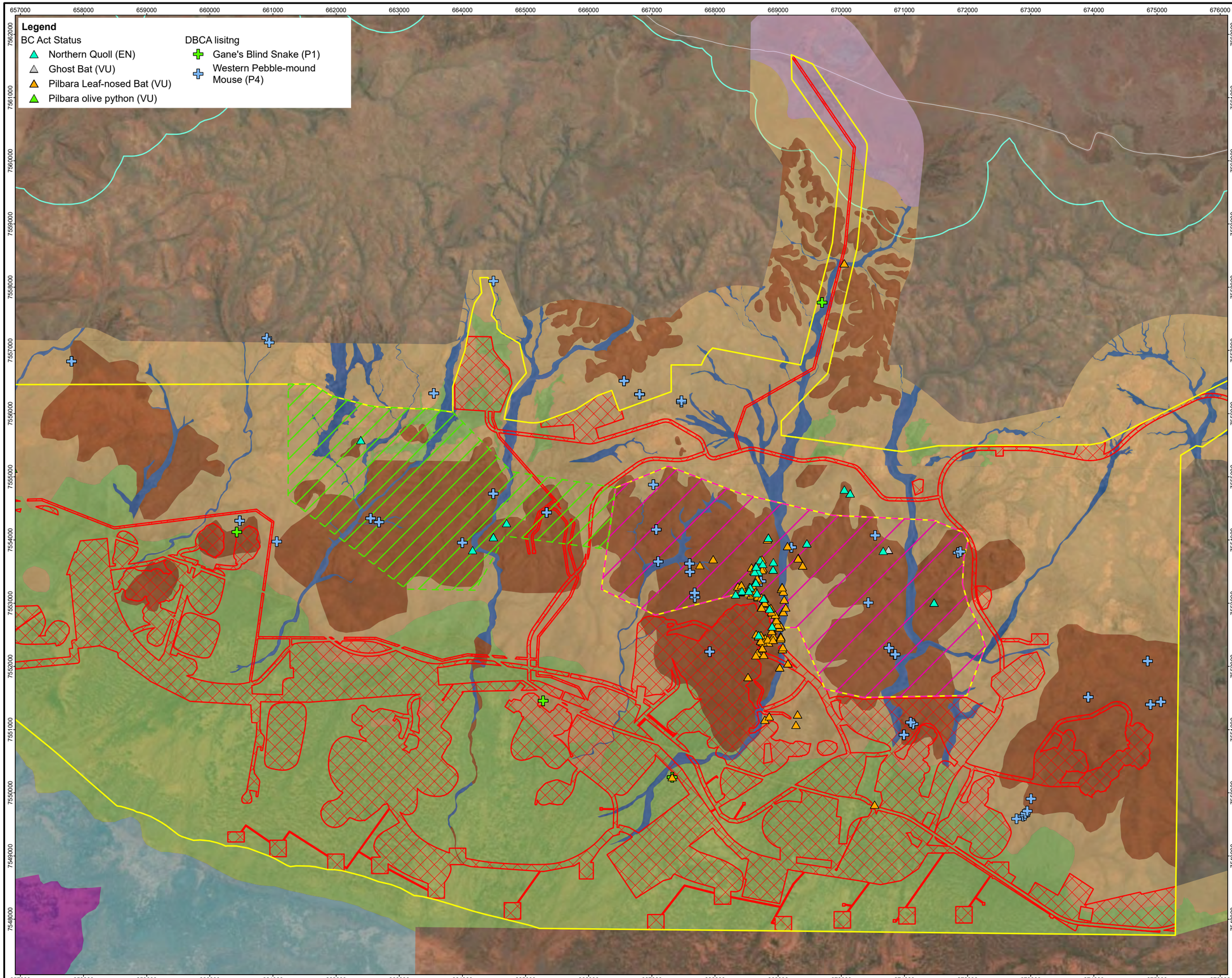
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 2 of 4

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Image Reference: World Imagery: Earthstar Geographics



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

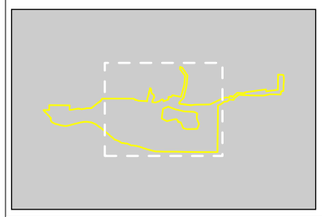
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

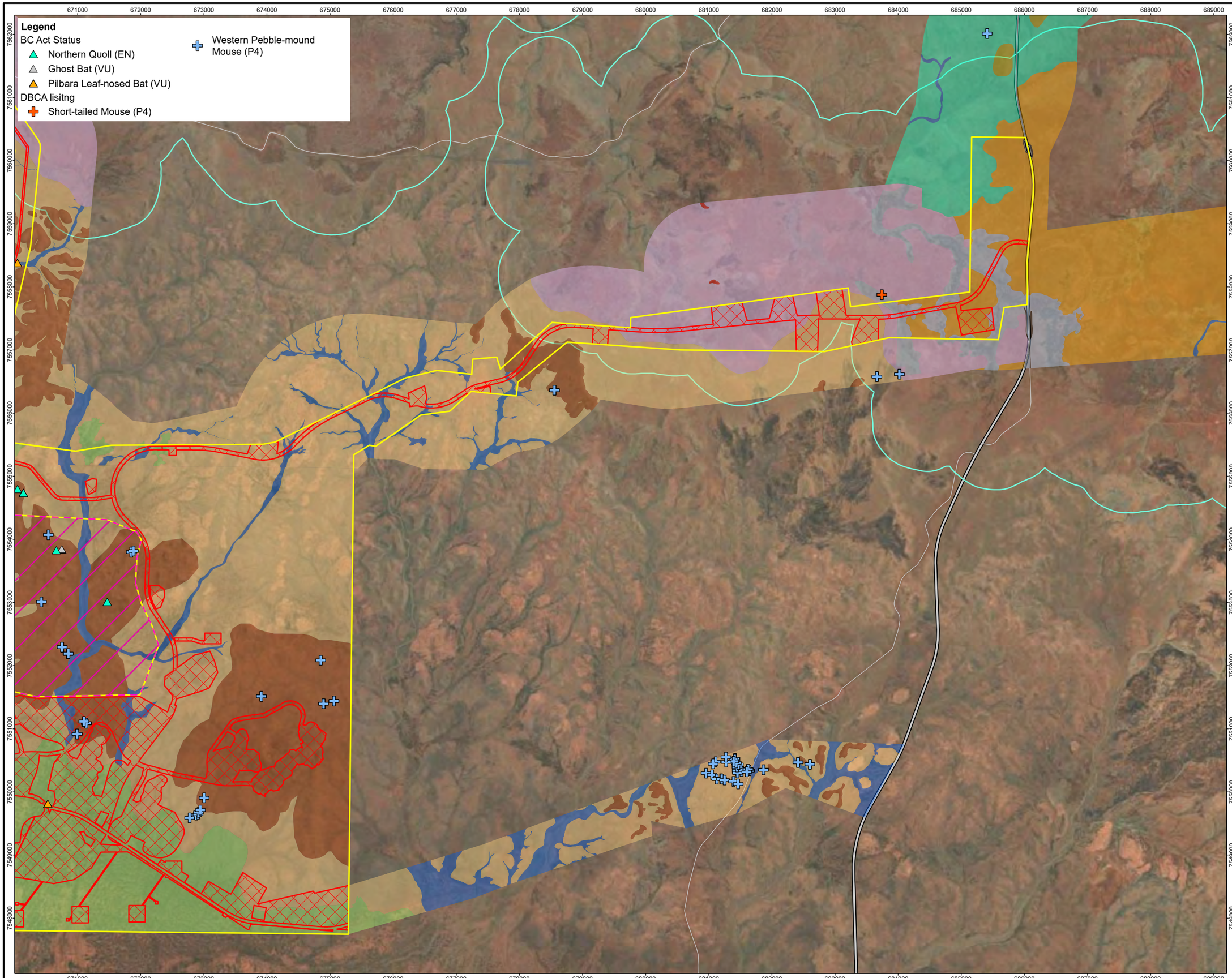
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

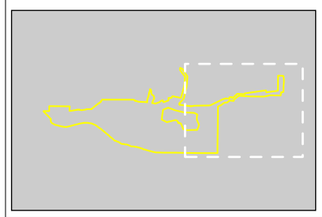
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

10.3.3.1 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form))

Conservation Status: BC Act, Vulnerable

Distribution, Habitat and Ecology

The Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form*)* is the Pilbara form of the orange leaf-nosed bat and is listed as Vulnerable under the EPBC Act and BC Act. While it is considered a separate form, formal reclassification has been hampered by the small size of the Pilbara population which appear morphologically similar to the northern form (Armstrong 2008).

This small, insectivorous bat occurs throughout the Pilbara and adjacent upper Gascoyne regions of Western Australia (Threatened Species Scientific Committee 2016a). The species was listed as Vulnerable in Western Australia in April 2001 as it had undergone a substantial reduction in numbers, its geographic distribution is precarious for its survival (being limited to the Pilbara), the estimated total number of mature individuals is limited, and this number is likely to continue to decline (Threatened Species Scientific Committee 2016a).

The Pilbara leaf-nosed bat has specific and very restrictive roost requirements including caves, adits and disused mines with hot to very hot (28-32˚C) and humid (96-100%) microclimates (Armstrong 2001); (Churchill et al. 2008). Individuals rapidly dehydrate and die within a short period of time if removed from their roost (Bat Call 2016). During the dry season, prior to the heavy summer rains, Pilbara leaf-nosed bat colonies are believed to contract to the deepest mines and caves that maintain microclimates suitable for roosting (Armstrong 2001; Van Dyck and Strahan 2008; Bullen and McKenzie 2011).

At dusk, Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies, and large watercourses for insects (Van Dyck & Strahan 2008). The Pilbara Leaf-nosed Bat is a highly acrobatic flyer which is capable of intercepting prey in the air (McKenzie & Bullen 2009) and are commonly encountered over small pools of water in rocky gullies and gorges (*ecologia* 2023a).

Mating occurs in July and females give birth to a single pup in late December/early January, and young are weaned and independent by late February/March (Churchill, 1995; Armstrong, 2001). The Pilbara leaf-nosed bat is known to travel large distances (e.g., up to 45 km from diurnal roosts to forage; Bullen, 2023) with one male travelling more than 170 km over 12 months (Bullen and Reiffer, 2020). Genetic studies have identified some evidence of female philopatry (Armstrong, 2006; Umbrello *et al*., 2022). The Pilbara Leaf-nosed Bat is relatively long-lived, with an estimated life span of eight to ten years (Umbrello *et al*., 2022).

Permanent diurnal roosts have been detected throughout most of the Chichester and Hamersley subregions of the Pilbara, with a small number also found in the nearby Ashburton (south) and Little Sandy Desert (east) bioregions (Bat Call WA, 2021b). Colony members begin to depart their roosts (cave or mine adits) at, or soon after, dusk civil twilight and, except for the coldest winter months, the last individuals arrive back to the roost just prior to the dawn civil twilight (Bullen and Reiffer 2021).

Foraging in a variety of habitats including the characteristic *Triodia* hummock grasslands of the Pilbara, the Pilbara Leaf-nosed Bat favours the highly productive and structurally complex riparian zones where water is permanently available and insect biomass is sufficiently high (Armstrong, 2001; McKenzie and Bullen, 2013). Females are highly dependent on foraging habitat within close proximity to maternal roosts, especially during

lactation (Woinarski *et al*., 2014). As such, diurnal roost sites (deep caves within banded ironstone strata and disused underground copper/gold mines; McKenzie and Bullen, 2013) are typically located within flying range (i.e., 5-7 km) of permanent water (Bullen 2023). Seasonal variation in intra-regional presence, corresponding with lower temperatures and higher humidity (i.e., April/May), has also been documented with bats travelling > 20 km from permanent diurnal roosts to occupy non-permanent roost caves (Bat Call WA, 2021b).

At least 10 caves and underground mine sites in the Pilbara have been confirmed as permanent diurnal roost locations (Category 1) and in some cases these roosts also function as breeding sites (DCCEEW 2016b).

Bat Call (2021b) has since modified the 2016 conservation advice for this species, and underground refuges used by Pilbara Leaf-nosed Bat can be placed into the below categories:

- Permanent diurnal (categories 1 and 2) roosts

Category 1 permanent roosts are maternity roosts where seasonal presence of young is proven. These often have large colonies present. Category 2 permanent roosts are occupied year-round but without the proven presence of young. Based on wet season presence, these must also be classed as maternal sites, and these often have smaller colonies present. Both categories are considered as critical habitat that is essential for the daily and long-term survival of the Pilbara Leaf-nosed Bat.

- Semi-permanent diurnal (category 3) roosts

These are used diurnally during some part of the year, but not occupied year-round. They may be used during the breeding cycle and may facilitate long distance dispersal in the region, particularly in the autumn. They are often associated with a nearby Category 1 or 2 permanent roost as a ‘satellite’ roost, that together make up a colony. They are considered as critical habitat that is essential for the long-term survival of the Pilbara Leaf-nosed Bat.

- Nocturnal refuge (category 4) roost

These are occupied or entered at night for resting, feeding, or other purposes, with perching not a requirement. These are not considered critical habitat but are important for persistence in a local area. Most moderately deep caves and shallow abandoned mines fall into this category.

The nearest known Pilbara Leaf-nosed Bat roost locations to Proposal is at Rio Tinto Iron Ore’s Koodaideri mine, approximately 70 km to the south-east. The Mt Webber roost is approximately 80 km to the north-east of the Proposal. There is a Category 1 or 2 roost in the vicinity of Wittenoom (as shown in Figure 1, Bat Call (2021b)) approximately 25 km -35 km to the southwest of the Development Envelope (*ecologia* 2023a).

- Foraging habitats

The Pilbara Leaf-nosed Bat has been observed foraging in a variety of habitats such as *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (DCCEEW 2023b).

Seasonal variation in intra-regional presence, corresponding with lower temperatures and higher humidity (i.e., April/May), has also been documented with bats travelling > 20 km from permanent diurnal roosts to occupy non-permanent roost caves (Bat Call WA, 2021b). Given the lack of understanding around which habitats are

necessary to sustain a roosting colony, it is difficult to define the specific critical foraging habitat for the species (DCCEEW 2016b). According to the Conservation Advice for the Pilbara Leaf-nosed Bat, foraging habitats are categorised as follows:

- Gorges with pools (Priority 1)—watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months, sites of relatively large biomass production, sometimes containing caves.
- Gullies (Priority 2)—primary drainage with limited riparian development in upland rocky habitats, sometimes containing small pools that may last for weeks, with less biomass production than Priority 1 gorge habitat.
- Rocky outcrop (Priority 3)—areas of exposed rock at the top of rocky outcrop and mesa hills that contain caves and overhangs, and boulder piles in the granite terrains.
- Major watercourses (Priority 4)—riparian vegetation on flat land plus the main gravelly or sandy channel of the riverbed, sometimes containing pools that persist for weeks or months, and generally supporting higher productivity of biomass than the surrounding habitats.
- Open grassland and woodland (Priority 5)—dominated by *Triodia,* on lowland plains, colluvial slopes and hilltops.
- This species is most commonly encountered over small pools of water in rocky gullies and gorges (refer to Attexo 2023).

Surveys

Surveys completed for the Proposal targeting the Pilbara Leaf-nosed Bat included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- *ecologia* (2021b) Mulga East Pilbara Leaf-nosed Bat Assessment (**Appendix 11a. 2**);
- Biologic (2022a) Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey (**Appendix 11f**).

Additionally, a desktop risk assessment was prepared by *ecologia* (2023a) (**Appendix 11h**) to confirm the classification of bat caves - confirming the presence or absence of any Category 1, 2, or 3 caves within or immediately adjacent to the Development Envelope.

Prior to this several additional surveys were undertaken by *ecologia* with peer reviews and advice provided by Bat Call and Specialized Zoological after analysis of the acoustic recordings to address the possibility of a Category 1 roost in the Development Envelope. The surveys included multiple basic, detailed, and targeted survey events conducted between April 2019 and March 2022. These surveys were undertaken according to State and Commonwealth guidelines and best practice methods. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA,

2016a). Surveys undertaken for the first year of the *ecologia* (2021b) survey program were prior to the release of the currently accepted Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020), and were therefore undertaken in accordance with EPA (2016a). All other surveys by *ecologia* (2021b), and the Biologic (2022a) survey program were conducted using methodologies from the latest Guidance.

SongMeters (SM2) ultrasonic bat recorders were deployed at each systematic trapping site and at prospective foraging and or roosting locations (caves) potentially utilised by bat species throughout the Development Envelope. These Autonomous Recording Units (ARUs) have a high sampling frequency, enabling the full spectrum of bat calls to be recorded without being transformed, allowing greater accuracy and sensitivity. Omnidirectional microphones were used on all devices and placed 1m off the ground in open habitats and pointing at cave entrances or inside caves (*ecologia* 2023a). Bat calls were provided to R. Bullen of Bat Call for analysis and reporting (Bat Call reports #1, #2 and #3 in *ecologia* 2021a). The data was also reviewed by Dr Kyle Armstrong and a report prepared (Appendix K in *ecologia* 2021a).

Cave habitat assessments were completed and any potential Pilbara Leaf-nosed Bat roost caves within the Mulga East portion of the Development Envelope were evaluated. These assessments included a review of the cave morphology, geology, and the condition of the caves to identify which were potentially suitable for ghost bats as maternity and/or roost caves (*ecologia* 2021b). These surveys were undertaken prior to the publication of Bat Call (2021) however the methods align with those outlined in the survey requirements recommended in this guidance document. All surveys were undertaken according to the survey guidelines for Australia's threatened bats (DEWHA 2010a) and were peer reviewed by Dr Kyle Armstrong (Appendix K in *ecologia* 2021a).

An Unmanned Aerial Vehicle (UAV) was used to identify potential cave habitat within Rocky Hills over the extent of the Development Envelope, and subsequently traversed on foot to undertake cave habitat assessments with the aim of outlining potentially suitable roosting caves for the Pilbara leaf-nosed bat (*ecologia* 2023a).

Long-term bat detectors (deployed for between 76-79 consecutive recording nights) were established at one cave (MEC016) and five sites (not cave entrances) to determine continued presence of this species (*ecologia* 2023a).

The total survey effort undertaken for the Pilbara Leaf-nosed Bat (*ecologia* 2021b) and Biologic (2022a) included:

- recording echolocation calls using ARUs at 268 sites over 577 recording nights;
- 107 kms of UAV flights;
- 82 cave habitat assessments; and
- long-term bat detectors at six sites.

The survey effort is considered adequate as the Development Envelope has been surveyed over multiple seasons six months apart and the detector nights far exceeded the minimum requirements.

Occurrence in the Development Envelope

Pilbara Leaf-nosed Bats calls were recorded consistently across all surveys and seasons. The consensus of these studies was that Pilbara Leaf-nosed Bats were likely present in the Development Envelope year-round, but that

there were likely no permanent roosts (Category 1, 2 or 3 roosts). All echolocation recordings were analysed by bat specialists Dr Kyle Armstrong and Bob Bullen. A review of surveys, interpretations of presence, and the use of caves by Pilbara Leaf-nosed bats was undertaken by Dr Kyle Armstrong (Specialised Zoological 2023).

During extensive searches for a potential permanent roost (Category 1 or 2 caves), 82 structures were found and 51 considered to be potential Category 4 roosts (occupied or entered at night for resting, feeding or other purposes). Pilbara Leaf-nosed Bats were recorded at 22 of them (**Figure 10-8**). Of the 51 caves, 36 Category 4 Nocturnal Roosts which have been identified as suitable for the Pilbara Leaf-nosed Bat are located within the FHEZ, and a further six are located in the FHEZ corridor. All caves with the potential to be used as a diurnal roost have been surveyed and there is no evidence to suggest a Category 1, 2 or 3 diurnal roost is present within the Development Envelope (*ecologia* 2023a). Several additional targeted surveys were completed by *ecologia* (2021b) to assess if a Category 1 roost existed close to the cave MEC016 (refer to *ecologia* 2023b). The source of the Pilbara Leaf-nosed Bats within the MDIOM remains nebulous, with the likelihood that there is a roost within approximately 40 km that foraging bats may fly from the home roost (Bat Call WA 2021). Without a permanent roost, the bats that are year-round but infrequent visitors are likely using the MDIOM as a foraging area or transiting through the MDIOM to or from the (assumed) nearby roost.

Habitat considered critical for this species includes Category 1, 2 or 3 roosts, as defined in Bat Call WA (2021b). Foraging habitat within 10 km radius of Category 1, 2 or 3 caves is also considered critical as is any permanent water source within 5 km – 7 km (according to literature, refer to Northover et al 2023).

Considerable survey effort undertaken within the Development Envelope has failed to locate permanent water sources within the area (Priority 1 habitat). Semi-permanent water sources within creek lines (small pools) may be found within the area following rain that may persist for weeks or months (*ecologia* 2023a).

No habitat considered to be critical for the survival of the Pilbara Leaf-nosed Bat was identified in the Development Envelope. Gorges bounded by sheer rock walls containing water lasting weeks or months typical of the Wittenoom and Karijini gorges are considered to be Priority 1 foraging habitat (TSSC 2016) are absent from the Development Envelope. Rocky Hills within the Development Envelope support Priority 2 and Priority 3 foraging habitat, while Drainage Lines/ Floodplains support Priority 4 foraging habitat and Stony Spinifex Plains and Hillslopes and Mulga Woodlands support Priority 5 foraging habitat. A semi-permanent channel pool (water lasting up to 3 months) was noted during the Biologic 2022 survey and is shown in **Figure 10-8**. It lies outside of the Development Envelope within Drainage Lines/Floodplain habitat.

These habitat types are considered widespread in the Development Envelope and in a regional context (in Attexo 2023; Spectrum 2023a). Regular detections in all seasons within the target valley indicate that the Drainage Line/Floodplains are a preferred commuting and foraging area and considered high priority foraging habitat (*ecologia* 2021b), though no Category 1, 2 or 3 roosts were detected and therefore they are not considered critical. This is consistent with other studies in the Pilbara (Northover et al. 2023).

10.3.3.2 Ghost Bat (*Macroderma gigas*)

Conservation Status: BC Act, Vulnerable

Distribution, Habitat and Ecology

The Ghost Bat is the largest Microchiroptera bat in Australia, is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (Van Dyck and Strahan 2008). It has a patchy but widespread distribution across northern Australia.

In the past decade, surveys for environmental impact assessments (Bullen 2021) have indicated a Pilbara Ghost Bat population of approximately 1,850 (350 across the Hamersley Range and 1,500 across the eastern Pilbara) (Bat Call 2021a).

Armstrong and Anstee (2000) suggested that Ghost Bats occur in small groups within the Hamersley Ranges and may move about in a local area, possibly in response to disturbance, microclimate, or social factors. Most shallow caves, shelters, and deep overhangs in the Pilbara are used in at least an opportunistic manner by itinerant Ghost Bats and are considered as Category 4 refuges (*ecologia* 2023a).

Preferred roosting habitat in the Pilbara includes caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles (Woinarski et al. 2014). Ghost Bats have also been known to roost in large colonies within sandstone caves, under boulder piles and in abandoned mines (Churchill 1998). They disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop 1985, JBS&G 2022). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong & Anstee 2000).

There are no species-specific policy guidelines on what constitutes habitat critical to the survival of the Ghost Bat, or what is defined as an important population; however, the conservation advice for the species indicates that persistence of the species in the Pilbara depends on the physiologically benign day roosts found deep underground in humid, temperature stable caves (TSSC 2016a).

Suitable roosts are rare and the presence of active roosts in an area is considered by DCCEEW to be the most important indicator of habitat for Ghost Bats. These roosts are generally the primary focus of conservation and/or monitoring (DoE 2015b). Ghost Bats utilise and require a group of caves/shelters including maternity, day and night roosts that open onto a plain or riparian line that provides good foraging opportunities. Night roosts (or feed caves) are used at night, either habitually or for transitory visits. They are often high in the strata and are typically shallow, poorly insulated caves and shelters that are well lit during the day. The Ghost Bat hunts at night and uses night roosts to consume prey it has captured in the surrounding area. These caves often contain Ghost Bat scats and/or feeding remnants (typically feathers and small animal bones). Day roosts are caves and disused mines that contain domed ceilings and are deeper and more complex than night roosts. They typically have one or more large chambers with additional fissures or chambers at the rear in the fully dark regions. They have a minimum roof height in the chambers of 2 m to 3 m providing protection from attack by terrestrial predators. They are often at mid-levels or lower in the strata, making them well insulated. The stable temperature and elevated humidity of these caves relative to the ambient conditions create physiologically benign conditions. Day roosts can vary in importance from almost continued use to occasional use by small numbers of Ghost Bats (DoE 2015b).

Maternal roosts are day roosts that usually include an interior chamber that rises toward the rear trapping warmer, more humid air at the top. Maternal roosts generally have a stable temperature of 23°C to 28°C and moderate to high relative humidity.

The Ghost Bat has previously been recorded on 13 occasions in the vicinity of the Proposal according to DBCA data. There is anecdotal evidence of a known roost occurring approximately 30 km south of the Development Envelope across the Fortescue Valley, near Wittenoom in the Hamersley Ranges (Bob Bullen pers. comm in *ecologia* 2023a).

In some parts of its range, the Ghost Bat shares roosts with the Pilbara leaf-nosed Bat, Finlayson's Cave Bat (*Vespadelus finlayson*), Common Heath-tailed Bat (*Taphozous georgianus*), and possibly Hill's Sheath-tailed Bat (*Taphozous hilli*) (DCCEEW 2023e). Ghost Bats are known to move between several caves seasonally or as dictated by weather conditions (Hutson et al. 2001) and disperse widely when not breeding but concentrate in a relatively few roost sites when breeding (DCCEEW 2016a).

The Ghost Bat is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (van Dyck and Strahan 2008). Ghost Bats are surface foragers ambushing prey either on the ground or in the air (Woinarski et al. 2014). Hunting behaviour within foraging areas consists of observing and locating prey from stationary vantage points with brief flights to catch prey before intermittently changing vantage point (Tidemann et al. 1985).

There is currently little confirmed data on foraging habitat. Bat Call (2021a) notes research that indicates Ghost Bats can forage up to 12 km from their diurnal roosts. Bats transiting to distant sites have been recorded between 20 and 30 km from their diurnal roost in a night. The available GPS/satellite data (Bullen unpublished data in Bat Call 2021a) suggest that the bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground. Isolated trees and trees on the edge of thin thickets on the plains, or trees along the edges of watercourse woodlands, appear to be preferred vantage points.

Extensive survey activity in the last decade has led to four proposed categories of roosting habitat used by Ghost Bats in the Pilbara region which are defined in the Bat Call (2021a) *A review of ghost bat ecology, threats and survey requirements*. These categories are:

- Category 1 maternity/diurnal roost sites with permanent Ghost Bat occupancy

There are several documented permanent roost caves and underground mines in northern Australia. These tend to have large but fluctuating populations (Bat Call 2021a). In the Pilbara, other than the large colonies (>100 individuals) in a number of historical underground mines for example, Klondyke Queen, Lalla Rookh and Bamboo Creek, very few such roosts in natural caves are documented. Usually, these caves are deep and dark, with one or more elevated roosting chambers that provide a stable microhabitat. Caves with proven permanent presence must all be assumed to be maternity caves, a source population for the surrounding district. They are therefore critical habitat for the ongoing presence of Ghost Bats in the area (Bat Call 2021a).

- Category 2 maternity/diurnal roost caves with regular occupancy

There are a number of Pilbara caves and adits where Ghost Bats have regular, but not continuous, presence over long periods. These caves have similar features as Category 1 caves but are often less complex with only a single inner chamber and are often in less productive areas that the bats only utilise periodically. These caves typically have several other caves, shelters, and overhangs within a few hundred meters. Together they make up an 'apartment block' grouping that supports the ongoing presence of the bats (Bat Call 2021a).

- Category 3 diurnal roost caves with occasional occupancy

There are many caves and adits where one to a few Ghost Bats roost occasionally, or rarely. Normally less well-developed structures, such places are often used as feeding sites (as evidenced by middens with food scraps) or temporary refuges. Surveys in recent years have identified numerous caves that have Ghost Bat scats or small food middens present but either no evidence of roosting bats or with rarely repeated presence observations (Bat Call 2021a).

When adjacent to Category 2 caves, these are considered to be a part of an 'apartment block' and are therefore critical habitat important for the ongoing presence of the species in the area. In contrast, isolated Category 3 caves are not considered critical habitat. However, these caves may enable the long-distance movement of individuals across a landscape, and therefore contribute to genetic exchange between neighbouring colonies (Bat Call 2021a).

- Category 4 nocturnal roost caves with opportunistic usage

Numerous observations suggest that the majority of shallow caves, shelters and deep overhangs in the Pilbara are used in at least an opportunistic manner by itinerant Ghost Bats. This may be anything from a single foraging visit to a longer visit, with a resting period or possibly a feeding session. Evidence of such visits is the widespread presence of small numbers of scats and/or food scraps found, or occasional echolocation calls recorded during surveys. These visits may or may not be repeated, depending on whether the bat is passing through a district or is a more permanent resident nearby. These are not considered critical habitat (Bat Call 2021a).

Surveys

Surveys completed for the Proposal targeting the Ghost Bat include:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a**); this assessment includes:
  - Phase 1 - Level 2 vertebrate fauna survey: 4- 16 April 2019
  - Phase 1 - Targeted conservation significant fauna survey: 22 - 30 July 2019
  - Targeted Pilbara leaf-nosed bat survey: 25 November to 2 December 2019
  - Long-term Pilbara leaf-nosed bat survey December 2019- March 2020
  - Phase 2 – Level 2 vertebrate fauna assessment: 14 – 27 April 2020
  - Phase 2 - Targeted conservation significant fauna survey: 29 June - 6 July 2020
  - Targeted Pilbara leaf-nosed bat Survey: 5 - 9 October 2020
  - *ecologia* (2021b) Targeted Pilbara leaf-nosed bat Gap Survey: 5 - 9 March 2021;
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Spectrum (2023a) MDIOM Solar Farm, Haul Road & Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and

- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

The surveys included multiple basic, detailed, and targeted survey events between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken for the first year of the *ecologia* (2021b) survey program were conducted prior to the release of the currently accepted '*Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment*' (EPA, 2020), and were therefore undertaken in accordance with EPA (2016a). All other surveys by *ecologia* (in 2021a), and the Biologic (2022a) survey program were conducted using methodologies from the latest Guidance.

SM2 ultrasonic bat recorders were deployed at each systematic trapping site and at prospective foraging and or roosting locations (caves) potentially utilised by bat species throughout the Development Envelope. These ARUs have a high sampling frequency, enabling the full spectrum of bat calls to be recorded without being transformed, allowing greater accuracy and sensitivity. Bat calls were analysed by suitability qualified ecologists to determine which species were present within the Development Envelope (Attexo 2023).

A UAV was used to identify potential cave habitat within the Rocky Hills habitat type over the extent of the Development Envelope, and these areas were subsequently traversed on foot to assess cave habitat with the aim of outlining potentially suitable roosting caves for the Ghost Bat. These assessments included a review of cave morphology, geology, and cave conditions to narrow down the list of potential Ghost Bat maternity and/or roost caves (*ecologia* 2021b; 2023a).

Long-term bat detectors (deployed for between 76 to 79 consecutive recording nights) were established at one cave (MEC016) and five sites (not cave entrances) to determine continued presence of this species (*ecologia* 2023a). All caves with the potential to be used as roost sites have been surveyed using ARUs. The total survey effort undertaken for the Ghost Bat by *ecologia* (2021b), Biologic (2022a,b) and Spectrum (2023a; 2024b) included:

- Recording echolocation calls using Acoustic Recording Units (ARUs) at 299 sites over 831 recording nights;
- 107 km of UAV flights;
- 82 cave habitat assessments; and
- Long-term bat detectors at six sites.

A further desktop assessment was prepared by *ecologia* (2023a) and addressed the requirement to categorise all the caves within the Development Envelope (**Appendix 11h**). A comprehensive review of the long-term data collected at MEC016 was conducted by Specialised Zoological (2021b, 2023) and included in *ecologia* (2023a).

The survey effort is considered adequate as the Development Envelope has been surveyed over multiple seasons, six months apart.

Occurrence in the Development Envelope

Ghost Bat calls were recorded at one site (MDARU27) within the Mixed Eucalypt/Mulga Floodplain habitat type located in the Fortescue Valley (**Figure 10-9**). This area is not in the Development Envelope. Secondary evidence (such as feeding debris, scats) of the Ghost Bat was found at two sites (MEC001 and MEC030) (**Figure 10-9**). Both

caves are located within the FHEZ, which is outside of the Development Envelope. MEC001 is considered a Category 4 nocturnal roost with occasional visitation from Ghost Bats. Cave MEC030 is a small cave with no diurnal roosting potential because there were open cracks in the cave ceiling and therefore cave humidity could not be maintained. Cave MEC030 was considered a nocturnal refuge and visitation only occasional. The majority of shallow caves, shelters and deep overhangs in the Pilbara are used in at least an opportunistic manner by itinerant Ghost Bats and are considered to be Category 4 nocturnal roosts (Bat Call WA 2021a). Within the Development Envelope, 51 caves were identified that possessed Category 4 cave attributes and considered to have opportunistic usage.

No known or potential Category 1, 2 or 3 (associated with "apartment blocks") caves exist within the Development Envelope, nor are documented within a 30 km radius. There is anecdotal evidence of roost caves south of the Fortescue Valley within the Hamersley ranges (Bob Bullen pers. comm in *ecologia* 2023a). Ghost Bat occurrence and habitation within the Development Envelope is low with only a few records of this species. A lack of deep caves limits the suitability for diurnal roosting for this species within the Development Envelope (*ecologia* 2023a).

After extensive survey effort, it is considered unlikely that a permanent Ghost Bat roost occurs within the Development Envelope. Previous acoustic surveys conducted to target the Pilbara Leaf-nosed Bat were also analysed for Ghost Bat calls and the absence of calls indicates that a Ghost Bat maternity roost is unlikely to occur within the Development Envelope (*ecologia* 2023a; Attexo 2023). Within the Development Envelope Rocky Hills habitat type is considered potential roosting habitat for the Ghost Bat. Drainage Lines/Floodplain, Stony Spinifex Plains and Hillslopes, Gibber Cracking Clay and Mixed Eucalypt/Mulga Floodplain (now excluded from the Development Envelope) are considered foraging habitat (open grassland and woodland). The record of the Ghost Bat within the Mixed Eucalypt/Mulga Floodplain indicates this species traverses the area (**Figure 10-9**).

Of the 82 cave assessments undertaken, 51 cave structures within the Development Envelope are considered as Category 4 (nocturnal refuges). It is unlikely a permanent Ghost Bat roost site exists.

A temporary water body (identified as a persistent channel pool in AQ2 2024b) was noted within the Development Envelope during a biological survey (Biologic, 2022a) (**Figure 10-9**). Two pools were located immediately adjacent to one another spanning a total length of approximately 40 m with a maximum depth of approximately 0.5 m. These pools are located within the northern infrastructure corridor. Camera traps were placed at this site in 2022 (Biologic, 2022a). A Pilbara Leaf-nosed Bat was recorded visiting the pool on an ARU. No taxa were recorded on any motion cameras. This pool does not fall within the Indicative Footprint and will be retained given the importance of this habitat. The Ghost Bat has the potential to forage in Rocky Hills, Stony Spinifex Plains and Hillslopes, Drainage Lines/Floodplain and Gibber Cracking Clay habitat types within the Development Envelope (**Table 10-6**). However, given the absence of critical roosting habitat and permanent water sources in the Development Envelope, habitats present are considered to be of low value to Ghost Bats.

Figure 10-8: Pilbara Leaf-nosed Bat records and Category 4 nocturnal refuges

659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000

7559000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

MEC016

MEC012

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Fauna habitat

- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Pilbara Leaf-nosed Bat records [ARU]
- Category 4 nocturnal refuges
- MEC012 and MEC016
- Water feature

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:40,000 at A3

0 250 500
Meters

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PILBARA LEAF-NOSED BAT RECORDS AND CATEGORY 4 NOCTURNAL REFUGES

FIGURE 10.8

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World Imagery: Maxar

Figure 10-9: Ghost Bat records and Category 4 Nocturnal Refuges

659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000

7559000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

MEC030

MEC001

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Fauna habitat

- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Ghost Bat (VU) records
- Category 4 nocturnal refuges
- MEC001 and MEC030
- Water feature

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 17-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:40,000 at A3

0 250 500
Meters

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GHOST BAT RECORDS AND CATEGORY 4 NOCTURNAL REFUGES

FIGURE 10.9

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World Imagery: Maxar

10.3.3.3 Northern Quoll (*Dasyurus hallucatus*)

Conservation Status: BC Act, Endangered

Distribution, Habitat and Ecology

The Northern Quoll (*Dasyurus hallucatus* Gould, 1842) is listed as Endangered under the BC Act. The Northern Quoll range once extended continuously across northern Australia from Western Australia to south-east Queensland. The Northern Quoll has been in gradual decline in population density and distribution for the last 50 years. Studies have shown a rapid decline in populations soon after colonisation of an area by cane toads (*Rhinella marina*), deaths attributable to poisoning from consumption of the cane toad (CoA 2016). The Northern Quoll populations are now restricted to five separate land units across the Pilbara, the Kimberley, parts of the Northern Territory and near-coastal Queensland (DCCEEW 2023c). The Pilbara is regarded as the stronghold population for the species as, at present, the desert forms a barrier to the movement of the cane toad into parts of the Pilbara (Woinarski et al. 2014). However, given the progression of the cane toad, strategies are being developed to address their invasion of the Pilbara.

This species is predominantly nocturnal, however can be sighted in daylight hours during their breeding season as well as on overcast days (Oakwood 2008). Mating season is from June to August. At the end of the breeding season, the Northern Quoll population is comprised almost entirely of mature females and their young. Males do not survive to breed a second year, primarily the result of excessive energy expended during roving. Females may live for two or three years (Hill & Ward 2010), though rarely survive to produce a litter in the third year. Females usually raise a litter of up to eight young. Male die-off, in combination with the fact females usually breed only once, makes local populations highly vulnerable to extinction. The most common cause of adult mortality (excluding post-reproduction die-off) is predation by dingoes, foxes, feral cats as well as native predators (snakes, owls, and kites) (Maxwell et al. 1996; Oakwood 2008). In areas infested with cane toads, mortality from cane toad ingestion is now considered as a main cause.

While Northern Quolls do not have highly specific habitat requirements (Hill & Ward 2010), rocky habitats with rock crevices and caves support higher densities of Northern Quoll (van Dyck & Strahan 2008). Predominantly inhabiting dissected rocky escarpments, a male quoll can have a home range of more than 100 ha while a female occupies territories of up to 35 ha (van Dyck & Strahan 2008).

Surveys

A number of surveys to assess the presence of the Northern Quoll were undertaken;

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm, Haul Road & Pipeline: Vertebrate & Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and

- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Additional information on the presence of Northern Quolls within drainage lines which have been identified as their preferred habitat for foraging and dispersal is presented in Spectrum (2024a) Mulga Downs Iron Ore Mine (**Appendix 11f**).

Attexo (2023) *Mulga Downs Iron Ore Mine Consolidated Terrestrial Fauna Report* is a consolidation of the terrestrial fauna surveys undertaken prior to 2023 and included surveys for short-range endemic invertebrates (**Appendix 11c**).

Surveys were scheduled following the season when maximum rainfall typically occurs in the Eremaean September to April as per the EPA *Technical Guidance: Terrestrial Fauna Surveys* (EPA, 2016a). Surveys for the first year of the *ecologia* (2021b) survey program were conducted prior to the release of the currently accepted *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA, 2020), and were therefore completed in accordance with EPA (2016). All other surveys by *ecologia* (2021b), and the Biologic (2022a) survey program were conducted using methodologies from the latest guidance.

A combination of cage traps, motion sensor cameras, and opportunistic searches to detect dens and scats were employed to detect the presence/absence of Northern Quolls as well as to gather an understanding of habitat use and population dynamics (*ecologia* 2021a, Biologic 2022a,b; Spectrum 2024b). To comply with the referral guidelines (CoA 2016), trapping transects along linear rocky ridgelines in the Development Envelope were used to achieve optimal coverage of potential habitat (*ecologia* 2021a).

The *ecologia* (2021a) surveys deployed the use of a UAV to identify potential denning and shelter habitat within the Rocky Hills habitat. The drone covered approximately 107 km searching for prospective Northern Quoll habitat. Once suitable habitat was identified, motion sensor cameras (Reconyx HC500 HyperFire) were baited with sardines and placed in selected areas (*ecologia* 2021a). Survey effort and type are shown in **Figure 10-10.**

Cage traps, consisting of two larger wire-frame box traps were placed at each systematic trapping site and baited with sardines. Traps were cleared within three hours of sunrise each morning (*ecologia* 2021a). Cage traps were covered by hessian shades to reduce the likelihood of animals suffering from overheating, excess stress from being out in the open and protection from predators. All traps were removed following the completion of the systematic trapping program (as summarised Attexo 2023).

Surveys included targeted searches for secondary signs associated with Northern Quolls (tracks and scats etc.) within habitat considered suitable for this taxon. These searches were undertaken as part of the cave habitat assessment and included the placement of motion cameras. Searches were undertaken during each phase of the survey.

Nocturnal searches were undertaken within suitable habitat with the aid of a Pulser Helion XP28 thermal monocular. Thermal imaging scopes use infra-red light to detect heat signatures emitted by endothermic species such as the Northern Quoll. The surveys which included nocturnal searches are summarised in **Table 10-2**.

The total survey effort for the Northern Quoll included:

- Motion sensor camera traps at 132 sites over 5,429 trap nights;

- Cage traps at 50 sites over 385 trap nights;
- Targeted searches, including 229.73 hrs of targeted surveys and 55 hours of nocturnal searches, and 34.8 kms of transect;
- 34.8km of transect length; and
- 107 km of UAV flight pathways.

Occurrence in the Development Envelope:

The outcome of the earlier surveys (2019) recorded only two quolls, one male and one female, which were captured in cage traps on six occasions (*ecologia* 2021a). The motion cameras were triggered by three Northern Quolls on 58 occasions at six locations within the Rocky Hills habitat (**Figure 10-10**). The individuals were identified using spot patterns. The location of Northern Quoll scats is show in **Figure 10-10**.

The rainfall records prior to this survey (from 2017 to 2019) were considered to be below average for the survey area resulting in a low count. Low rainfall is known to impact the size of a Northern Quoll population. No Northern Quolls were detected during the Phase 2 survey despite camera traps being placed at 39 locations within habitat considered suitable for this species. Nocturnal spotlighting did not yield any records. Northern Quoll scats were noted at six locations within the Rocky Hills habitat, three of these locations are in the FHEZ (**Figure 10-10**) (*ecologia* 2021a).

Subsequent surveys in 2021 (Biologic 2022a, b) did not detect the presence of Northern Quolls. The two Phase surveys included targeted searches and camera traps at 25 sites spanning from the far west of the Development Envelope across to the Great Northern Highway.

Targeted searches for the Northern Quoll in March 2023 did not find evidence of Northern Quolls along the northern section of the Development Envelope (Spectrum 2023a). Motion cameras were placed in areas considered suitable; however, none were triggered by Northern Quolls. Targeted searches did not yield any results either (Spectrum 2023a). No Northern Quoll dens were found during any of the terrestrial fauna surveys. Targeted searches along drainage lines and spotlight searches were completed as part of the Bilby targeted survey and opportunistic sightings did not result in any evidence of quolls within the drainage lines (Spectrum, 2024a).

The FHEZ contains 1,320.82 ha of suitable habitat, 950.81 ha of which is Rocky Hills – habitat which is critical to the survival of the Northern Quoll. A targeted survey was commissioned in June 2024 to further assess the presence of the Northern Quoll in the FHEZ (Spectrum 2024b). Rainfall records prior to the survey stated above average which is optimal for the survey (Spectrum, 2024b) (**Appendix 11**).

Northern quolls were detected within the FHEZ on motion cameras and from secondary evidence (scat records) at 10 of the 14 sites. All were in the Rocky Hills and near the Drainage Lines/Floodplains habitat which intersected the Rocky Hills (**Figure 10-10**). According to the Northern Quoll referral guidelines (CoA 2016), a low-density population is characterised by infrequent captures of one or two individuals confined to one or two traps or where no trapping has identified a Northern Quoll, but latrine evidence remains. A high-density population may be characterised by numerous camera triggers by multiple individuals across multiple cameras and/or traps on the site (CoA 2016).

Initially, the population within this area was classified as low density given that only three quolls triggered 58 camera traps (*ecologia*, 2021a). The lack of any further records during subsequent surveys supported this understanding. In 2024, following better conditions, the outcome of a targeted survey was that a potential high-density Northern Quoll population was present. The area which was targeted for this survey was the FHEZ and therefore the Northern Quolls recorded, were concentrated in the area outside of the Development Envelope (refer to Spectrum 2024b). Northern Quolls have been recorded in Rocky Hills habitat within the Development Envelope, and within the Indicative Footprint (**Figure 10-10**). The presence of the Northern Quolls within the FHEZ and in the FHEZ Corridor support the exclusion of these areas for the purpose of mitigating impacts to this MNES. In particular, the FHEZ Corridor comprises habitat critical to the survival of this MNES and supporting habitat such as Drainage Lines/Floodplains and Stony Spinifex and Hillslopes. The FHEZ Corridor also has a number of caves and ridges which are considered critical habitat for the Northern Quoll (Hernandez-Santin et al., 2022).

Critical to the survival of the Northern Quoll is habitat for denning and foraging located within their home range (from 35 ha up to 100 ha during the breeding season). This includes habitat of low rocky hills – such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or tree lined creek lines (CoA, 2016). Within the Development Envelope, the Rocky Hills habitat is considered critical habitat for the Northern Quoll. Approximately 2,658.23 ha of Rocky Hills habitat is present within the Development Envelope. Multiple patches of suitable habitat for this species were identified in the Rocky Hills habitat area which would be considered habitat critical to the survival of this species. These micro-habitats provide shelter for breeding and refuge from fire/predation. Should the Cane Toad invade, this habitat is considered to provide protection to the Northern Quolls (CoA 2016). The Rocky Hills habitat is considered common and widespread throughout the Pilbara (Attexo 2023; Spectrum 2024a).

The Drainage Line/Floodplains habitat provides Northern Quoll populations dispersal habitat. Foraging habitat is recognized to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of shelter habitat, or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (CoA, 2016). Potential foraging/dispersal habitat for the species within the Development Envelope consists of:

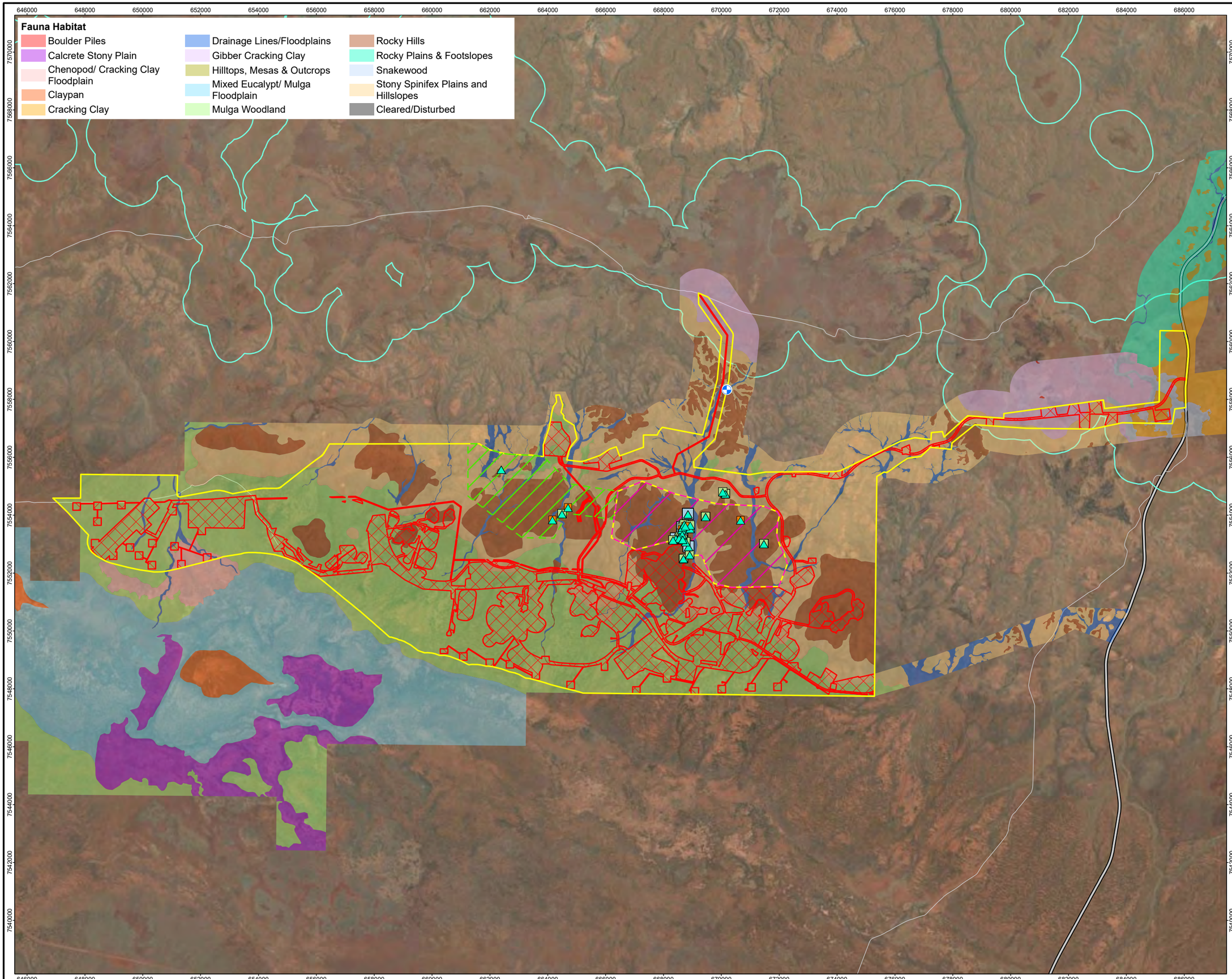
- Drainage Line/Floodplains;
- Rocky Hills; and
- Stony Spinifex Plains and Hillslopes.

The extent of these habitat types and the extent of impact of the Proposed Action on each is provided in (**Figure 10-10).** These habitats are in both the FHEZ and the connecting FHEZ Corridor and extend outside the Development Envelope (**Figure 10-10**). The FHEZ contains 1,320.82 ha of Northern Quoll habitat, 950.81 ha is Rocky Hills habitat intersected by 107.62 ha of Drainage Line/Floodplains and 262.39 ha of Stony Spinifex Plains and Hillslopes habitat.

To further protect the Northern Quoll and avoid fragmentation of the breeding population, the FHEZ Corridor provides a further 991.45 ha of habitat. Of this, 548.14 ha is Rocky Hills habitat. This corridor allows the Northen Quoll to safely disperse form the FHEZ to similar habitat within the Chichester Ranges to the north. In total, over 1,400 ha of Rocky Hills habitat will be preserved for the protection of the Northern Quolls and ensure the

population within the Development Envelope is not isolated from the population in the Chichester Ranges. There are several DBCA long term study sites for the Northern Quoll in the Chichester – one being at Mt Florance Station (Dunlop et al., 2018) which is the neighbouring pastoral station to Mulga Downs.

Figure 10-10: Northern Quoll records and Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature
- Northern Quoll (EN) records

Observation method

- Scat
- Cameras (motion)
- Cage traps

Roads (LGATE-195)

- Highway
- Minor Road

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Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics

Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Northern Quoll (EN) records

Roads (LGATE-195)

- Minor Road

JBS&G

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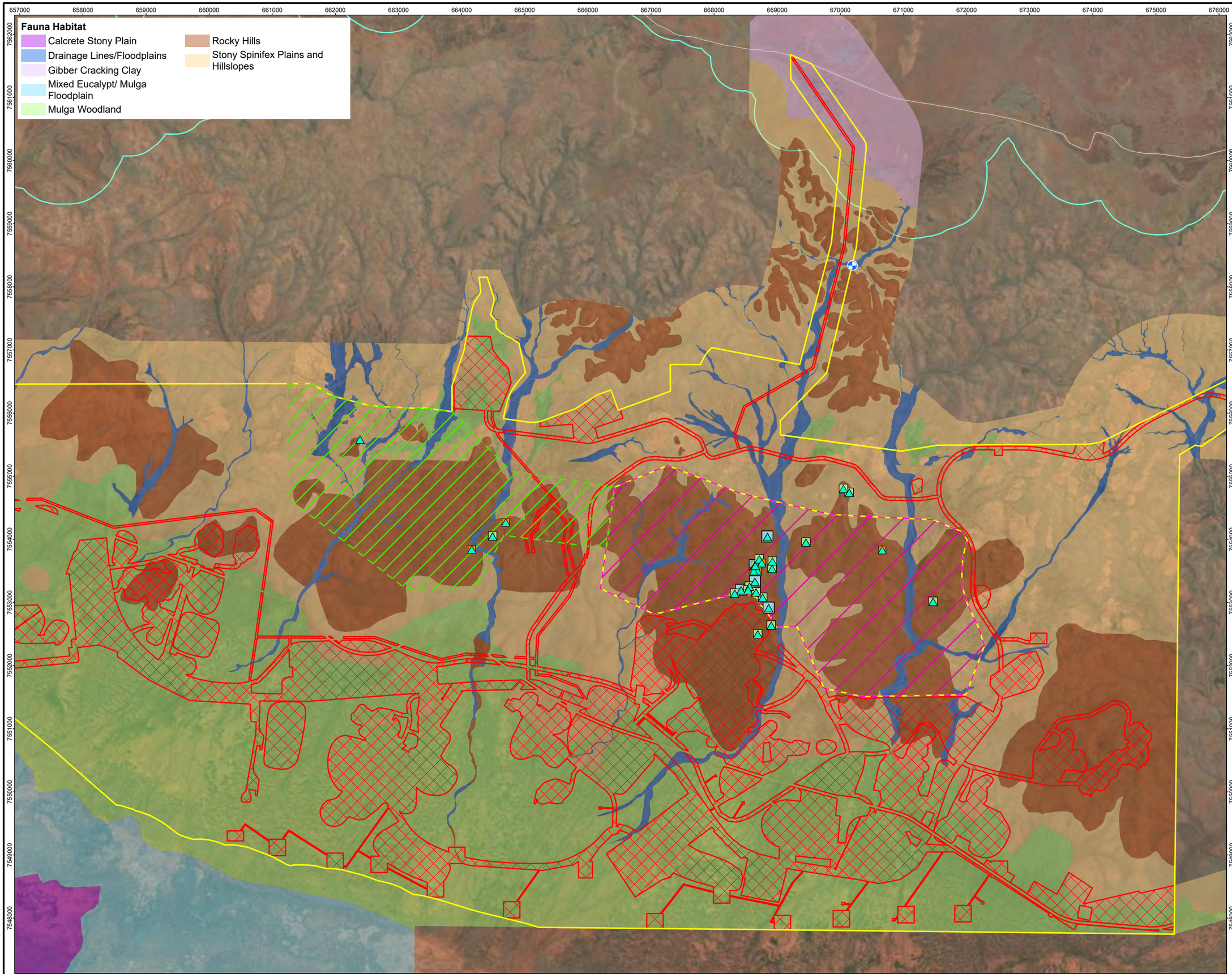
Coord. Sys. GDA2020 MGA Zone 50

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NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 2 of 4

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Image Reference: World Imagery: Earthstar Geographics



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature
- Northern Quoll (EN) records

Observation method

- Scat
- Cameras (motion)
- Cage traps

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
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Scale 1:55,000 at A3

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Coord. Sys. GDA2020 MGA Zone 50

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Central Pilbara, Western Australia

NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 3 of 4

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Image Reference: World Imagery: Earthstar Geographics

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature
- Northern Quoll (EN) records

Observation method

- Scat
- Cameras (motion)

Roads (LGATE-195)

- Highway
- Minor Road

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
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Scale 1:55,000 at A3

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Coord. Sys. GDA2020 MGA Zone 50

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NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics

10.3.3.4 Greater Bilby (*Macrotis lagotis*)

Conservation Status: Vulnerable, BC Act

Distribution, Habitat and Ecology

The Greater Bilby (*Macrotis lagotis*) is a medium-sized, omnivorous, nocturnal burrowing marsupial with a long tail and distinctive big ears. The species is distinguished by its large rabbit-like ears, silky blue-grey fur, and long black tail with a furred white tip (Johnson, 2008). Weighing between 0.8 kg to 2.5 kg and measuring up to 550 mm in length (head and body), Bilbies have strong forelimbs for digging and construct complex burrow systems for shelter (Johnson, 2008). The Bilby is considered an ecosystem engineer (Fleming *et al*., 2014), with their foraging enhancing soil health and plant productivity (Chapman, 2013) and their (used/disused) burrows providing important refuge sites for other fauna (Hofstede and Dziminski, 2017).

Throughout most of its range, the distribution of Bilby is patchy and often occurs in low abundance (Southgate et al. 2007). The Bilby will utilise multiple burrows throughout its range. Bilbies occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils which are typically sandy, for burrow excavation. The Bilby suffered a sudden and widespread population crash in the early 20th Century and is now confined to the driest and least fertile parts of its former range, and its distribution is negatively correlated with foxes (Southgate 1990). Population monitoring in the Pilbara, Kimberley and central desert regions indicates that wild Bilby populations are small, comprising roughly 2-15 individuals (DBCA, 2018; Dziminski *et al*., 2020a; DBCA, 2021b); wild populations in the Pilbara are isolated and distinct (Dziminski *et al*., 2020a) (DCCEEW 2018a).

Capable of breeding throughout the year, Bilbies typically raise no more than two young, which remain attached to the teat for approximately 80 days prior to deposition in a burrow. Young stay in the burrow for around two weeks before weaning (Johnson 2008). Bilbies are cryptic and generally solitary (Bradley *et al*., 2015), with reported low site fidelity (Southgate *et al*., 2007). In the wild, Bilbies are relatively short-lived, with a generation length of approximately four years (Woinarski et al., 2014). Bilbies can be highly mobile with variable home ranges, particularly males (Bradley et al., 2015).

Bilbies occupy a range of habitats including open tussock (*Triodia* spp.) grassland on uplands and hills; mulga (*Acacia aneura sens. lat.*) woodland/shrubland growing on ridges and rises; and hummock grassland on plains and in alluvial areas (Woinarski et al. 2014). Bilby distribution is limited by the availability of soils suitable for burrowing, such as sandy areas, where burrow excavation is easier (Southgate 1990; Moseby & O'Donnell 2003; Dziminski and Carpenter 2016).

In the north of Western Australia, suitable habitat for the Bilby includes woodlands (<10 m) with *Eucalyptus* and *Acacia* spp., Pindan woodlands with hummock and tussock grass, on coarse sand to light medium clay; low shrub cover of *Acacia* spp. over hummock and tussock grasses, on sandy soils, loams and red earth; spinifex grasslands with low shrub cover of *Acacia* and *Melaleuca* spp. on sandy and sandy loam soils (Cramer et al. 2016).

Using presence data, DBCA commenced habitat modelling in 2017 using physical habitat characteristics (i.e., topography, geology and soil properties). Preliminary results (Dziminski and Carpenter, 2017) identified elevation, and soil type and depth as key predictor variables contributing to habitat suitability for the Bilby.

Using publicly available species occurrence data, Cadenhead *et al*. (2015) mapped the habitat suitability and distribution of four Pilbara MNES species using MaxEnt (Phillips *et al*., 2006). For the Bilby (n = 46), '*mean diurnal temperature range, seasonal temperature variation, precipitation of the driest period, amounts of clay in the soil and the mean temperature of the driest quarter*' were the most important parameters predicting the distribution of Bilbies in the Pilbara. Predictive species habitat modelling has also been conducted by environmental consultants and mining proponents for environmental impact assessment processes (e.g., Eco Logical, 2015; for the BHP iron ore mining in the Pilbara strategic assessment); Bilbies were '*strongly associated with hotter regions of the eastern part of the Pilbara bioregion, with lower, flatter and sandier areas identified as higher potential habitat*' (BHP, 2016).

Adult males will commonly move up to two to three kilometres between burrows per night, whereas females often only move 500 m to 2 km between burrows (Moseby & O'Donnell 2003). An individual Bilby may have over a dozen regularly used burrows which are used as shelter during the day and rest at night (Attexo 2023).

The Bilby is often associated with three vegetation types, open tussock grassland on uplands and hills, hummock grassland in plains and alluvial areas, and occasionally mulga woodland/shrubland growing on ridges and rises (Southgate 1990). One of the three major vegetation types outlined in the national recovery plan for the Bilby is hummock grassland growing on sand plains and dunes, drainage systems, salt lake systems, and other alluvial areas.

Surveys

Surveys completed for the Proposal targeting the Bilby include:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment; (**Appendix 11a.1**)
- Spectrum (2023a) MDIOP Solar Farm. Haul Road, and Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment; (**Appendix 11g**)
- Spectrum (2024a) Mulga Downs Iron Ore Mine Targeted Bilby and Night Parrot Survey; (**Appendix 11e**) and
- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey. (**Appendix 11f**)

The surveys were undertaken between April 2019 to May 2024. All surveys included an initial desktop assessment followed by on-ground habitat assessment to determine if suitable burrow or foraging habitat was present.

The results of soil assessments undertaken within the Development Envelope (Mine Earth 2019) were interrogated for suitable substrates for Bilby burrows. To identify habitat which was likely to be used by the Bilby a UAV was deployed. Preferred habitat was initially selected from habitat sampling and the UAV allowed for assessment of areas which were difficult to access. UAV flights were completed in a linear pattern, with transects separated by no more than 500 m (usually between 200 m and 400 m) within Mulga Woodland habitat type to identify potentially suitable habitat and secondary signs (diggings and burrows) (*ecologia* 2021a). The UAV path is shown in **Figure 10-11.**

The Drainage Line/Floodplain habitat was also identified from the desktop assessments as likely to support the Bilby and these were also targeted for on ground searches. Habitat which may be considered critical for the

survival of the Bilby has also been defined as habitat along palaeo drainages near salt lake systems such as the Fortescue Valley (Northover et al 2023).

Targeted searches were also undertaken in March 2023 by Spectrum within six locations along the proposed pipeline route from the Mine to the Mulga West Borefield (Spectrum 2023a). Earlier Level 2 (detailed) terrestrial fauna surveys in 2012 and 2013 undertaken across the Mulga Downs Development Envelope did not find any evidence of the Bilby in the area. The information from these surveys is included in each of the desktop assessments completed as part of the terrestrial fauna assessment by *ecologia* and Spectrum (refer to *ecologia* 2021a for details on the earlier surveys by Terrestrial Ecosystems).

The targeted surveys involved surveying habitat known to support populations of the Bilby in Western Australia, including *Acacia aneura* (mulga) woodland/shrubland growing on ridges and rises which was surveyed extensively with a UAV during the survey (*ecologia* 2021a). Mulga Woodland habitat was targeted by Spectrum during the March 2023 survey along the proposed pipeline route (Spectrum 2023a).

In 2024, a targeted Bilby and Night Parrot survey was completed across a broader area for the Proposal. Thirty habitat assessments and 49 targeted Bilby searches were conducted across the Survey Area over a two phase sampling program, totalling 80 person-hours of effort and 132.2 km traversed (Refer to Map 2.2 in Spectrum, 2024a). Targeted searches were completed using the 2 ha plot technique as defined in the Bilby survey guidelines (DBCA, 2017). Due to the size of the Survey Area, plots were spaced at approximately 4 km (where possible) over the Survey Area to ensure sampling independence, with additional sites located in areas of preferred habitat.

The targeted searches included looking for Bilby evidence in the form of tracks, scats, diggings, and burrows for approximately one person hour at each site. Where plant species could be identified in the field, more focus was placed on specific *Acacia* species) known to contain root-dwelling larvae that the Bilby favours as a food source (Southgate et al., 2019). Bilbies can be surveyed any time of the year using non-invasive techniques (DBCA, 2017).

No secondary evidence of the Bilby was recorded during any of the surveys. These surveys included on ground targeted searches in the Mulga Woodlands and Drainage Line/Floodplain habitat, which is considered the preferred habitat for the Bilby as it contains vegetation associations considered preferred habitat. Each survey adopted the recommendations of Dziminski and Carpenter (2018) with on-ground searches to identify signs – tracks, scats and multiple diggings into the base of Acacia shrubs where grubs are accessed.

The total survey effort undertaken for the Greater Bilby by *ecologia* (2021b) and Spectrum (2023a; 2024a) included:

- 9 targeted searches, including 74 habitat assessments and 89 person hours; and
- 228 kms of UAV flights identifying the location of suitable habitat.

Occurrence in the Development Envelope

Seventy Bilby records were identified from desktop database searches within 40 km of the Development Envelope, and one anecdotal verbal record (2001) exists in proximity to the Development Envelope (Mulga

Downs homestead). The verbal record lacks some credibility as the associated data indicates the record locality is 'Telfer' and the site is listed as 'Mulga Downs Station', which covers a relatively large range (*ecologia* 2021a).

Despite the targeted survey effort, no primary or secondary evidence of Bilbies was recorded in the Development Envelope from any of the surveys. The likelihood of Bilbies breeding and forming dens within the Development Envelope is considered low and this species is instead considered to be a visitor. The presence of cats, foxes and wild dogs, which are known predators of the Bilby (DCCEEW 2023j; Pavey 2006), further decreases the likelihood of Bilbies being residents within the Development Envelope (*ecologia* 2021a).

No Bilby evidence (scats, diggings, tracks or burrows) was recorded within the Survey Area during the 80 person-hours of targeted searches in 2024 (Spectrum, 2024a). No Bilby evidence was observed across these four habitat types identified in previous surveys and as characterised by DCCEEW (2022), with 41.98 km traversed over Stony Plains and Slopes, 3.31km over Chenopod/Cracking Clay, 38.77 km over Drainage Area/Floodplain, and 48.13 km traversed over Mulga Woodland. Sandy substrate required for burrow excavation occurred patchily in some drainage lines but was largely absent across the Survey Area (Spectrum, 2024a).

Habitat considered to be suitable for the Bilby was identified during the database searches for each of fauna surveys. Database search results indicated that Drainage Lines/Floodplain and Mulga Woodland habitats could provide suitable supporting habitat for Bilbies. Habitat which may be considered critical for the survival of the Bilby has also been defined as habitat along palaeo drainages near salt lake systems such as the Fortescue Valley (Northover et al 2023) which can be considered habitat within the home range of paleo drainage systems for the Bilby (DCCEEW, 2021).

Systematic fauna surveys were undertaken within the following habitats: Drainage Line/Floodplains, Mulga Woodland, and Chenopod/ Cracking Clay Floodplain. These all exist within the Fortescue Valley paleo drainage system and also includes habitat such as Mixed Eucalypt/Mulga Floodplain. Earlier targeted searches included the use of a UAV to allow for a greater area to be assessed for evidence of the Bilby.

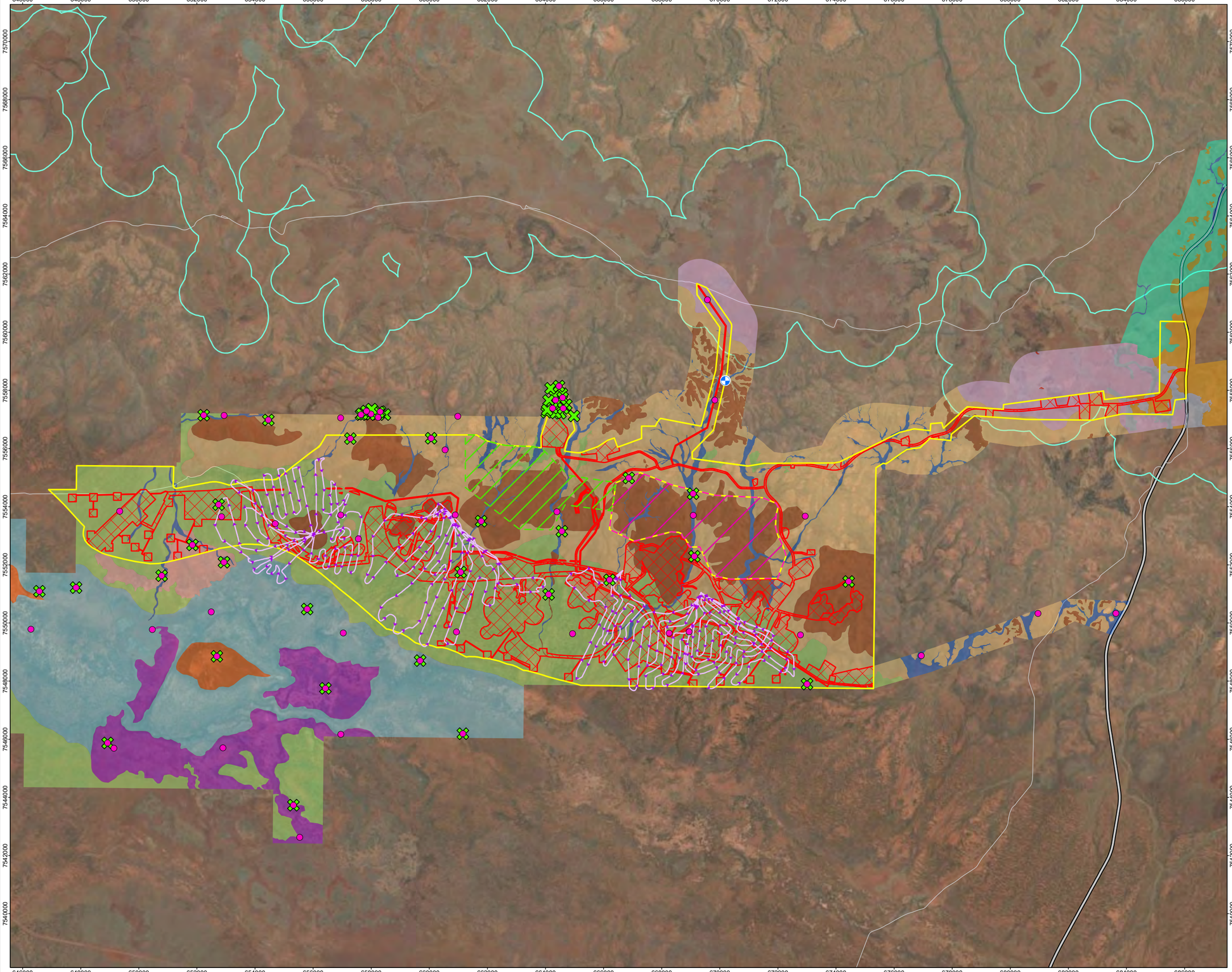
No Bilby dens or burrows were identified in any targeted surveys or systematic surveys sites undertaken within the Fortescue Valley paleodrainage system within and south of the Development Envelope. The presence of soil substrate suitable for burrow construction is critical (Dziminski and Carpenter 2016). The Mulga Woodland was found to have compacted alluvial loamy clay soils with occasional surface stones, not suitable for burrowing.

Surveys to the east of the Proposed Action for the Mulga Downs Hub and Rail Project located active dens and captured the Bilby on motion cameras. This provides evidence that Bilbies appear to have a greater presence toward the drier sandier sections of the Fortescue region.

Figure 10-11: Bilby Survey Effort

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Targeted surveys
- Habitat assessments
- Water feature
- Bilby flight path UAV effort

Roads (LGATE-195)

- Highway

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Kilometers

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Central Pilbara, Western Australia

BILBY SURVEY EFFORT

FIGURE 10.11 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Targeted surveys
- Habitat assessments
- Bilby flight path UAV effort

Roads (LGATE-195)

- Minor Road

JBS&G

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Kilometers

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BILBY SURVEY EFFORT

FIGURE 10.11 Map 2 of 4

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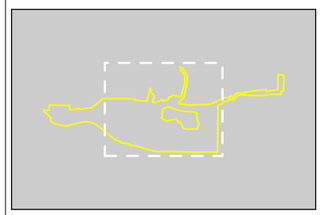
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Targeted surveys
- Habitat assessments
- Water feature
- Bilby flight path UAV effort

Roads (LGATE-195)

- Minor Road



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BILBY SURVEY EFFORT

FIGURE 10.11 Map 3 of 4

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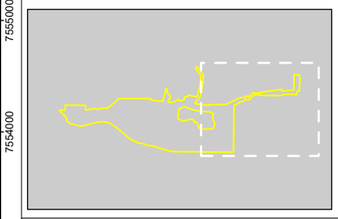
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Targeted surveys
- Habitat assessments
- Water feature
- Bilby flight path UAV effort

Roads (LGATE-195)

- Highway
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BILBY SURVEY EFFORT

FIGURE 10.11 Map 4 of 4

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10.3.3.5 Pilbara Olive Python (*Liasis olivaceus barroni*)

Conservation Status: Vulnerable.

Distribution, Habitat and Ecology

The Pilbara Olive Python (*Liasis olivaceus barroni*) is a dull olive-brown to pale fawn or rich brown python with a white/cream belly, pale lips finely dotted with pale grey or brown, pitted anterial scales bordering the lips and smooth scales in 55–80 rows at mid-body. The Pilbara Olive Python is one of Australia's largest snakes and can grow to 4 m in length with an average size of 2.5 m (Cogger 2000). The Pilbara subspecies is larger and can grow up to 6.5 m in length (Wilson & Swan 2017) and females are slightly longer than males (Shine & Slip 1990). Pilbara Olive Pythons have been known to eat prey as large as rock wallabies (Wilson & Swan 2017).

The Pilbara Olive Python is restricted to ranges within the Pilbara region, north-western Western Australia, such as the Hamersley Range, and islands of the Dampier Archipelago (DCCEEW 2023d). Two distinct populations of the Pilbara Olive Python exist (not including the northern subspecies *L. olivaceus olivaceus*) with one isolated around Mt Augustus in the Gascoyne, and the other occurring across a vast area from the Burrup Peninsula, Ord Ranges and Meentheena, south to Nanutarra and Newman (Storr et al. 2002). Population size estimates are difficult due to the Pilbara Olive Python's cryptic nature and lack of reliable trapping or census techniques (DCCEEW 2008a).

The Pilbara Olive Python is restricted to gorges, rocky habitats, and escarpments of the Pilbara (Wilson & Swan 2017). Bush & Maryan (2011) noted that Pilbara Olive Pythons have been observed from locations some distance from water sources including granite outcrops, elevated mesas, and spinifex plains on stony ground, preferring to shelter in caves, crevices, and beneath large boulders.

At present, there are no species-specific policy guidelines on what constitutes habitat critical to the survival of the species or what represents an important population. This is likely due to the species' cryptic nature which makes conducting reliable surveys difficult (DEWHA 2008a). An accepted 'default' definition of critical habitat for this species is rocky gorges, gullies and permanent waterholes (Northover et al, 2023).

Surveys

Surveys completed for the Proposal targeting the Pilbara Olive Python included:

- *ecologia* (2021b) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment;
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey;
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment; and
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417).

The surveys included multiple basic, detailed, and targeted survey events between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA *Technical Guidance: Terrestrial Fauna Surveys* (EPA, 2016a). The surveys included multiple basic, detailed, and targeted surveys between April 2019 and June 2024. The detailed surveys were conducted following the period

of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken were compliant with the required guidance. For the Pilbara Olive Python these were:

- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b); and
- Threatened Species Scientific Committee: Conservation Advice for *Liasis olivaceus barroni* (Olive Python-Pilbara subspecies) Canberra: Department of the Environment, Water, Heritage and the Arts.

Targeted searches conducted in rocky hills habitats for secondary evidence (sloughs and scats) were conducted concurrently with cave habitat assessments, Northern Quoll targeted searches, and while deploying bat ARUs. Spotlighting through rocky habitat on foot and nocturnal road spotting for this cryptic nocturnal species was undertaken during the targeted surveys. Four zoologists conducted spotlighting on foot through suitable rocky habitat for a total of 480 minutes. Nocturnal road spotting was also undertaken on spotlighting for cryptic nocturnal species including the Pilbara Olive Python during each phase of the surveys for a total of 3840 minutes. Camera traps deployed in the Rocky Hills targeting Northern Quolls were also used to detect presence of Pilbara Olive Pythons resulting in greater survey effort for the species (*ecologia* 2021a).

A motion camera was placed near an ephemeral water hole in the Powerline Corridor which lies within Drainage Line/Floodplains habitat in the northern section of the Proposed Action (Biologic 2022b). The total survey effort undertaken for the Pilbara Olive Python by *ecologia* (2021a), Biologic (2022b) and Spectrum (2023a; 2024b) and included:

- Motion sensor camera traps at 140 sites over 7,067 trap nights;
- Cage traps at 50 sites over 385 trap nights;

Targeted searches, including 229.38 hours targeted surveys and 55 hours of nocturnal searches.

Occurrence in the Development Envelope

A single Pilbara Olive Python was opportunistically recorded from the Mulga East camp (*ecologia* 2021a) confirming the likely presence of this species within the Development Envelope (**Figure 10-12**). As the Pilbara Olive Python habitat requirements overlaps the Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat, active searches for the species were undertaken concurrently with the other targeted surveys. Despite considerable survey effort, no Pilbara Olive Pythons or secondary signs of this species were recorded during targeted searches. A motion camera was placed above an ephemeral water feature in the Powerline Corridor (**Figure 10-12**) and no Pilbara Olive Pythons were detected (Biologic 2022b).

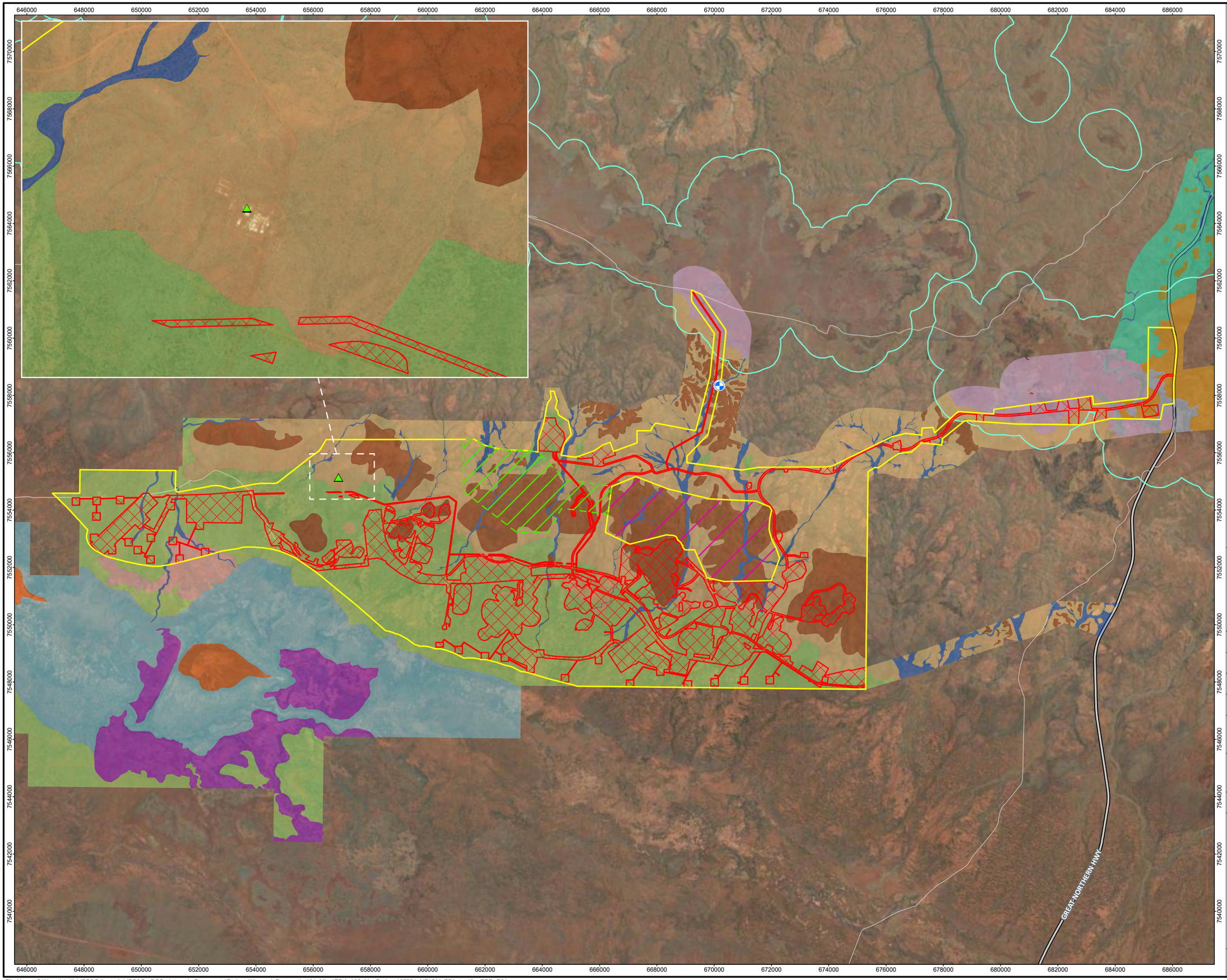
There are multiple records of the Pilbara Olive Python from the Fortescue's Solomon mine (40 km west), the most recent in March 2024 (FMG 2024). This species has also been recorded 13 km south of Malay Well in Wittenoom Gorge in 2013, 10 km north of Mulga East in 2013, and in the Chichester Ranges 7 km north-west of the proposed rail corridor in 2012. The distribution of this species to the south, west, north, and north-east of the Development Envelope indicates this species occurs widely across the broader landscape and is not restricted to specialised habitats within the Development Envelope (*ecologia* 2021a).

Within the Development Envelope, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills (rocky outcrops, breakaways and small gorges), however it has also been known to inhabit spinifex grasslands and travel large distances. Drainage Line/Floodplains habitat also provides suitable foraging habitat

Although one Pilbara Olive Python was found at the Mulga East camp within the Development Envelope, the habitat type present (Stony Spinifex Plains and Hillslopes) (**Figure 10-12**)is not consistent with defined habitat for the species in the most recent work by DBCA (*ecologia* 2021a).

Rocky Hills habitat is considered common and widespread throughout the Pilbara (*ecologia* 2021a). No deep gorges or permanent sources of water considered preferred habitat for this species have been recorded within the Development Envelope. While the Rocky Hills habitat may support the Pilbara Olive Python, it cannot be considered critical for the survival of this species given the absence of permanent water holes. The closest water source is the ephemeral water feature in the Powerline Corridor. This feature is outside the Indicative Footprint and will be clearly demarcated.

Figure 10-12: Pilbara Olive Python record



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Pilbara olive python (VU)
- Water feature
- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PILBARA OLIVE PYTHON RECORD

FIGURE 10.12

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar

10.3.3.6 Night Parrot (*Pezoporus occidentalis*)

Conservation Status: Critically Endangered

Distribution, Habitat and Ecology

The Night Parrot (*Pezoporus occidentalis*) is listed as Critically Endangered under the BC Act. The survey area occurs within the classified "high priority area" for occurrence of the Night Parrot (DPaW 2017).

The Night Parrot is one of Australia's rarest birds, with very few confirmed sightings in recent years (Pyke & Ehrlich 2014). It is a highly elusive nocturnal ground dwelling parrot found in the arid and semi-arid zones of Australia. The Night Parrot was thought to be extinct but, in 2013, was rediscovered in Queensland (Pullen Pullen Reserve) (DCCEEW 2023f). The Night Parrot is currently known from at least eight sites in northern WA and a single site in south-western Qld (Leseberg et al., 2021b; A.H. Burbidge, unpubl.).

This species is known to occur at the Fortescue Marsh (Davis and Metcalf 2008) approximately 60 km east of the Development Envelope. Calls were detected in 2005 however, no more calls were recorded until 2017 (Jackett et al. 2017) indicating the species is present in some areas, and more recently from Fortescue's Cloudbreak mine area (Fortescue Metals Group 2021). Only a few of these records are from long-term stable roost sites, with the remainder being records of birds that are foraging or moving between sites with central and norther WA now considered the stronghold for this species (Leseberg 2021).

There is one population recently recorded in the Diamantina National Park/Pullen Pullen Reserve area in western Queensland, and other recent records in the Wiluna district of central WA, and the Lake Gregory area of northern WA (Burbidge 2018). Night Parrot foraging calls were recently recorded at Lake Mackay (East Pilbara) (Stantec, 2021).

The species is relatively sedentary spending the day roosting in low, dense vegetation, usually as pairs or as small groups. The Night Parrot is predictably vocal and when emerging at dusk they engage in a brief period of calling before leaving their roost sites to feed. They then typically return for another brief period of calling just before dawn (Murphy et al. 2017b).

Night Parrots reportedly occur in spinifex grasslands in stony or sandy areas on floodplains or near creeks, shrubby samphire, and chenopod vegetation on claypans or at the edges of salt lakes, and in dense, low vegetation, around watercourses (Murphy et al. 2017a, Pyke & Ehrlich, 2014). Based on limited data, Night Parrots seem to prefer to nest in large spinifex hummocks (Murphy et al. 2017b), which is a common and widespread habitat type throughout much of the Pilbara region.

Critical habitat for the species is defined as:

- Nesting and foraging in areas that can support multiple to many occurrences of dense roosting habitat such as old-growth dense hummock-forming spinifex (*Triodia* spp.), thickets of lignum, or dense shrubby samphire.
    - Nesting and foraging in old-growth spinifex (*Triodia* spp.) in close proximity to ephemeral water sources, which may be associated with the following: Hummock grasslands (unburnt) in stony or sandplain environments;
    - Paleo-drainage features in a landscape mosaic with spinifex (*Astrebla* spp.) and *Acacia aneura* (Mulga) woodland; and

- Treeless areas and bare gibber. The species has a home range of 10 ha to 100s of ha (depending on the size of either permanent or ephemeral food resource habitat in the landscape that is surrounding breeding habitat).

Supporting habitat includes:

- Areas that are likely to be of relatively high vegetative or seed productivity such as run-on areas, floodplains, salt or clay pans, salt-lake margins;
- Paleo-drainage systems, salt lakes and pans;
- Permanent or ephemeral sources of free water, or areas where high soil moisture ephemerally or permanently support vegetation that offers a source of water; and
- Flyways varying from river and creek drainage systems, surrounding dune-fields, forb–grasslands on mainly ironstone gravel-covered plains, low ranges and low dissected tablelands supporting sparse shrublands, undulating stony clay plains supporting Mitchell Grass, and Gidgee.

Surveys

Surveys completed for the Proposal targeting the Night Parrot included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm. Haul Road, and Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024a) Mulga Downs Iron Ore Mine Targeted Bilby and Night Parrot Survey (**Appendix 11e**).

The surveys were undertaken between April 2019 to May 2024. All surveys included an initial desktop assessment followed by on-ground habitat assessment to determine if suitable roosting or foraging habitat was present. The desktop assessment included previous surveys and imagery to assess Night Parrot habitat at a landscape scale.

Surveys were scheduled following the season when maximum rainfall typically occurs in the Eremaean September to April (EPA, 2020). All surveys listed above were compliant with State (Western Australian) and Commonwealth guidelines (refer to **Table 10-2**).

ecologia (2021a) also included the use of UAVs to investigate habitat which may be suitable for the Night Parrot. ARUs were then deployed at small patches of sparsely distributed long unburnt spinifex. The location of where the ARUs were placed and the oath of the UAV flight to assess habitat suitability for the Night parrot is shown in **Figure 10-13**.

Habitat considered suitable for the Night Parrot in the Development Envelope includes:

- Unburnt spinifex. These areas were confined to the north-eastern portion of the Development Envelope (*ecologia* 2021a);

- Rocky Hills habitat includes vegetation complexes of sparse hummock grasslands of *Triodia* spp. and sparse chenopod – both which have been identified as suitable for the Night Parrot; and
- The Stony Spinifex Plains and Hillslopes occur interspersed between the Rocky Hills habitat may contain habitat which may be critical or supporting. Burbridge (2020) identifies breeding and roosting habitat which includes old dense spinifex surrounded by rocky ridges.

Acoustic monitoring has proven to be the most efficient technique for monitoring Night Parrots at known locations and detecting at new locations (Leseberg et al., 2020). SongMeter SM4 long term passive Acoustic Recording Units (ARUs) have a high sampling frequency and are appropriate to detect Night Parrot calls (DBCA, 2024). The use of SongMeter SM4 is discussed further below.

Many suitable habitat types for the species are extensive and the terrain difficult and therefore it is appropriate to use drones in such a landscape. *ecologia* (2021a) also included the use of UAVs to investigate habitat which may be suitable for the Night parrot. ARUs were then deployed at small patches of sparsely distributed, long unburnt spinifex. The location of where the ARUs were placed and the oath of the UAV flight to assess habitat suitability for the Night Parrot is shown in **Figure 10-13**.

A targeted survey for the Night Parrot was undertaken by Spectrum in 2024, in the Fortescue Valley area where areas of relatively high productivity (vegetative or seed) were identified from previous habitat assessments in floodplain, near claypans and the paleodrainage system of the Fortescue River floodplain (**Figure 10-13**). The ephemeral claypans and pools (Claypan habitat shown in Figure 2.3 of Spectrum 2024b) is outside of the Development Envelope and the habitat assessment did not find it suitable for placing an ARU. Instead, one was placed within the Calcrete Stony Plain habitat which was adjacent to the Claypan. ARUs were placed within the Chenopod/Cracking Clay Floodplains habitat abutting the drainage system and close to the Freshwater Claypan PEC.

Other habitat which can support the Night Parrot are the Drainage Lines/Floodplains and Stony Spinifex Plains and Hillslopes and ARUs were also placed within these habitats. The survey was undertaken after above average rainfall with the floodplain area inundated in March 2024 (Spectrum 2024a).

The total survey effort undertaken for the Night Parrot by *ecologia* (2021b), Biologic (2022a) and Spectrum (2023a; 2024a) included:

- Recording calls using ARUs at 39 sites over 260 recording nights; and
- 33 kms of UAV flights.

In March 2023, additional surveying was conducted for the Night Parrot by Spectrum (2023a) (**Appendix 11e**) which covered the Solar Farm (in addition to the pipeline route and revised haul road which are now outside the Development Envelope). The survey effort for the Night Parrot included a habitat assessment, opportunistic sightings, and deployment of two Song Meter acoustic recorders in potential habitat for six nights.

A targeted survey for the Night Parrot was undertaken in the Fortescue Valley area where areas of relatively high productivity (vegetative or seed) were identified from previous habitat assessments in floodplain, near claypans and the paleodrainage system of the Fortescue River floodplain. The ephemeral claypans and pools (Claypan habitat shown in Figure 2.3 of Spectrum 2024b) is outside of the Development Envelope and the habitat assessment did not find it suitable for placing an ARU. Instead, one was placed within the Calcrete Stony Plain

habitat which was adjacent to the Claypan. ARUs were placed within the Chenopod/Cracking Clay Floodplains habitat abutting the drainage system and close to the Freshwater Claypan PEC.

SongMeter acoustic recorders were also deployed throughout the Survey Area in an effort to target the Night Parrot. These ARUs were deployed in seven locations within the long unburnt spinifex for a minimum of six nights, with three ARUs also deployed within the Chenopod/Cracking Clay Floodplain and Stony Spinifex Plains and Hillslopes habitat types during the initial targeted survey (*ecologia* 2021a).

The ARUs deployed by Spectrum in 2023 at two locations in Goodiadarrie Swamp in March 2023 were analysed using single parameters optimised for detecting Night Parrot calls by N. Leseberg, of Adaptive NRM (Spectrum 2023a).

Research in western Queensland has demonstrated Night Parrots occupy long-term stable roost sites for periods of up to several years. These long-term stable roost sites support both roosting and breeding. The birds also have predictable year-round calling periods at dusk and dawn (Murphy et al. 2017a, Leseberg et al. 2019). This ensures that if Night Parrots are roosting at a particular site, the likelihood of detecting them using ARUs is very high, provided the ARU is placed for a minimum of four nights in calm weather, and the recorder is set to record during the peak calling periods. During breeding, and following large rain events, calling is more frequent, extends throughout the night, and the likelihood of detection is increased (Murphy et al. 2017a). Preliminary results from research in central Western Australia suggest patterns of behaviour in that region are similar (Jackett et al. 2017).

The likelihood of detection is also influenced by the type of ARU being used. In calm conditions, a Song Meter 4 (Wildlife Acoustics, MA, USA) is known to be capable of reliably detecting 95% of Night Parrot calls out to a range of around 205 m (Leseberg et al. 2022).

Occurrence in the Development Envelope

No calls attributable to Night Parrots were detected on any of the recording units, despite considerable survey effort (*ecologia*, 2021a; Biologic 2022a, b; Spectrum 2023a; 2024a). Calls recorded in the 2024 targeted survey were analysed by Dr Nick Leseberg (Adaptive NRM and one of the leading subject matter experts for the Night Parrot) (Spectrum 2024a). Conclusion from the targeted survey was that no calls for the Night Parrot were detected from 131 recording nights (1,572 hrs of acoustic recordings) from 18 sites in habitat considered suitable for Night Parrot foraging. A total of 57 other species were recorded. It was determined that no Night Parrots existed within 200 m of the 18 sites. The number of nights of data collected was sufficient to allow robust conclusions around the presence of long-term stable roost sites in the immediate vicinity of each survey point at the time of the survey (Spectrum 2024a). The survey spanned the Development Envelope and extended outside.

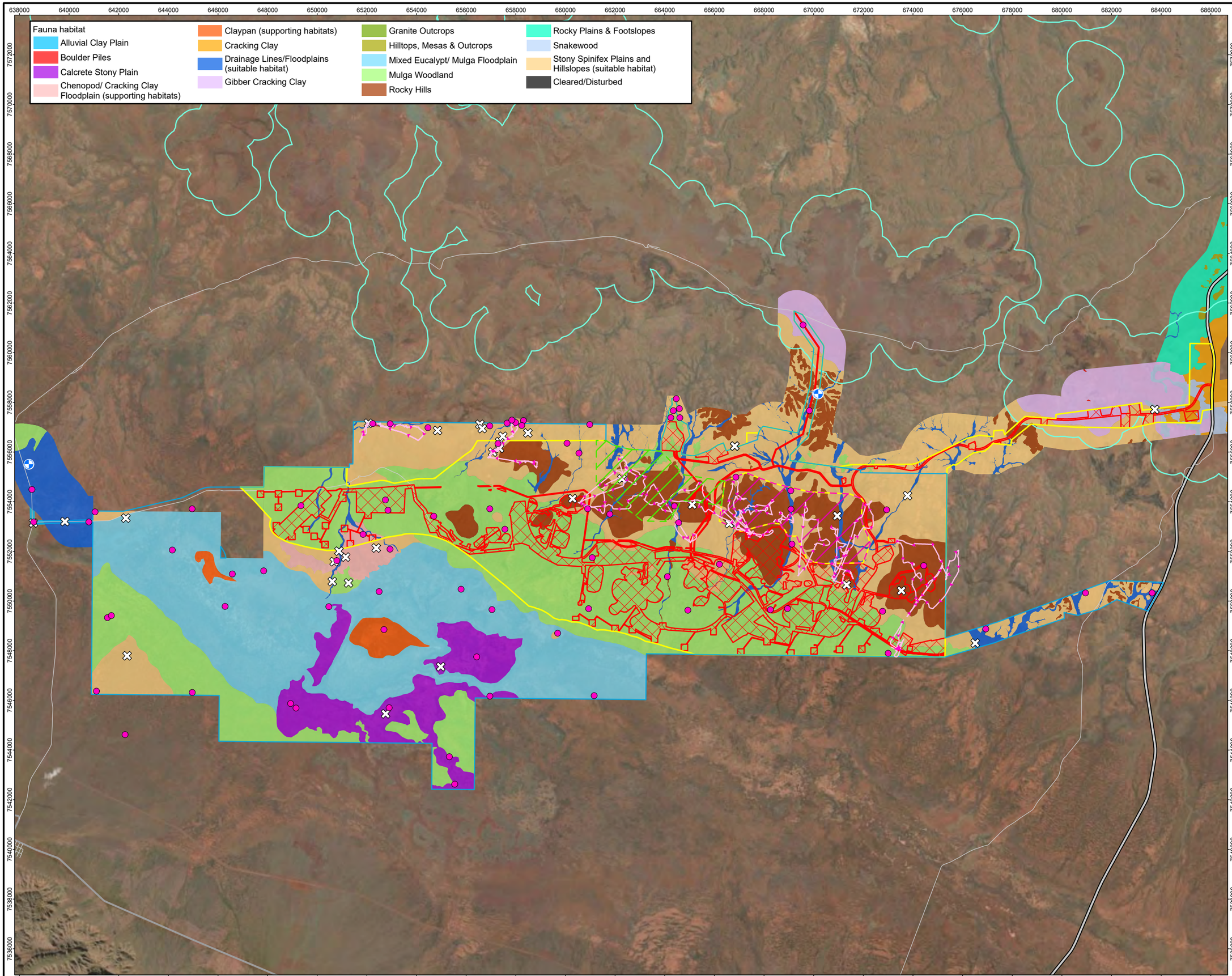
There are no historical records of the Night Parrot within 40 km of the Development Envelope. Long unburnt spinifex is sparse in the Development Envelope, with one location existing within an access road corridor towards the north within Stony Spinifex Plains and Hillslopes. The remaining identified patches were restricted to the south of, and outside the Development Envelope, towards the Fortescue Valley (Figure 10-14).

Habitat considered suitable for the Night Parrot within the Development Envelope includes Drainage Line/Floodplains and Stony Spinifex Plains and Hillslopes (ecologia 2021a). In the absence of long unburned

spinifex, this habitat is considered as supporting only. Potential supporting (foraging) habitat for the Night Parrot is also found in Chenopod/Cracking Clay Floodplains.

None of the surveys recorded any Night Parrot calls. The desktop assessment and results from the field surveys indicate that the Night Parrot, while not recorded, could potentially intermittently use the survey area (including within the Development Envelope), for foraging and dispersal. However, the habitats present are sub-optimal for the Night Parrot and it is unlikely that it resides in this area.

Figure 10-13: Night Parrot Survey Effort



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Survey area Spectrum Ecology & Spatial (2024)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Night Parrot flight path UAV effort
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 19-Aug-2025
Drawn By: jcrute	Checked By: SB

Scale 1:140,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_13_67751_ERD_Night Parrot Survey Effort

Fauna habitat
- Alluvial Clay Plain
- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain (supporting habitats)
- Claypan (supporting habitats)
- Cracking Clay
- Drainage Lines/Floodplains (suitable habitat)
- Gibber Cracking Clay
- Granite Outcrops
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes (suitable habitat)
- Cleared/Disturbed

Legend
- Development Envelope
- Indicative Footprint
- Survey area Spectrum Ecology & Spatial (2024)
- FHEZ Corridor
- Night Parrot flight path UAV effort
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 19-Aug-2025
Drawn By: jcrute	Checked By: SB

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 2 of 4

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Image Reference: World Imagery: Earthstar Geographics
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Fauna habitat
- Alluvial Clay Plain
- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain (supporting habitats)
- Claypan (supporting habitats)
- Cracking Clay
- Drainage Lines/Floodplains (suitable habitat)
- Gibber Cracking Clay
- Granite Outcrops
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes (suitable habitat)
- Cleared/Disturbed

Legend
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Survey area Spectrum Ecology & Spatial (2024)
- FHEZ Corridor

Priority Ecological Communities (DBCA)
- Four plant assemblages of the Wona Landsystem (Priority 1)

- Night Parrot flight path UAV effort
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 19-Aug-2025
Drawn By: jcrute	Checked By: SB

Scale 1:55,000 at A3

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Kilometers

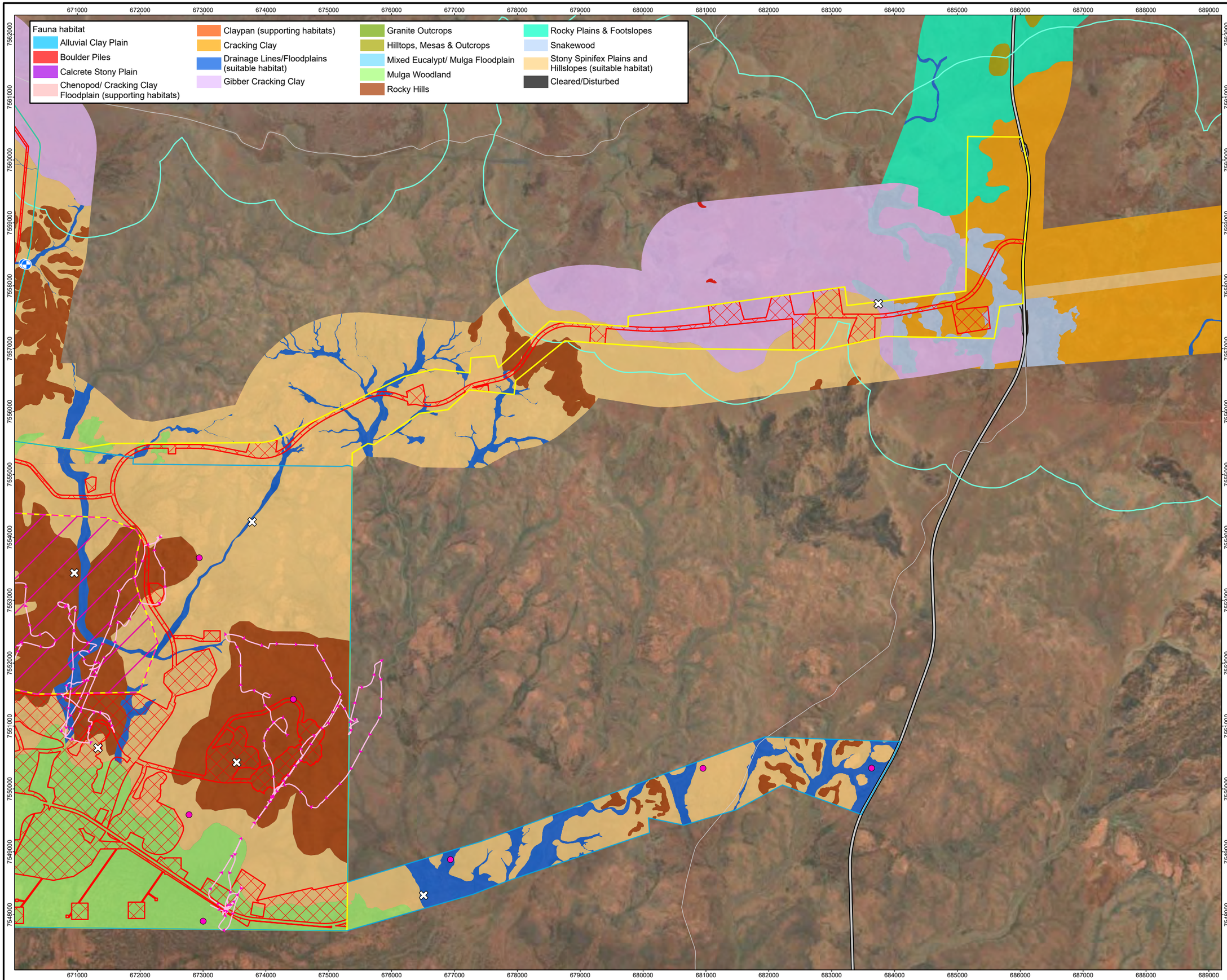
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 3 of 4

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Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_13_67751_ERD_Night Parrot Survey Effort



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Survey area Spectrum Ecology & Spatial (2024)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Night Parrot flight path UAV effort
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 19-Aug-2025
Drawn By: jcrute	Checked By: SB

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

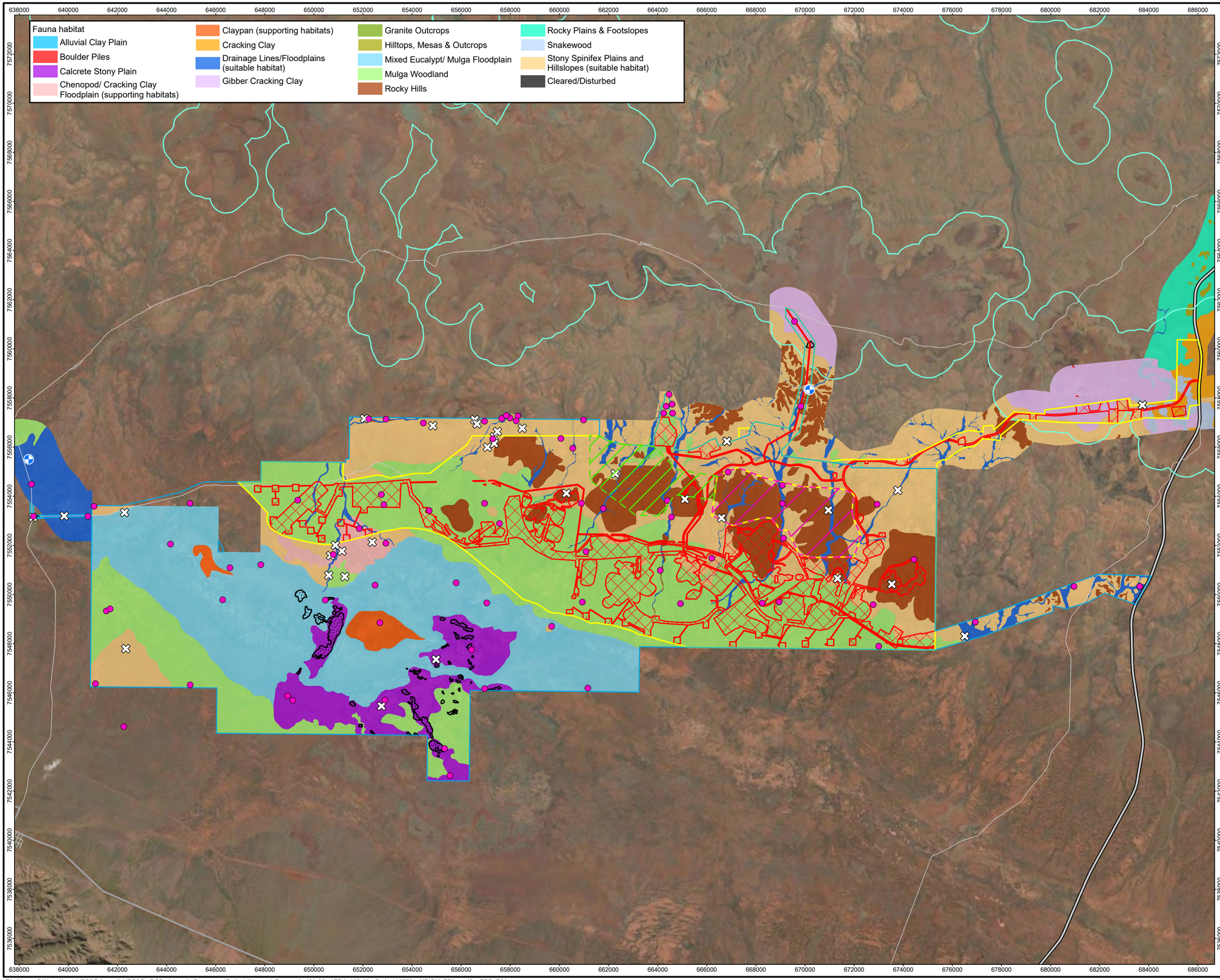
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_13_67751_ERD_Night Parrot Survey Effort

Figure 10-14: Night Parrot Mature Triodia locations



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Survey area Spectrum Ecology & Spatial (2024)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Mature Triodia (Spectrum 2024)
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 28-Aug-2025
Drawn By: jcrute	Checked By: SB

Scale 1:140,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT HABITAT

FIGURE 10.14 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_14_67751_ERD_Night Parrot Habitat

Fauna habitat
- Alluvial Clay Plain
- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain (supporting habitats)
- Claypan (supporting habitats)
- Cracking Clay
- Drainage Lines/Floodplains (suitable habitat)
- Gibber Cracking Clay
- Granite Outcrops
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes (suitable habitat)
- Cleared/Disturbed

Legend
- Development Envelope
- Indicative Footprint
- Survey area Spectrum Ecology & Spatial (2024)
- FHEZ Corridor
- Mature Triodia (Spectrum 2024)
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 28-Aug-2025

Drawn By: jcrute | Checked By: SB

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT HABITAT

FIGURE 10.14 Map 2 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_14_67751_ERD_Night Parrot Habitat

Fauna habitat
- Alluvial Clay Plain
- Boulder Piles
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- Cracking Clay
- Drainage Lines/Floodplains (suitable habitat)
- Gibber Cracking Clay
- Granite Outcrops
- Hilltops, Mesas & Outcrops
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- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes (suitable habitat)
- Cleared/Disturbed

Legend
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Survey area Spectrum Ecology & Spatial (2024)
- FHEZ Corridor

Priority Ecological Communities (DBCA)
- Four plant assemblages of the Wona Landsystem (Priority 1)
- Mature Triodia (Spectrum 2024)
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 28-Aug-2025
Drawn By: jcrute	Checked By: SB
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Kilometers

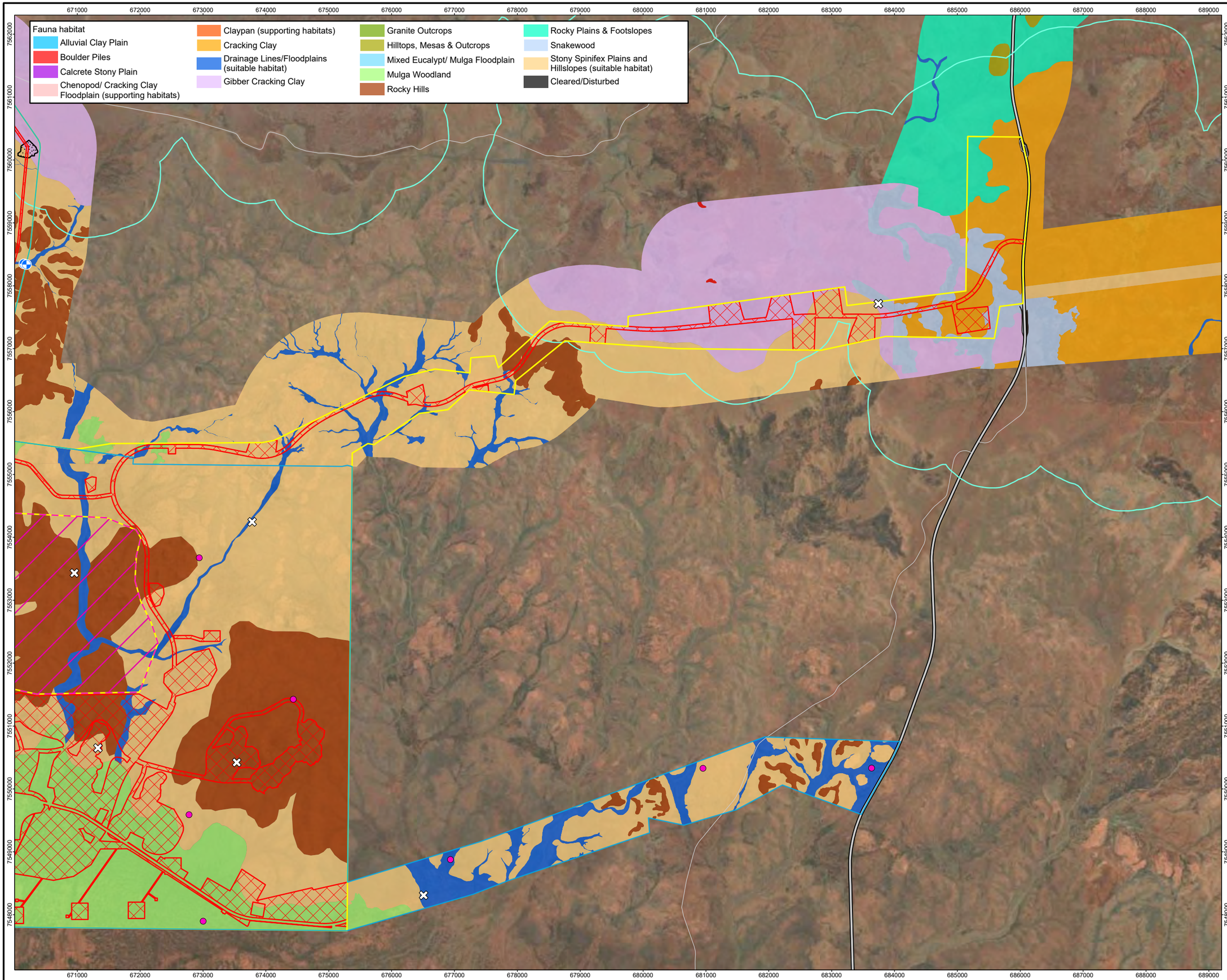
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT HABITAT

FIGURE 10.14 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_14_67751_ERD_Night Parrot Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Survey area Spectrum Ecology & Spatial (2024)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Mature Triodia (Spectrum 2024)
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 28-Aug-2025
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Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT HABITAT

FIGURE 10.14 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
Layout: Fig_10_14_67751_ERD_Night Parrot Habitat

10.3.3.7 Grey Falcon (*Falco hypoleucos*)

Conservation Status: BC Act: Vulnerable.

Distribution, Habitat and Ecology

The Grey Falcon is the rarest falcon in Australia with an estimated population size of <1000 individuals (Schoenjahn, 2013). They occur very sparsely in a wide variety of arid and semi-arid zones across an area of about 5 million km^2 (Schoenjahn, Pavey and Walter, 2020). They have not been found to be associated with any particular vegetation types, however climate characteristics such as temperature and rainfall appear to strongly influence the distribution of the species (Schoenjahn, Pavey and Walter, 2020).

Breeding occurs from June to November, with eggs laid in the old nests of other birds, particularly those of other raptors or corvids. The nests chosen are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but falcons also nest in telecommunication towers (Marchant & Higgins 1993).

The species is a resident or nomadic visitor to inland parts and occurs in lightly wooded riverine plains. It often nests in Eucalypts along watercourses and has been recorded from both River red gum (*Eucalyptus camaldulensis*) and Coolabah (*Eucalyptus coolabah*) (Garnett et al. 2011). Breeding habitat appears to be localised in zones with the highest annual average temperatures, and areas with persistently dry and winter drought climatic conditions (Schoenjahn, 2013). Grey Falcons, like most falcons, typically use the nests of other large birds (typically corvids and raptors) in trees or on human infrastructure such as repeater towers or power-line pylons (Olson and Olson, 1986b). Nests are often used over several years and can be near nests of other falcons or raptor species (Schoenjahn, 2013).

The Grey Falcon forages in open landscapes such as rocky plains with hummock grasslands, lower shrublands, and small drainage lines where they predominantly prey on birds, mainly pigeons and parrots (Olson and Olson, 1986b; Schoenjahn, 2013).

Surveys

The field surveys conducted for the Proposal included multiple basic, detailed, and targeted survey events between October 2018 and August 2023.

Surveys completed within the Development Envelope for the Grey Falcon include:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm. Haul Road, and Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2023b) Mulga Downs Iron Ore Mine, Targeted Grey Falcon Survey, August 2023 (**Appendix 11i.2**).

The surveys were compliant with survey guidelines as outlined in:

- EPA Environmental Factor Guideline: Terrestrial Fauna (Environmental Protection Authority, 2016);
- EPA Technical Guidance Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (Environmental Protection Authority, 2020);
- Survey guidelines for Australia's Threatened birds (Department of the Environment Water Heritage and the Arts, 2010); and
- Conservation Advice – *Falco hypoleucos* Grey Falcon (Threatened Species Scientific Committee, 2020).

Field surveys were completed following EPA guidelines for terrestrial fauna and included multiple basic, detailed, and targeted surveys between October 2018 and August 2023. A targeted survey was undertaken in August 2023 over 7 days. Habitat identified as suitable for the Grey Falcon nesting was traversed and any potential nesting trees and potential nests were mapped (Spectrum 2023b). The habitats identified from the *ecologia* 2023a desktop assessment identified as potential habitat were the Mixed Eucalypt / Mulga Floodplain and Drainage Lines / Floodplains. Mixed Eucalypt / Mulga Floodplain is no longer in the Development Envelope however is present to discuss the area of occupancy for this species.

Surveys for avifauna used 20-minute set-time searches at each systematic trapping site by an experienced ornithologist. During each set-time survey, the number of individuals of each species observed was recorded while actively searching similar habitat within a 2 ha area surrounding the survey site. This approach is in accordance with systematic survey methods recommended by BirdLife Australia and *Technical Guidance: Sampling methods for terrestrial vertebrate fauna* (EPA 2016). Survey effort was conducted within three hours of dawn and dusk, which is deemed to be optimal for recording majority of bird species (*ecologia* 2021a).

Set time surveys were conducted at each systematic trapping site for avifauna on a minimum of two occasions. Opportunistic surveys were conducted at sites considered to potentially support a different avifauna assemblage to systematic trapping locations, with specific focus on areas exhibiting surface water (*ecologia* 2021a). The survey undertaken by Spectrum (2023a) included noting any Grey Falcon nesting trees or infrastructure in the survey area.

A desktop risk assessment was also prepared by *ecologia* (2023b), provided in **Appendix 11i.1**. The desktop assessment considered potential habitat within the Development Envelope and reviewed the most recent specific research undertaken for the Grey Falcon.

Following the desktop assessment a survey was undertaken targeting the Grey Falcon habitat in August 2023. The habitats identified from the *ecologia* 2023a desktop assessment identified as potential habitat were the Mixed Eucalypt / Mulga Floodplain and Drainage Lines / Floodplains. Mixed Eucalypt / Mulga Floodplain is not in the Development Envelope. Habitat identified as suitable for the Grey Falcon nesting was traversed and any potential nesting trees and potential nests were mapped (Spectrum 2023b).

The Spectrum (2023b) survey included targeted searches for individuals and suitable nests within potential Grey Falcon habitat (**Appendix 11i.2**).

The total targeted survey effort for the Grey Falcon by *ecologia* (2021b), Biologic (2022) and Spectrum (2023a; 2023b) included:

- 80 sites, 91.8 hrs;

- Targeted surveys for the Grey Falcon include 212 set time surveys (2,686 minutes); and
- Targeted searches at 54 sites including foot and driving traverses.

Occurrence in the Development Envelope

Based on the desktop assessments the Grey Falcon was considered likely to occur in the Development Envelope. DBCA Threatened and Priority Fauna database search results identified a total of eight Grey Falcon records occurring within 70 km of the Development Envelope

ecologia (2021b) recorded one individual of this species during a reconnaissance survey in the Mulga East tenement area. *ecologia* (2023a) found eight additional records from DBCA Threatened Fauna Database Search are located within 70 km of the Development Envelope. Suitable foraging habitat exists in the form of Drainage Lines/Floodplains.

A targeted survey for Grey Falcon nesting trees within the Development Envelope did not yield any records of Grey Falcons (2023b). The survey was undertaken during the known breeding season for the Grey Falcon (as per the Conservation Advice – TSSC 2020). The area surveyed was identified as suitable habitat in the desktop assessment (*ecologia* 2023b; Spectrum 2023b). A total of 46 nests were recorded from 27 locations and assessed for suitability for the Grey Falcon, all of these nests identified were suitable for potential breeding activities, but none were occupied or in use during the survey **(Figure 10-15**). No secondary evidence of Grey Falcon breeding activities was noted.

None of these nests were occupied by the Grey Falcon and no secondary evidence of breeding activity was found within those nests. It is considered likely that the Grey Falcon forages within the Development Envelope, at least on an occasional basis, and whilst no evidence of breeding was identified during multiple years of surveys, the Development Envelope contains habitats which potentially support breeding. However, this species is known to prefer nesting on man-made structures as they are higher than most trees and therefore any nests are out of the reach of predators. These structures are not present in the Development Envelope at this stage of the Proposal but may occur at nearby projects. Trees which contained potential Grey Falcon nests were predominantly *Eucalyptus vitrix*. Other trees which had potential Grey Falcon nests included *Acacia aneura* and *Corymbia* species. Nest locations were identified to the southwest of the mine pits within Drainage Lines / Floodplains and Mixed Eucalypt / Mulga Floodplains.

Although significant avifauna survey effort has been undertaken since 2013 within the Development Envelope, this species has only been recorded on one occasion, indicating intermittent visitation within the Development Envelope and surrounding areas, which aligns with the habits of this nomadic species (*ecologia* 2023b).

While habitat critical to the survival of this species has not been defined, the Conservation Advice (DCCEEW 2020) identifies that Grey Falcon nests are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but Grey Falcons also nest in telecommunication towers (Marchant & Higgins 1993; Schoenjahn 2013, 2018; Falkenberg 2010).

The tendency of Grey Falcons to utilise the nests of other birds (corvids and raptors) in the largest eucalypts restricts suitable nesting habitat presence within the Development Envelope to one habitat type (*ecologia* 2023b):

No examples of River Red Gum (*Eucalyptus camaldulensis*) or Coolibah (*E. coolabah*) have been recorded within the Development Envelope, however, the banks of some Drainage Line/Floodplains support *Eucalyptus victrix* trees that have the potential to be used for nesting if they possess previously built nests. The Grey Falcon recorded by *ecologia* (2021b) was in close proximity to a drainage line in the Mulga East portion of the Development Envelope**.**

The Mixed Eucalypt/Mulga Floodplain habitat type is associated with the Fortescue Marsh Environmentally Sensitive Area (ESA)(WA0066) as identified by the Directory of Important Wetlands in Australia (DIWA) and supports trees (*Eucalyptus victrix*) of a suitable size for nesting if they possess previously built nests (*ecologia* 2023b). This habitat type occurs outside of the Development Envelope (**Figure 10-15**).

Based on the results of surveys to date, it is likely that the Development Envelope is used by this species on an occasional basis for foraging and potential breeding.

The remainder of the habitat types within the Development Envelope are unlikely to provide suitable nesting habitat for the Grey Falcon. The Chenopod/Cracking Clay Floodplains habitat has been identified a suitable for foraging and has been considered in this assessment.

10.3.3.8 Peregrine Falcon (*Falco peregrinus*)

Conservation Status: BC Act Other Specially Protected Fauna.

Distribution, Habitat and Ecology

The Peregrine Falcon is one of the most widespread birds in the world, breeding on all continents except Antarctica (Olsen et al., 2006). It occurs across most of Australia though are an uncommon species and are rare across all states and territories (Bird Life Australia, 2012a). They are known to be both a nomadic and sedentary species and are uncommon in the Kimberley, Hamersley and Darling Ranges. They inhabit cliffs, coastal habitats, rivers, wooded water courses and lakes as well as urban environments. Peregrine Falcons usually nest by making a scrape on a high cliff edge but will also use stick nests of other large birds and tree hollows in some areas (Olsen et al., 2006). Hunting is mainly done during the day and feeding is primarily on small to medium sized birds caught in flight, often above drainage lines and rivers. Favoured prey species include the Galah (*Eolophus roseicapilla*) and Sulphur-crested Cockatoo (*Cacatua galerita*) (Bird Life Australia, 2012b).

Surveys

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments, including the Peregrine Falcon. These searches primarily focused on recording species from direct observation, secondary evidence and/or habitat features of importance likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023; **Appendix 11c**).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included identification of secondary evidence (Attexo 2023). At all times while surveying, all records pertaining to species not previously recorded during the

survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary evidence (Attexo, 2023).

Occurrence in the Development Envelope

One historical record of this species was found in the Development Envelope (*ecologia* 2020). It is also likely to occur in the Solar Farm area. Numerous additional records from the DBCA Threatened Fauna Database Search are located within 60 km of the Development Envelope.

This species occupies extremely diverse habitats and has the potential to occur in the Development Envelope in all the habitats present, for foraging. No suitable nesting habitat was recorded within the Survey Areas.

Figure 10-15: Grey Falcon records and potential nesting trees

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

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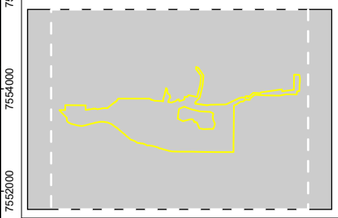
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem

EPBC Act Status

- Grey Falcon (VU)
- Suitable nest

Fauna habitat

- Chenopod/ Cracking Clay Floodplain
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed



JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

EPBC Act Status

- Grey Falcon (VU)
- Suitable nest

Fauna habitat

- Chenopod/ Cracking Clay Floodplain
- Drainage Lines/Floodplains
- Mulga Woodland
- Rocky Hills
- Rocky Plains and Footslopes

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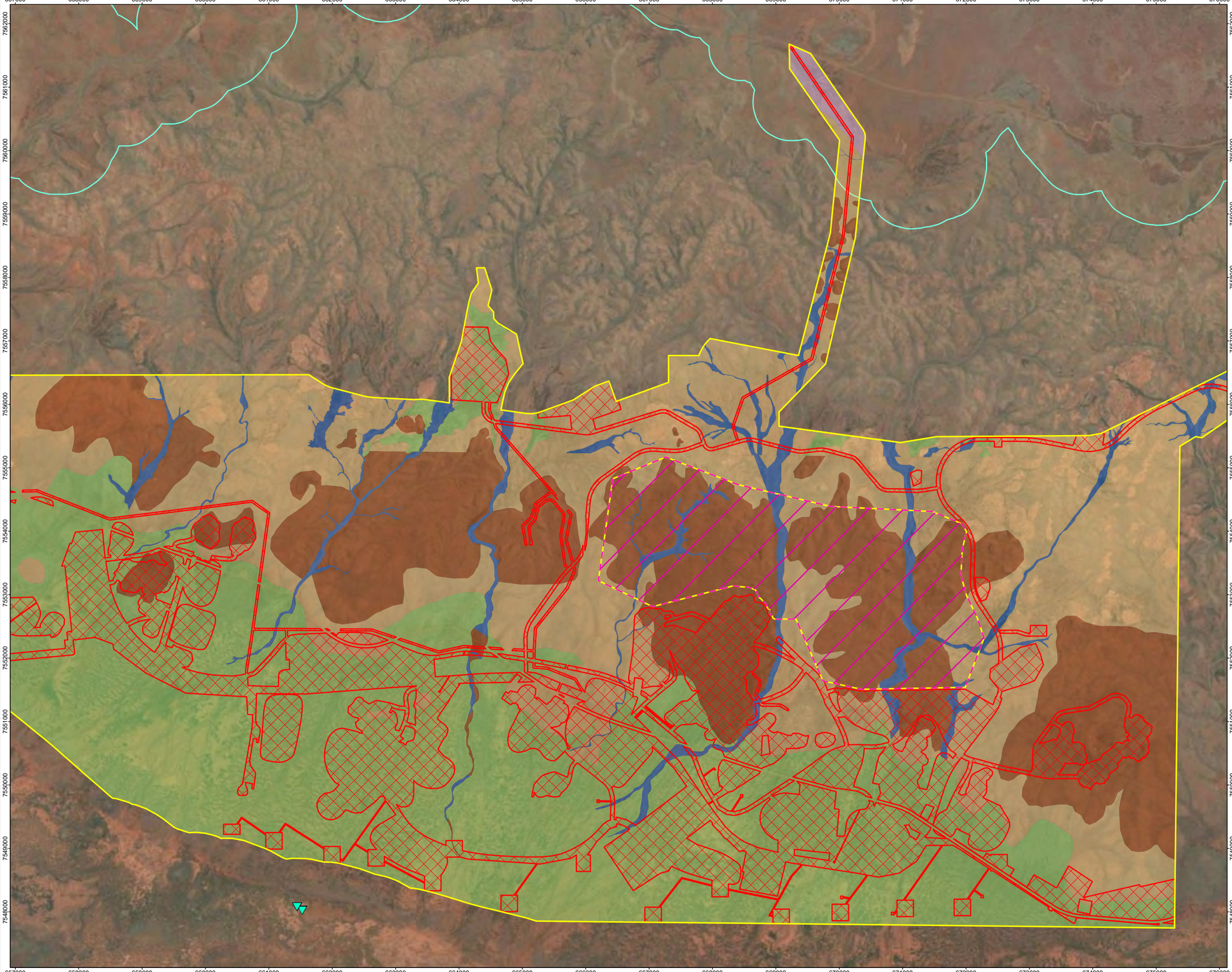
GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 2 of 4

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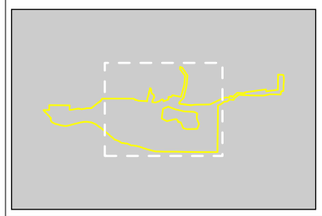


Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem
- Suitable nest

Fauna habitat

- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Rocky Plains and Footslopes



JBS&G

Job No: 67751	
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0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 3 of 4

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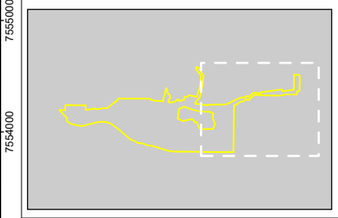
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Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem

Fauna habitat

- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed



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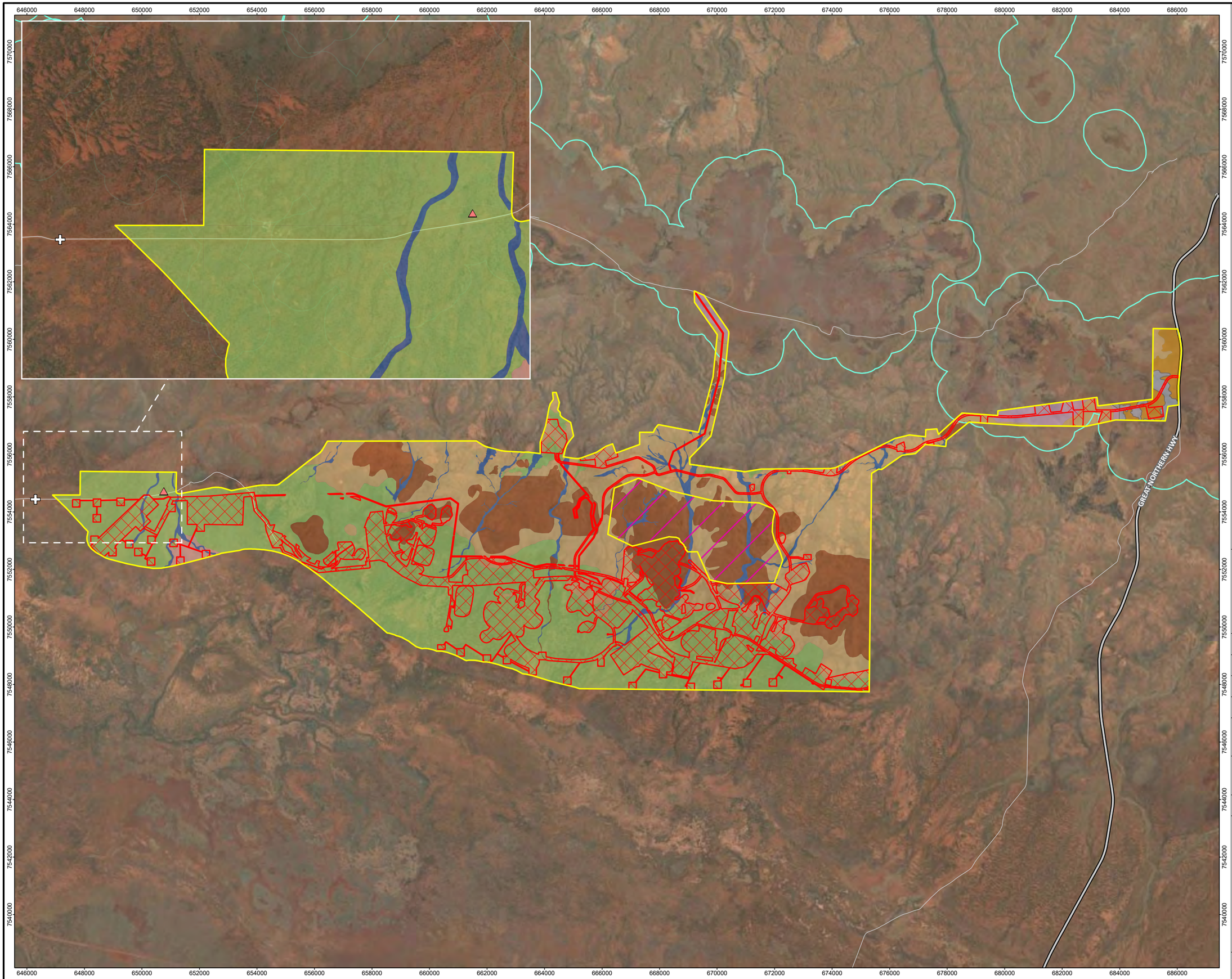
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GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-16: Peregrine Falcon and Grey Falcon Records and Habita



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem

Fauna habitat

- Chenopod/ Cracking Clay Floodplain
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed

BC Act Status

- Grey Falcon (VU)

DBCA lisitng

- Peregrine Falcon (OS)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 30-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PEREGRINE FALCON AND GREY FALCON RECORDS AND HABITAT

FIGURE 10.16

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10.3.3.9 Gane's Blind Snake (*Anilios ganei*)

Conservation Status: DBCA: Priority 1.

Distribution, Habitat and Ecology

The Gane's Blind Snake is an elusive, moderately robust blind snake that lives primarily underground. Due to its subterranean lifestyle, the species is rarely recorded and relatively little is known of its ecology. The Gane's Blind Snake has a rounded snout that is greyish on the upper side and cream on the underside (Wilson and Swan, 2017). Its distribution is limited to the Pilbara region between Newman and Pannawonica (Wilson and Swan, 2017; DBCA 2021). The species is likely to enter social insect nests to feed on termite and ants, as well as their eggs and pupae. The Gane's Blind Snake is thought to be associated with moist gullies and gorges though little published information exists (Aplin, 1998). A specimen was recorded in the Hamersley Range from a stony clay-loam valley floor vegetated with *Triodia* sp. suggesting that the species may utilize moist gullies and gorges though is not restricted to them (Ecoscape 2011).

Surveys

Surveys completed for the Proposal targeting the Gane's Blind Snake included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

The surveys included multiple basic, detailed, and targeted survey events between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA *Technical Guidance: Terrestrial Fauna Surveys* (EPA, 2016a). The surveys included multiple basic, detailed, and targeted surveys between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken were compliant with the required guidance. For the Gane's Blind Snake these were:

- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b).

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence and/or habitat features of importance likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area.

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included raking leaf litter and spoil heaps,

overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence (Attexo 2023). At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., shed skins) evidence (Attexo, 2023).

The total survey effort undertaken for the Gane's Blind Snake by *ecologia* (2021b), Biologic (2022b) and Spectrum (2023a; 2024b) and included:

- Motion sensor camera traps at 140 sites over 7,067 trap nights;
- Cage traps at 50 sites over 385 trap nights;

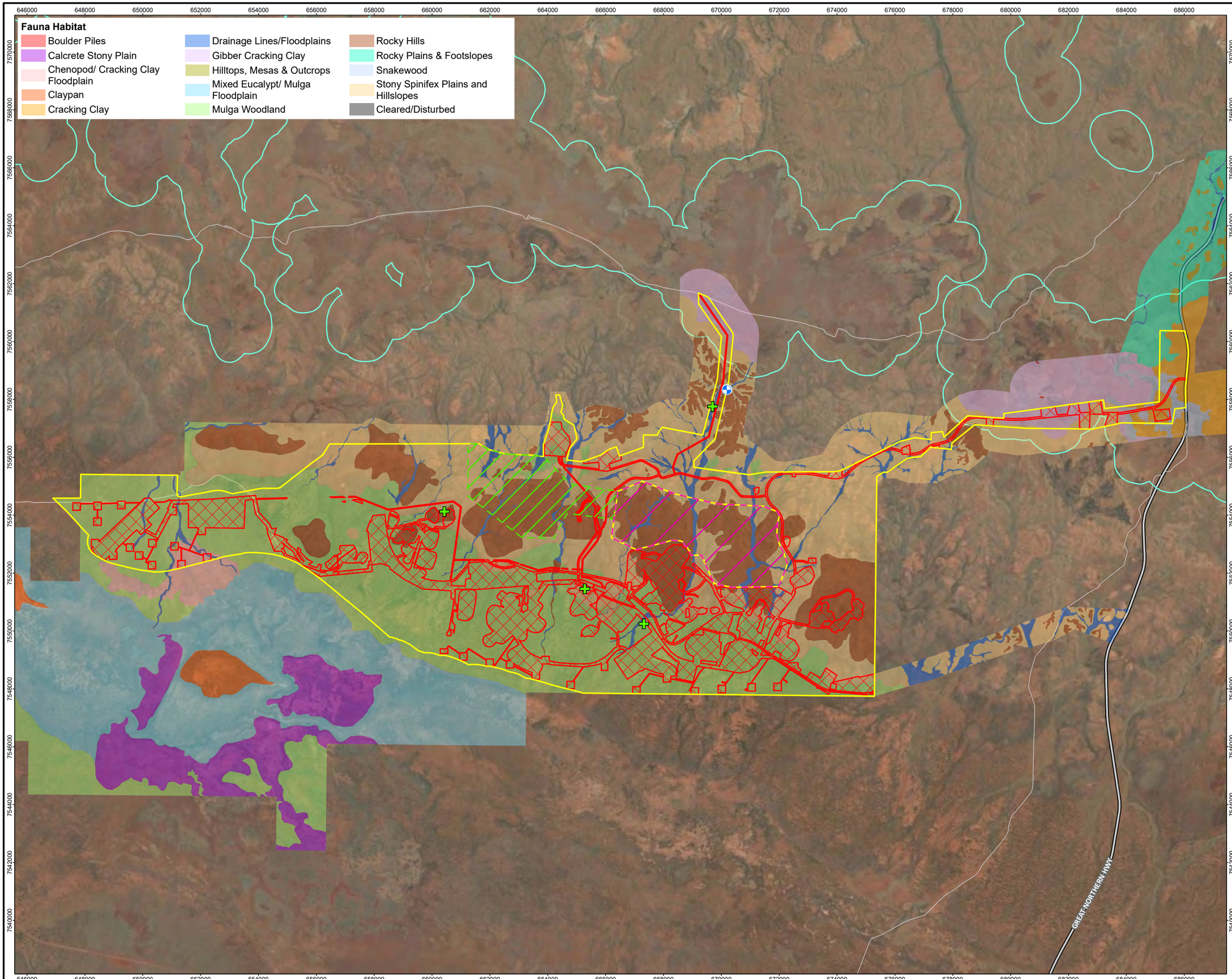
Targeted searches, including 229.38 hours targeted surveys and 55 hours of nocturnal searches.

Occurrence in the Development Envelope

Four individual Gane's blind snakes were recorded from two sites in phase 1 and on one occasion during phase 2 at another site MDPT017 by *ecologia* (2021a). This species was recorded within Mulga Woodlands and Stony Spinifex Plains and Hillslopes habitat types (*ecologia* 2020) and gullies and gorges. This species

Suitable habitat for the Gane's Blind Snake includes Rocky Plains and Footslopes, Rocky Hills, and Mulga Woodlands.

Figure 10-17: Gane's Blind Snake records and Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Gane's Blind Snake (P1) records
- Water feature

Roads (LGATE-195)

- Highway
- Minor Road

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

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GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 1 of 4

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Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Gane's Blind Snake (P1) records

Roads (LGATE-195)

- Minor Road

JBS&G

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Client: Hancock Prospecting Pty Ltd

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Scale 1:55,000 at A3

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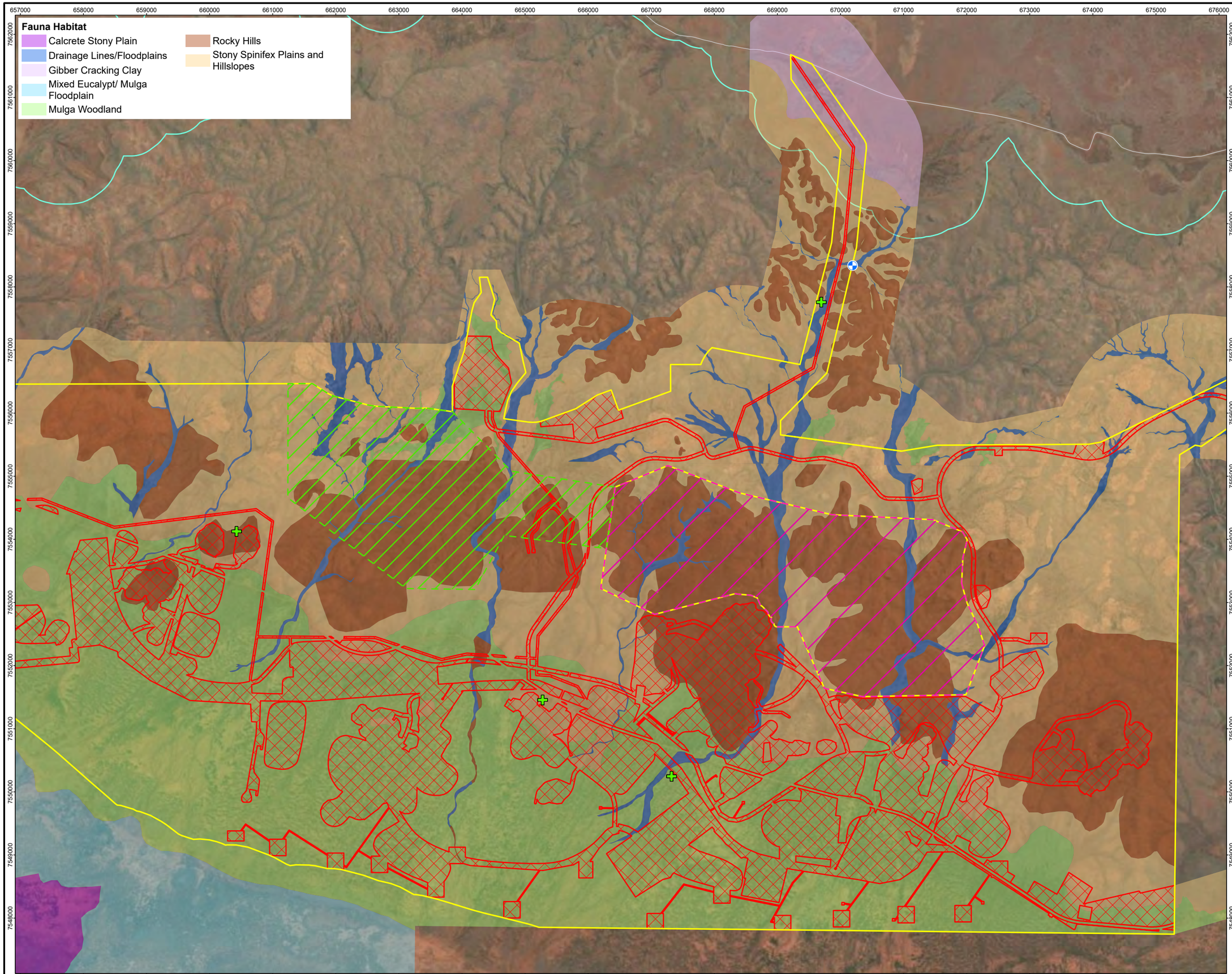
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 2 of 4

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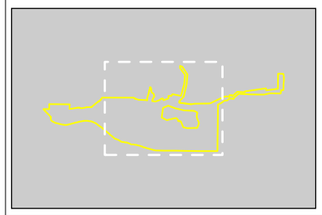
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Gane's Blind Snake (P1) records
- Water feature

Roads (LGATE-195)

- Minor Road



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Mulga Downs Iron Ore Mine
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GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 3 of 4

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Image Reference: World Imagery: Earthstar Geographics

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

GREAT NORTHERN HWY

Legend

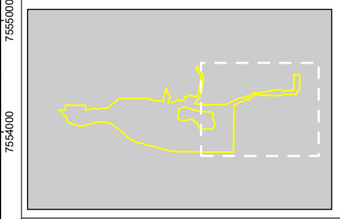
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Water feature

Roads (LGATE-195)

- Highway
- Minor Road



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Kilometers

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GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics

10.3.3.10 Spotted Ctenotus (*Ctenotus uber johnstonei*)

Conservation Status: DBCA: Priority 2.

Distribution, Habitat and Ecology

Habitat preferences for the Spotted Ctenotus are poorly known however previous records of the subspecies in the Pilbara region are associated with stony hillslope and plain habitats with variable vegetation cover often dominated by open Acacia shrubland and Triodia hummock grasslands (Cogger 2014).

Surveys

Surveys completed for the Proposal targeting the Spotted Ctenotus included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

The total survey effort undertaken for the Spotted Ctenotus by *ecologia* (2021a), Biologic (2022b) and Spectrum (2023a; 2024b) and included 229.38 hours targeted surveys and 55 hours of nocturnal searches.

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats, shed skins and pebble-mounds) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included raking leaf litter and spoil heaps, overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence (Attexo 2023).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

No evidence of this species was recorded in the Development Envelope. This species has previously been recorded approximately 30 km west of the Development Envelope and is considered likely to be a resident of

Mulga Woodland, Stony Plains and Slopes and Drainage Area/Floodplain habitats. It should be noted that there is currently some taxonomic uncertainty regarding the isolated Pilbara population of this subspecies, and the population may represent an undescribed taxon.

Habitat considered suitable for the Spotted Ctenotus include Mulga Woodland, Stony Spinifex Plains and Hillslopes, and Drainage Line/Floodplain.

10.3.3.11 Western Pebble-mound Mouse (*Pseudomys chapmani*)

Conservation Status: DBCA: Priority 4.

Distribution, Habitat and Ecology

The Western Pebble-mound Mouse is endemic to the Pilbara region of Western Australia. Distribution extends from southern and central Pilbara to the Little Sandy Desert (Van Dyck and Strahan, 2008a) It is one of three species of Australian rodent that constructs an underground burrow system with a permanent arrangement of stones above ground at the entrances (Anstee, Roberts and Shea, 1997a). They are found on pebbled soil in arid tussock grassland and acacia woodland on gentle slopes of rocky ranges, with hard spinifex and scattered shrubs. The mice have a complex social structure and are known to occur in groups of up to 12 animals, who may utilise several burrow structures (Anstee, Roberts and Shea, 1997b). Male home ranges were found to be considerably larger than those of females, particularly during breeding season (Anstee, Roberts and Shea, 1997b).

Surveys

Surveys completed for the Proposal targeting the Western pebble-mound Mouse included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey(**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**);
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Additionally, the Spectrum (2024a) Mulga Downs Iron Ore Mine Targeted Bilby and Night Parrot Survey identified mounds at 26 sites during this survey.

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats and pebble-mounds) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence (Attexo 2023).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., mounds, scratching, diggings, tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

The Western Pebble-mound Mouse was recorded across the Development Envelope via secondary evidence in the form of used and disused mounds. Gibber cracking clay habitat type is considered important breeding and foraging habitat but the records within the Development Envelope show the species occurs primarily within Stony Spinifex Plains and Hillslopes and Rocky Hills habitats (Table 10-6**;** Figure 10-18**).** This habitat type is within the FHEZ and the FHEZ Corridor with numerous mounds, both active and inactive present.

Habitat which supports the Western Pebble-mound Mouse includes Rocky Plains and Footslopes, Gibber Cracking Clay, Stony Spinifex Plains and Hillslopes, and Rocky Hills.

10.3.3.12 Brush-tailed Mulgara (*Dasycercus blythi)*

Conservation Status: Priority 4, DBCA

Distribution, Habitat and Ecology

The Brush-tailed Mulgara is a significant mesopredator in arid Australia occupying both sand plains and gibber plain habitats, the latter being a new habitat for the species (Pavey et al., 2011). This species displays home ranges that overlap between sexes encompassing both mature spinifex and open regrowth. Mature spinifex hummocks appear to be important for protection from introduced predators (Kortner et al., 2017). The Brush-tailed Mulgara excavates single entrance burrows with multiple side tunnels that may terminate at surface 'pop-holes'. It is a nocturnal hunter, predating upon rodents, reptiles, and arthropods. Breeding takes places during the winter months with females recorded carrying young in September (Van Dyck and Strahan 2008).

Surveys

Surveys completed for the Proposal targeting the Brush-tailed Mulgara included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**);
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. Unmanned Aerial Vehicles (UAVs) were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence (Attexo 2023).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., burrows, scratching, diggings, tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

The Brush-tailed Mulgara was not recorded during surveys within the Development Envelope, however is considered likely to occur. The nearest record of this species is located approximately 23 km north east of Mulga

East. The likelihood of occurrence within the Development Envelope is possible as a resident of Drainage Area/Floodplain habitats where suitable vegetation cover and sandy or loamy substrates permitting burrowing are present. The species occurrence and abundance is dependent on seasonal conditions particularly following rainfall events when resources are more abundant.

10.3.3.13 Northern Short-tailed Mouse (*Leggandina lakedowensis*)

Conservation Status: Priority 4, DBC

Distribution, Habitat and Ecology

The Short-tailed Mouse is a small rodent with a 50-85mm snout vent length. The Short-tailed Mouse has been recorded sporadically across northern Australia from the tropical coast extending to semi-arid regions (Moro and Kutt 2008). They are found in a variety of habitats including spinifex and tussock grasslands, samphire shrublands, sedgelands and open woodlands. Most records are from seasonally inundated sandy clay or cracking clay soils in which it constructs simple, single chambered burrows (Kutt and Kemp, 2005). Its diet consists of primarily invertebrates but also plants, which supplement water requirements (Watts and Aslin 1981). This species is sparsely distributed across Australia with the most abundant population occurring on Thevenard Island and the recently established Serrurier Island (Moro and Morris 2000).

Surveys

Surveys completed for the Proposal targeting the Northern Short-tailed Mouse included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**);
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats) and/or habitat features of importance (i.e., den sites) likely to be utilized by these species. Unmanned Aerial Vehicles (UAVs) were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence (Attexo 2023).

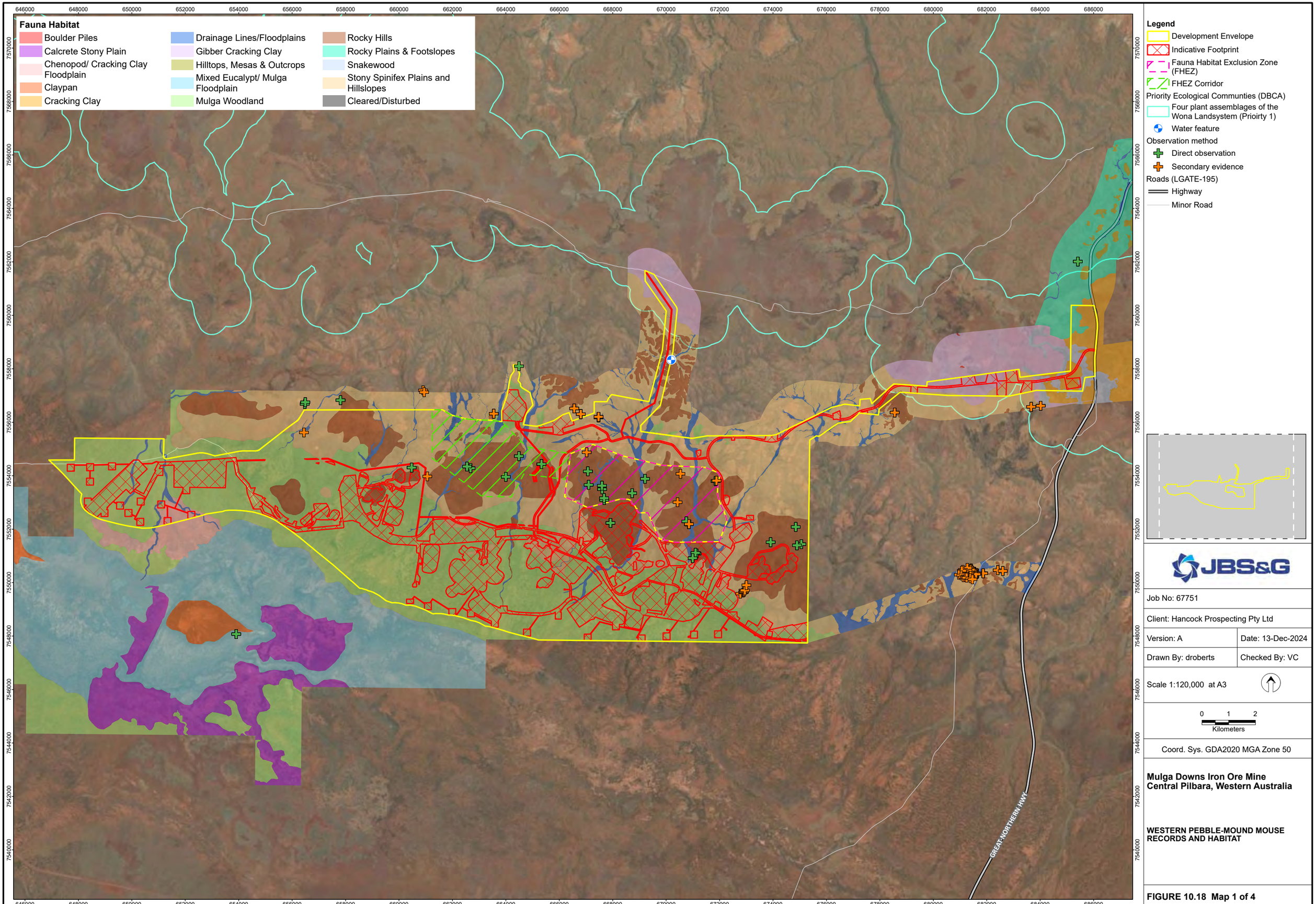
At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., burrows, scratching, diggings, tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

The Northern Short-tailed Mouse was not recorded during surveys within the Development Envelope; however, it is considered likely to occur. Suitable habitat likely to support the species occurs within Drainage Area/Floodplains, Mulga Woodland and Gibber Cracking Clay habitats. Abundance within the Development Envelope is likely to fluctuate particularly following rainfall events when resources are most abundant.

Despite the targeted survey effort, no primary or secondary evidence of Northern Short-tailed Mouse was recorded in the Development Envelope from any of the surveys. The likelihood of Northern Short-tailed Mouse breeding and forming dens within the Development Envelope is considered low and this species is instead considered to be a visitor. The presence of cats, foxes and wild dogs, which are known predators of the Northern Short-tailed Mouse (DCCEEW 2023j; Pavey 2006), further decreases the likelihood of Northern Short-tailed Mouse being residents within the Development Envelope (*ecologia* 2021a).

Figure 10-18: Western Pebble-mound Mouse records and Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature

Observation method

- Direct observation
- Secondary evidence

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

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Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)

Observation method

- Direct observation
- Secondary evidence

Roads (LGATE-195)

- Minor Road

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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 2 of 4

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Fauna Habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature

Observation method

- Direct observation
- Secondary evidence

Roads (LGATE-195)

- Minor Road

JBS&G

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Version: A	Date: 13-Dec-2024
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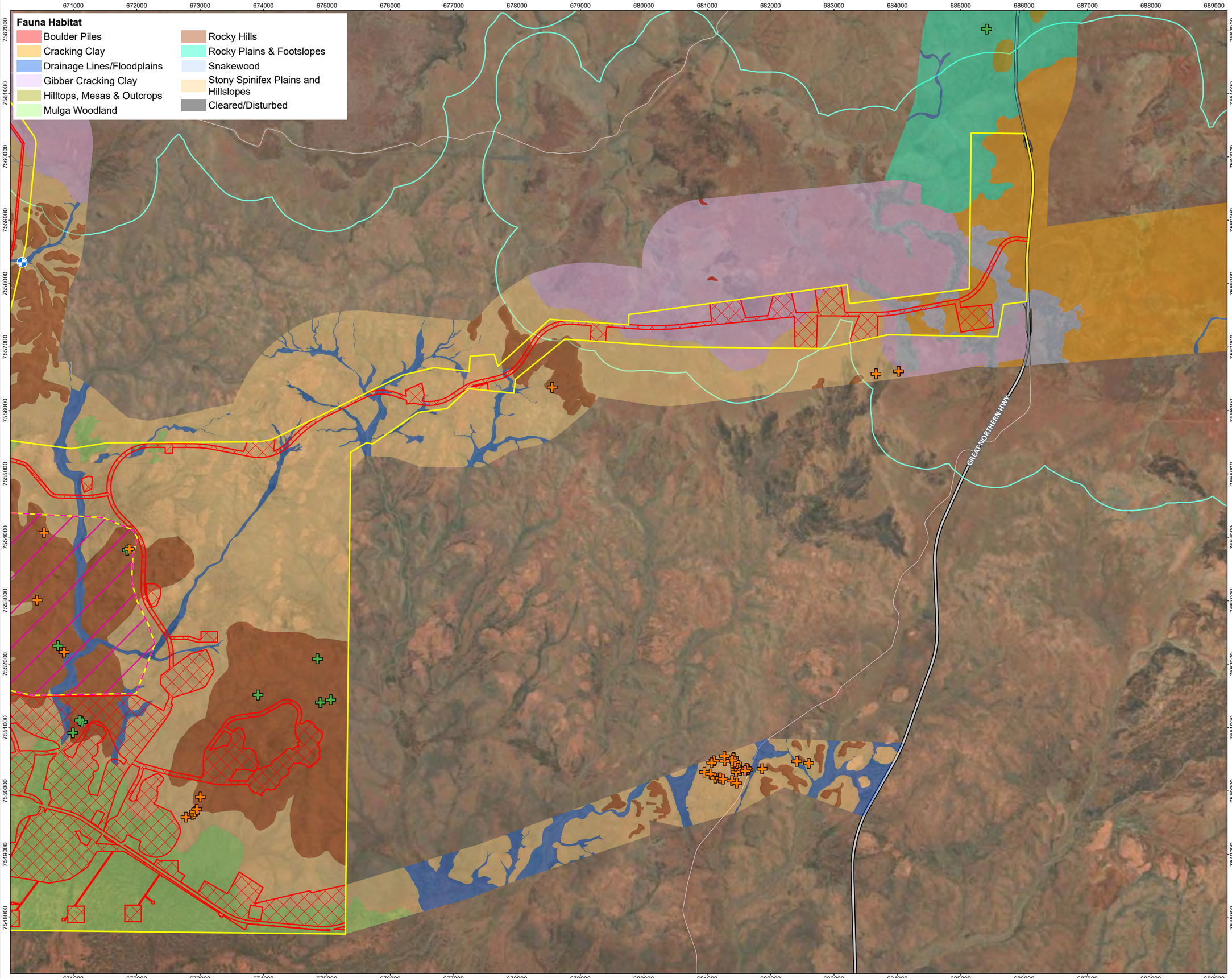
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 3 of 4

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Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature

Observation method

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- Secondary evidence

Roads (LGATE-195)

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WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics

10.3.3.14 Migratory Bird Species

The following migratory species have the potential to be located in the Development Envelope:

- Common Greenshank (*Tringia nebularia*);
- Wood Sandpiper (*T. glareola*);
- Glossy Ibis (Plegadis falcinellus); and
- Red-necked Stint (*Calidris ruficollis*).

Conservation Status: Migratory

Distribution, Habitat and Ecology

The migratory bird species which are considered of particular relevance to the Development Envelope are the Common Greenshank (*Tringia nebularia*), Wood Sandpiper (*T. glareola*), Red-necked Stint (*Calidris ruficollis*), and Glossy Ibis (*Plegadis falcinellus*). All are categorised as Migratory under the BC Act.

The Common Greenshank is a heavily built, elegant wader, 30 cm –35 cm in length, with a wingspan of 55 cm–65 cm and weight up to 190 g for both males and females. It does not breed in Australia. However, this species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia. In Western Australia, the Common Greenshank is generally absent from the Western Deserts although there are a few records from the Great Sandy Desert and the Nullarbor Plain. It occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberley, it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago (Higgins & Davies, 1996).

The Wood Sandpiper is species is of a similar size and has similar habits to the Common Greenshank. It breeds in northern Europe, north Asia and winters in southern areas including Australia where it inhabits shallow freshwaters (river pools, lakes, claypans, lagoons, swamps) and is less likely to occur in salty or brackish waters (Johnstone and Storr 1998, *ecologia* 2021a). This species is highly mobile and tends to be found around any open body of water including pools in drainage lines after rain. Largest numbers are recorded in north-west Australia, with all areas of national importance located in Western-Australia.

The Red-necked Stint is a small *Calidridinae* approximately 13 cm – 16 cm in length and is the smallest shorebird in Australia (Geering et al. 2007, JBS&G 2022). It is distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint has been recorded in all coastal regions and found inland in all states when conditions are suitable. Important populations are found at the Eighty Mile Beach (Ramsar Listed) and Port Hedland Saltworks and various other coastal areas in Australia. The Red-necked Stint breeds in Siberia and sporadically in north and west Alaska.

The Glossy Ibis is the smallest ibis known in Australia. It is found singularly, in pairs or in small flocks. Large flocks are also occasionally large, for example the largest was about 60 000 birds in the Alligator Rivers region, Northern Territory (Morton et al. 1989). The Glossy Ibis is found in the company of other ibis such as the Straw-necked Ibis (*Threskiornis spinicollis*) or Australian White Ibis (*Threskiornis molucca*). Breeding is colonial and often with or near other ibis, herons, and egrets (Marchant & Higgins 1990).

Surveys

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence and/or habitat features of importance likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023; **Appendix 11c**).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g. scats, nests) evidence (Attexo 2023).

Occurrence in the Development Envelope

The Common Greenshank is highly mobile species and was recorded on several occasions utilising the surface water features within the Gnalka Gnoona Claypan. The species is considered to be an infrequent visitor to the Claypans and Drainage Lines habitat and Mixed Eucalypt/Mulga Floodplain within the Development Envelope, when these areas have been inundated after rainfall (**Figure 10-19**).

The Wood Sandpiper was recorded during surveys across the Mulga East area within the Gnalka Gnoona Claypan and is considered to be an infrequent visitor to the Claypan and Mixed Eucalypt/Mulga Floodplain habitats in the Development Envelope when this area is inundated after rainfall. This species has been previously recorded within the Upper Fortescue Marsh (EPA, 2013).

Two records of the Glossy Ibis were identified by database searches within 40 km of the Development Envelope including one historical record at the Gnalka Gnoona Claypan in 2004. Although this species was not recorded during surveys, it is likely to be an infrequent visitor to the Claypan habitat in the Development Envelope

Eight Red-necked Stints were recorded within the Gnalka Gnoona Claypan on two separate occasions during surveys across the Mulga East area. It is considered likely that this species will be an infrequent visitor to the Claypan habitats in the Development Envelope when inundated after rainfall. The large salt crust habitat on the margins of the Upper Fortescue Marsh is considered to be optimal foraging habitat for waders such as the stint.

Figure 10-19: Migratory Species Records

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

Legend

- Development Envelope
- Indicative Footprint
- Claypans
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed

BC Act (Migratory)

- Common Greenshank
- Little Curlew
- Red-necked Stint
- Wood Sandpiper

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 02-Apr-2025
Drawn By: dmills	Checked By: VC

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MIGRATORY SPECIES RECORDS

FIGURE 10.19

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Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.4 Vertebrate Fauna Habitat

Basic fauna habitat assessments were conducted throughout the Development Envelope to broadly describe areas of habitat that were distinguishable by vegetation, soil characteristics and land features. The identified habitats were considered likely to support different fauna assemblages to those found in adjoining habitat types. The assessment of the Development Envelope paid particular attention to the likelihood of conservation significant fauna to be present in each habitat type. Extensive ground truthing of habitat types during subsequent surveys allowed fauna habitat mapping within the Development Envelope to be further refined.

10.3.4.1 Habitat Types

Nine broad terrestrial fauna habitat types were identified within the Development Envelope (**Table 10-6**) and shown in Attexo (2023) and Spectrum (2023a). These habitats are:

- Stony Spinifex Plains and Hillslopes;
- Rocky Hills;
- Gibber Cracking Clay;
- Drainage Line/Floodplain;
- Mulga Woodland;
- Chenopod/Cracking Clay Floodplain
- Cracking Clay;
- Snakewood; and
- Rocky Plains and Footslopes.

The condition of the habitats within the Development Envelope ranged from 'Degraded' to 'Excellent' (Attexo 2023). Areas identified as 'Degraded' were primarily disturbed by cattle grazing. The Mulga Downs Station has been an operational pastoral lease for over 100 years. As a result, there is long-term impacts to vegetation from overgrazing, trampling, and from the spreading of weeds. The most impacted are the Chenopod/Cracking Clay Floodplain, Drainage Line and Mulga Woodland habitats which have a lower rating of 'Good'. The lower rating in habitat condition for the Mulga Woodland is a result of exploration activities, with areas cleared for drill lines (Attexo 2023) (refer to **Section 8**– Flora and Vegetation, **Figure 9-3** for mapped vegetation condition).

Table 10-6: Mapped Vertebrate Fauna habitat within the Development Envelope [2]

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
Mulga Woodland	Compacted alluvial loamy clay soils with occasional surface stones are generally not favourable for burrowing species with few burrows recorded during the surveys. Dead wood, peeling bark, stumps and leaf litter provide shelter for marsupials, monitors, geckos and skinks. Open woodland of *Acacia aneura, A. xiphophylla* with isolated *A. pruinocarpa* over *Acacia* spp., *Eremophila* spp., *Dodonaea petiolaris* and *Hakea* sp. over sparse soft grasses or *Triodia hummock* grasslands. The Mulga Woodland has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Regionally this habitat type is generally well represented.	43,575.10	8,203.43	2,824.74	**Low:** Considered generally of low value to conservation significant fauna. Fauna recorded: • Gane's Blind Snake; This habitat type is foraging habitat for: • Pilbara Leaf-nosed Bat (Priority 5 foraging habitat); • Bilby • Peregrine Falcon; • Spotted Ctenotus; and • Northern Short-tailed Mouse. This habitat type may be potential nesting habitat for Bilby.	
Rocky Hills	The Rocky Hills provides quality refugia, shelter and caves for conservation significant species. Ridgelines, boulders, crevices and caves provide shelter, denning and roosting habitat for species including Northern Quolls, Pilbara Leaf-nosed Bat, Ghost Bat , Pilbara Olive Python, Rothschild's Rock Wallaby, rock rats, monitor lizards and *Pseudantichinus* sp.. This habitat is recognised as an area where the Northern Quoll population have retreated, allowing for the population to persist. Rocky Hills are considered common and widespread throughout the Pilbara.	11,982.01	2,658.23	520.80	**High**: The Pilbara Leaf-nosed Bat and Northern Quoll were recorded within this habitat type within and outside of the Development Envelope. Provides shelter, denning and roosting habitat for species including: • Northern Quolls, • Pilbara Leaf-nosed Bat (Priority 2 foraging habitat), • Ghost Bat, • Pilbara Olive Python, • Ganes Blind Snake Potential foraging habitat for the: • Peregrine Falcon • Western Pebble-mound Mouse	
Stony Spinifex Plains and Hillslopes	Coarse stony red clay soils, the substrates and vegetation support termitaria which are a known refuge for vertebrate fauna. The coarse stony red clay soils provide habitat for the Western Pebble-mound Mouse (DBCA, Priority 4), recorded within and outside of the Development Envelope. Isolated E*ucalyptus leucophloia* over sparse shrubland of mixed *Acacia* spp. Over open spinifex hummock grassland. The *Triodi*a hummocks found are generally small and few isolated long unburnt patches are present. Stony Spinifex Plains and Hillslopes are widespread in the Pilbara.	62,690.54	4,758.15	813.97	**Moderate:** Stony Spinifex Plains and Hillslopes are considered as moderate value as they generally offer minimal refugia to species of conservation significance however, where they are adjacent to high value breeding habitat they are a supporting habitat. The following conservation significant species are known to forage within this habitat type: • Pilbara Olive Python • Northern Quoll; • Pilbara Leaf-nosed Bat (Priority 5 foraging habitat); and • Ghost Bat. • Grey Falcon • Night Parrot • Potential foraging habitat for Peregrine Falcon, • Spotted Ctenotus	

[2] area calculations are based on multiple surveys with some overlap and as a result some figures may be an overestimate.

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
					• Westen Pebble-Mound Mouse This habitat type may also provide roosting habitat for Night Parrot in areas of mature unburnt spinifex.	
Chenopod/ Cracking Clay Floodplain	This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. This habitat type is not considered widespread in the Pilbara.	983.20	92.78	15.72	**Low:** Due to the condition of this habitat type within the Development Envelope, it is considered low value to species of conservation significance. This habitat type is: • Priority 5 foraging habitat for the Pilbara Leaf-nosed Bat. • Foraging habitat for Night Parrot – in proximity to mature spinifex only. • Potential foraging habitat for Peregrine Falcon.	
Drainage Line/Floodplain	The banks provide quality burrowing substrates for monitors while trees and shrub species provide habitat for birds such as honeyeaters and corellas. Drainage lines are of low to moderate conservation value as they provide foraging and dispersal habitat for fauna. This habitat is considered widespread in the Pilbara. The area has a vegetation system of scattered *Eucalyptus victr*ix or *Corymbia hamersleyana* over an open shrubland of *Acacia tumida* and *A. pyrifolia* over hummock and tussock grasses.	38,141.21	522.64	71.26	**Moderate - High**: Drainage lines are of moderate conservation value as they provide foraging and dispersal habitat for fauna. They are considered high value when they are within the home range for the Northern Quoll breeding habitat. Conservation significant species known to utilise drainage lines include: • Northern Quoll – dispersal and foraging habitat; • Ghost Bat - foraging habitat; and • Pilbara Leaf-nosed Bat - Priority 5 foraging habitat. • Greater Bilby; • Potential foraging habitat for Peregrine Falcon, • Spotted Ctenotus • Brush-tailed Mulgara • Northern Short-tailed Mouse This habitat type may also support foraging and potential breeding habitat for the Grey Falcon and Night Parrot in areas of mature unburnt spinifex.	
Gibber Cracking Clay	This habitat was previously known as the 'Cracking Clays of the Chichester and Mungaroona Range' P1 Priority Ecological Community (PEC). This PEC is a stony gibber community occurring on the tablelands and forms one of the plant assemblages of the 'Four Plant Assemblages of the Wona Land System' P1 PEC. Primarily a stony gibber community with very little vegetative cover during the dry season with a suite of ephemerals/annuals and short-lived perennials during wet season. While sporadic in nature, this habitat is considered widespread in the Pilbara.	3,556.27	257.69	56.48	**Moderate:** This habitat type is known to be important breeding, foraging and dispersal habitat for: • Short-tailed Mouse; • Western Pebble-mound Mouse. This habitat also supports non-critical foraging habitat for the following species: • Ghost Bat; and • Peregrine Falcon.	

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
Cracking Clay	Cracking Clay habitat overlaps the 'Four plant Assemblages of the Wona Land System' Priority Ecological Community (PEC) (Priority 1). The land system consists of cracking clays with little vegetation cover during the dry season. With the onset of the wet season numerous ephemerals/annuals and short-lived perennials emerge. Vegetation type: Sparse chenopod shrubland of *Sclerolaena trigona*, *S. bicornis, S. densiflora* over low tussock grasses of *Eragrostis xerophila* on a substrate of cracking clays. Vegetation is generally very sparse with patches of scattered Snakewood *(Acacia xiphophylla)* and occasional Mulga over Buffel and scattered native grasses. Leaf and wood litter was sparse or absent due to lack of vegetation; however, basalt rock cover was found to be abundant. While sporadic in nature, this habitat is considered widespread in the Pilbara.	5529.69	217.84	28.10	**Low:** This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. Marginally suitable as foraging habitat for the Night Parrot. This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby.	
Snakewood	Vegetation type: Vegetation dominated by discrete patches of Snakewood (*Acacia xiphophylla*). The Snakewood (*Acacia xiphophylla*) habitat is restricted to scattered patches within the cracking clay habitat type. Other vegetation recorded in this habitat type included *Acacia inaequilatera* and scattered Mulga and Mesquite over Buffel grass. Leaf and wood litter was very sparse and basalt rock cover was abundant. This habitat occurs within the 'Four plant Assemblages of the Wona Land System' PEC (Priority 1) in association with the Cracking Clay habitat and support the same conservation significant fauna.	731.62	96.55	8.04	**Low:** Provides potential foraging for fauna which occur on Cracking Clay habitat. This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby.	
Rocky Plains and Footslopes	Vegetation characterising this habitat includes *Corymbia hamersleyana*, *Acacia inaequilatera* and *Hakea chordophylla* over hummock grassland of *Triodia* sp.. This habitat type comprises flat to low undulating areas and low hills. Much of the Rocky Plain and Footslope habitat occurs within the lower lying plain which can often be subjected to sheetflow following large rainfall events. In this habitat type there was high abundance of pebbles and stones, while leaf litter was generally very sparse to absent and restricted to beneath shrubs with occasional fallen timber. The substrate of this habitat type consists of loamy clay soils.	32,444.58	37.75	0.00	**Low:** This habitat provides potential foraging habitat in the drainage lines and grasslands. This habitat type has the potential to support: • Northern Quoll • Western Pebble-mound Mouse; • Gane's Blind Snake; • Grey Falcon; • Brush-tailed Mulgara; • Greater Bilby; • Night Parrot (however no suitable breeding habitat was known nearby and the area was recently burnt); and • foraging habitat for the Ghost Bat and Peregrine Falcon.	
Cleared / Disturbed		771.02	3.47	0.04		
Total		**184,423.23**	**16,848.53**	**4,339.16**		

10.3.4.2 Regional Extent of Habitat

Detailed fauna habitat mapping has been completed within the Development Envelope and extending beyond (refer to Attexo 2022 for extent of mapping and refer to Figure 10-20)**.** Mapping is not available for the broader Pilbara region; however, an assessment of land systems provides an indication of the diversity and distribution of fauna habitats present. Van Vreeswyk et al. (2004) classified and mapped the land systems of the Pilbara according to similarities in landform, soil, vegetation, geology and geomorphology.

The land systems represented and typical mapped fauna habitats within the Indicative Footprint are outlined in **Table 10-7.** The dominant land systems within the Development Envelope are also the dominant land systems surrounding the Development Envelope. All mapped land systems extend well beyond the Development Envelope in the Pilbara Bioregion (refer to **Figure 3-2**) with the Development Envelope representing 11% or less of the mapped extent of any system.

Table 10-7: Land Systems and Related Fauna Habitat

Land System	Description	Current Extent in the Pilbara Bioregion (ha)	Extent within Development Envelope (ha)	% of mapped extent in the Pilbara Bioregion that occurs within Development Envelope	Key Aligned Fauna Habitat Types within the Indicative Footprint
Bonney System	Low rounded hills and undulating stony plains supporting soft spinifex grasslands.	74,940.55	61.07	0.08	Gibber Cracking Clays
Boolgeeda System	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	955,011.33	1,681.95	0.18	Stoney Spinifex plains
Brockman System	Level non-saline alluvial plains with clay soils and gilgai microrelief and flanked by slightly more elevated hardpan wash plains.	74,102.33	91.39	0.12	Chenopod / Cracking Clay Floodplain
Hooley System	Level plains of clayey and stony alluvium as a mosaic of surfaces with gilgai microrelief, sometimes stony and non-gilgaied surfaces with abundant stony mantles.	59,081.14	1,578.16	2.67	Mulga Woodland
Jamindie System	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	192,227.16	6,881.74	3.58	Mulga Woodland
Jurrawarrina System	Plains receiving overland sheet flow and with prominent drainage groves.	66,431.76	17.79	0.03	Mulga Woodland Drainage Lines / Floodplains
McKay System	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary	424,812.89	1,514.26	0.36	Stoney Spinifex Plains

Land System	Description	Current Extent in the Pilbara Bioregion (ha)	Extent within Development Envelope (ha)	% of mapped extent in the Pilbara Bioregion that occurs within Development Envelope	Key Aligned Fauna Habitat Types within the Indicative Footprint
	rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.				Rocky Plains and Footslopes
Newman System	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,986,807.91	4,282.31	0.22	Rocky Hills Stoney Spinifex Plains Rocky Plains and Footslopes
Wona System	Basalt upland gilgai plains supporting Roebourne Plains grass and Mitchell grass tussock grasslands, minor hard spinifex grasslands or annual grasslands/herbfields.	194,792.87	583.40	0.30	Chenopod / Cracking Clay Floodplain
Rocklea System	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.	2,881,635.56	156.49	0.01	Rocky Plains and Footslopes

10.3.4.3 Claypans

Two claypans, which form part of the 'Freshwater claypans of the Fortescue Valley' P1 PEC occur outside the Development Envelope: Gnalka Gnoona to the south-east and Koodjeepindarranna to the west (refer to **Section 9.3.5.2**). They are considered to provide temporary habitat for migratory species following rain and the ponding of surface water. While these claypans are not within the Development Envelope, they are located in the vicinity of the Proposal (refer to **Figure 9-4**).

The claypans also support a diverse and highly unique aquatic invertebrate assemblage which are discussed further in **Section 10.3.6**.

The potential impact to these claypans from the Proposal is addressed under the environmental factors Inland Waters in **Section 7** and Flora and Vegetation in **Section 8**.

10.3.4.4 Caves

The Proposal is located within the Chichester IBRA subregion flanking the Fortescue Valley IBRA subregion. The area contains rocky outcrops known to support numerous caves which may provide habitat for fauna. Extensive searches were conducted of all rocky outcrops within the Survey Area by *ecologia* (2021a) to identify the presence of suitable diurnal roosting caves. Any caves within the Survey Area with the characteristics to be used as a diurnal roost were surveyed using autonomous recording units (ARUs). Rocky ridgelines and breakaways

were identified using aerial imagery and unmanned aerial vehicles (UAVs), and subsequently traversed on foot to undertake cave habitat assessments, with the aim of outlining potentially suitable roosting caves for the Pilbara Leaf-nosed and Ghost bats (*ecologia*, 2021a; 2023a).

A total of 82 caves, all located within the Rocky Hills habitat type, were assessed within the Survey Area for characteristics required for bat roosts. Cave habitats were assessed against the following criteria (*ecologia* 2023a):

- **Permanent diurnal (Categories 1 and 2) roosts** - Permanent diurnal roosts - Category 1 permanent roosts are maternity roosts where seasonal presence of young is proven. These often have large colonies present. Category 2 permanent roosts are occupied year-round but without the proven presence of young. Based on wet season presence, these must also be classed as maternal sites, and these often have smaller colonies present. Both categories are considered as critical habitat that is essential for the daily and long-term survival of the Pilbara Leaf-nosed Bat and Ghost Bat.
- **Category 3** - Semi-permanent diurnal roosts - These are used diurnally during some part of the year, but not occupied year-round. They may be used during the breeding cycle and also may facilitate long distance dispersal in the region, particularly in the autumn. They are often associated with a nearby Category 1 or 2 permanent roost as a 'satellite' roost, that together make up a colony. They are considered as critical habitat that is essential for the long-term survival of the Pilbara Leaf-nosed Bat and Ghost Bat.
- **Category 4** - Nocturnal refuge - These are occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. These are not considered critical habitat but are important for persistence in a local area. Most moderately deep caves and shallow abandoned mines fall into this category.

From earlier surveys, one cave (MEC016) was identified as a potential transitory roost (Category 3) for the Pilbara Leaf-nosed Bat (*ecologia* 2021b). Further assessment by *ecologia* (2023a) along with a comprehensive peer review of the long-term data collected at MEC016 (Specialised Zoological 2021) concluded that Cave MEC016 is a Category 4 nocturnal refuge or place of occasional visitation (*ecologia* 2023a). The assessment and the peer review are provided in **Appendix 11h**.

No known or suspected Category 1, 2 or 3 caves exist within the Development Envelope or documented within a 30 km radius. There is anecdotal evidence of roost caves south of the Fortescue Valley within the Hamersley ranges (Bob Bullen pers. comm in *ecologia* 2023a). A summary of the caves surveyed, and the assigned roost categories is presented in Table 2.3 of *ecologia* (2023a).

Of these 82 cave assessments within the Survey Area, 51 were determined as having characteristics of a Category 4 cave (nocturnal refuge) (**Table 10-8**).

In applying the mitigation hierarchy, HPPL identified an area which was not proposed for mining and supported habitat considered high value for MNES. The FHEZ was initially removed from the Development Envelope via a section 43A (EP Act) variation to the Proposal. The FHEZ was expanded via a subsequent section 43A variation to include the Rocky Hill habitat to the west. This measure has resulted in the preservation of 36 caves which are suitable as Category 4 nocturnal roosts within 1,320.82 ha exclusion zone (FHEZ). The FHEZ contains Rocky Hills (950.81 ha), Drainage Line/Floodplains (107.62 ha) and Stony Spinifex Plains and Hillslopes (262.39 ha) habitat, all are important for conservation significant fauna when proximal to Rocky Hills habitat.

Given the high value of the FHEZ and the significance that fragmentation may have on fauna, HPPL implemented further mitigation with the establishment of a corridor (FHEZ Corridor). This area is within the Development Envelope and comprises 991.45 ha which connects the FHEZ to the Chichester Ranges north of the Development Envelope. The FHEZ Corridor allows for the continuation of high value habitat (548.14 ha of Rocky Hills habitat) which is interspersed by Drainage Lines/Footslopes (75.00 ha) with Stony Spinifex Plains and Hilltops habitat (331.16 ha) (refer **Figure 10-20**). Fauna can forage and disperse along the Drainage Lines/Footslopes which also connect to the McKay Land System which supports Rocky Hills, ridges, plateaux remnants and breakaways.

Of the 51 Category 4 caves, 36 will remain in the FHEZ. The FHEZ will not be developed as it is not in the Development Envelope. The FHEZ supports habitat considered high value to the Pilbara Leaf-nosed Bat, Ghost Bat and Pilbara Olive Python. It also supports habitat critical for the survival of the Northern Quoll. An additional six Category 4 caves are located in the FHEZ Corridor and will also be avoided. In total 42 caves found suitable for the Pilbara Leaf-nosed Bat and/or Ghost Bat will be preserved (**Table 10-8**).

Of the 51 Category 4 caves found suitable for Pilbara Leaf-nosed Bat, 15 are located within the Development Envelope and eight are within the Indicative Footprint. Twenty-four of the 51 Category 4 caves were found suitable for the Ghost Bat. Nine are located within the Development Envelope of which five are within the Indicative Footprint. Of the remaining caves suitable for the Ghost Bat which will be preserved – 15 are located outside the Development Envelope within the FHEZ and five are in the FHEZ Corridor (**Table 10-8**).

These Category 4 caves are nocturnal refuge with the potential for these caves to be used at night for resting, feeding or other purposes. They are not considered critical habitat for both the Pilbara Leaf-nosed and Ghost Bat species but may play a role for the persistence of the species in the local area, with the majority of moderately deep caves in the Pilbara falling into this category (Bat Call WA 2021b).

Figure 10-20: Mapped Vertebrate Fauna Habitat

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7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 15-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

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0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 2 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

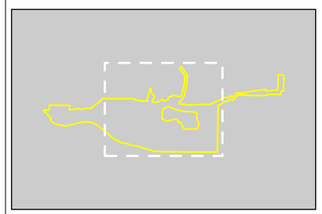
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road



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Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

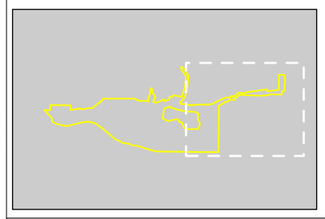
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 15-Nov-2024
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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Table 10-8: Category 4 Caves Surveyed for Pilbara Leaf-nosed and Ghost Bats (X = cave found to be suitable)

Cave ID	Caves in the Development Envelope		Caves in the Disturbance Footprint		Caves in the FHEZ		Caves in FHEZ Corridor[1]	
	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat
MEC001					X	X		
MEC002					X	X		
MEC004					X	X		
MEC006					X	X		
MEC007					X	X		
MEC008					X			
MEC009					X			
MEC010					X			
MEC012					X	X		
MEC015	X	X					X	X
MEC016					X	X		
MEC017	X						X	
MEC018	X	X					X	X
MEC022	X	X					X	X
MEC024	X	X					X	X
MEC025					X			
MEC027					X	X		
MEC030					X	X		
MEC031					X			
MEC033					X			

Cave ID	Caves in the Development Envelope		Caves in the Disturbance Footprint		Caves in the FHEZ		Caves in FHEZ Corridor[1]	
	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat
MEC034					X			
MEC035					X	X		
MEC036	X	X	X	X				
MEC037	X	X	X	X				
MEC038	X							
MEC039					X	X		
MEC041	X	X	X	X				
MEC042	X	X	X	X				
MEC044					X	X		
MEC045					X			
MEC046					X			
MEC048	X							
MEC049					X			
MEC052					X			
MEC054					X			
MEC055					X			
MEC056					X			
MEC062					X			
MEC063					X			
MEC065					X			
MEC066					X			

Cave ID	Caves in the Development Envelope		Caves in the Disturbance Footprint		Caves in the FHEZ		Caves in FHEZ Corridor[1]	
	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat
MEC068					X	X		
MEC069					X	X		
MEC070					X			
MEC073					X	X		
MEC074					X			
MEC075	X							
MEC076	X						X	
MEC079	X	X	X	X				
MEC080	X							
MEC082					X			
Total suitable for each Species	**15**	**9**	**5**	**5**	**36**	**15**	**6**	**4**
Total Suitable Bat Caves	**15**		**5**		**36**		**6**	

10.3.4.5 Water Bodies/Pools

No permanent water pools were found within the Development Envelope during the surveys (*ecologia* 2023a; Biologic 2022b, Spectrum, 2023a, b). A temporary water body (identified as a persistent channel pool in AQ2 2024b) was noted within the Development Envelope during a biological survey (Biologic, 2022a). This feature is located within the northern infrastructure corridor. Two pools were located immediately adjacent to one another spanning a total length of approximately 40 m with a maximum depth of approximately 0.5 m. *Melaleuca glomerata* was recorded immediately adjacent to the pool. Although *Melaleuca glomerata* prefers subsurface soil moisture, it is a low-level indicator of a GDE. The pool is temporary (persisting for up to 3 months), with the presence of water likely due to rainfall preceding and during the survey (Biologic, 2022a). This pool is likely to provide foraging habitat for Northern Quoll, Pilbara leaf-nosed Bat, Ghost Bat and Pilbara Olive Python, particularly given their preference for dispersal corridors such as drainage lines.

Camera traps were placed at this site in 2022 (Biologic, 2022a). An ARU placed at this location recorded the presence of a Pilbara leaf-nosed Bat. No taxa were recorded on the motion cameras placed at this location. This pool does not fall within the Indicative Footprint. This pool will be retained given the importance of this habitat.

10.3.5 Short Range Endemic Invertebrate Fauna

SRE invertebrates are invertebrates which have naturally small distribution which can be influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions, and historical conditions. These not only influence their distribution but also the tendency for differentiation and speciation (Ponder & Colgan, 2002). The range criterion proposed by Harvey (2002) for terrestrial short-range endemism (for terrestrial invertebrates) of less than 10,000 km^2 (or 100 km x 100 km) has been adopted for EIA (EPA, 2016e). Some better-known SREs have been listed under State legislation. The incomplete taxonomic resolution of many SRE taxa has resulted in a limited number of listings, as such the majority of the SREs are categorised as Potential SREs.

The SRE categorization follows the Western Australia Museum's (WAM) revised classification system for SRE invertebrates, based upon the 10,000 km^2 range criterion proposed by Harvey (2002), and uses three categories (Confirmed SRE, Potential SRE, and Widespread) to describe the degree of certainty with which a species can be considered to be SRE or not (**Table 10-9**).

Table 10-9: SRE categorization

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
Species range < 10,000 km^2	• Confirmed SRE. • A known distribution of < 10,000 km^2. • The taxonomy is well known. • The group is well represented in collections and/or has been comprehensively sampled.	• Potential SRE. • Patchy sampling has resulted in incomplete knowledge of geographic distribution. • Incomplete taxonomic knowledge.

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
Species range > 10,000 km^2	Widespread • A known distribution of > 10,000 km2. • The taxonomy is well known. • The group is well represented in collections and/or has been comprehensively sampled.	• The group is not well represented in collections. • Any other significant knowledge gaps occur.

10.3.5.1 Desktop Assessment

SRE invertebrate desktop assessments undertaken as part of the *ecologia* (2021a), Biologic (summarised in 2022c report) and Spectrum (2023a) faunal assessment yielded 888 records of specimens collected in 144 taxa. Comparing these records and those found through the literature review, a total of 15 Confirmed and 91 Potential SRE invertebrate taxa occur within a 40 km radius of the Development Envelope. Of the potentially occurring taxa, 12 have previously been recorded within the Development Envelope. A summary of the confirmed and potentially occurring SRE invertebrate taxa that have been previously recorded within the Development Envelope are provided in **Table 10-10**.

Table 10-10: SRE Invertebrate Taxa (Confirmed and Potential SRE Status) Identified in Desktop Assessments.

Higher Taxon	Taxon	SRE Status
Araneae		
Actinopodidae	*Missulena* sp. indet.	Potential
Anamidae	*Kwonkan* `MYG325`	Confirmed
	Aurecocrypta `chichester`	Potential
Barychelidae	*Synothele* `MYG237`	Confirmed
	Synothele `MYG311`	Confirmed
Halonoproctidae	*Conothele* `MYG279`	Confirmed
Idiopidae	*Anidiops* `sp. B02`	Potential
	Idiosoma `MYG083`	Confirmed
	Idiosoma `MYG085`	Confirmed
	Idiosoma `MYG300`	Confirmed
Selenopidae	*Karaops banyjima*	Confirmed
	Karaops fortey	Confirmed
Pseudoscorpiones		
Garypidae	*Synsphyronus gracilis*	Confirmed
Scorpiones		
Buthidae	*Lychas* `SCO036`	Potential
	Lychas `bituberculatus complex`	Potential

Higher Taxon	Taxon	SRE Status
	Lychas `*splendens* ms`	Potential
	Lychas sp. indet.	Potential
Urodacidae	*Urodacus* `firetail`	Confirmed
Millipedes		
Paradoxosomatidae	*Antichiropus antius*	Confirmed
	Antichiropus nimbus	Confirmed
Isopods		
Armadillidae	*Acanthodillo* `sp. B14`	Potential
	Buddelundia `sp. 20`	Confirmed
	Buddelundia `sp. B47`	Potential
	Buddelundia `sp. B48`	Potential
	Buddelundia `sp. B49`	Potential
	Buddelundia `sp. B50`	Potential
	Buddelundia `sp. B53`	Potential
Gastropoda		
Camaenidae	*Quistrachia* `*cancellate*` n. sp.	Confirmed

10.3.5.2 Field Surveys

Details of the SRE surveys are presented in **Table 10-2.**

Surveys targeting SREs for this Proposal included:

- *ecologia* (2020) Baseline Terrestrial Invertebrate Fauna (SRE) Level 2 Assessment; (**Appendix 11d**)
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm, Haul Road & Pipeline: Vertebrate & Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**).

Across all SRE surveys, 705 invertebrate specimens were collected from 60 sample sites. Consolidation of the data identified one confirmed SRE, being an isopod– *Buddelundia* 56 and up to 31 potential SREs (**Table 10-11**). This species was recorded during the *ecologia* Phase 2 survey and the Biologic detailed Phase 2 survey both inside and outside of the Development Envelope (**Figure 10-21**).

Each survey included dry pitfall trapping, hand foraging, litter collection as well as active burrow searches (*ecologia* 2020; Biologic 2022a; Spectrum 2023a). JBS&G (2024) provides a summary of SRE surveys undertaken and the phases completed and the limitations.

Details of targeted searches are provided in *ecologia* (2020), Biologic (2022a, b, c) and Spectrum (2023a). Searches were each undertaken according to the *Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2020). **Table 10-2** provides and overview of the relevant survey reports.

Specimens which were unidentifiable were submitted for DNA sequencing, each subsequent survey comparing with the original sequences. DNA was extracted and DNA barcoding sequences (COI) were cross checked with publicly accessible sequences in GenBank and with databases derived from research projects. Fauna-specific genetic distances thresholds for delimiting species (identification) and operational taxonomic units (OTUs – final assigned names) were used wherever possible, based on published literature and the previous survey reports. Where these thresholds were not available, the assessment used average divergence thresholds for related groups or higher taxa developed by broad level studies. In general, ≤ 8% COI divergence is considered appropriate to determine OTUs (Herbet et al. 2003) and this has been applied to the data for MDIOM (refer to Biologic 2022b). Details for the genetic analyses and interpretations are provided in each of the reports.

A summary of the outcomes from each of the surveys is provided below.

ecologia (2021a) collected 496 invertebrate specimens from 52 sites across two Phases of survey. These specimens were from seven target SRE groups including 152 isopods, 129 spiders, one harvestman, 75 pseudoscorpions, 58 scorpions, 33 millipedes and 48 land snails.

Of the specimens recorded, a single isopod species collected during Phase 2 was a confirmed SRE species (*Buddelundia* 56) and 23 species were considered potential SRE species. These include isopods, arachnids, harvestman, pseudoscorpions, millipede and a terrestrial snail. The *Buddelundia* 56 was recorded in the Drainage Line/Floodplain habitat and in the Chenopod/Cracking Clay Floodplain habitat (**Figure 10-21**).

Nine specimens could not be delimited due to a lack of morphological features and were from known or potential SRE groups. These specimens were sent for molecular investigation at the Western Australian Museum (WAM) to determine identity. Single specimens of *Dampetrus* HBI-6519, *Conothele* sp. indet., *Beierolpium* '8/3', *Indolpium* sp. 1, *Indolpium* sp. 2, Olpiidae sp. 3 were selected for molecular analysis. In addition, specimens from each of the scorpion species complexes *Lychas* '*bituberculatus* complex', *Lychas* 'hairy tail complex' and *Lychas* '*multipunctatus* complex' were selected.

Biologic (2022a) found 140 invertebrate specimens representing 28 morphological and molecular taxa, collected from sites outside the Development Envelope. The specimens collected were comprised of mygalomorph spiders (all morphologically identified as the widespread species *Aname mellosa*), pseudoscorpions, scorpions, a polyxenid millipede, aquatic and land snails, and terrestrial isopods. Fifty specimens were sequenced for further elucidation of their identification by Biologic (2022a). The isopod *Buddelundia* 56 was the only confirmed SRE (**Appendix 11**). Both records were from the same site in the Mulga West Borefield which is no longer part of the Proposal as this area has been removed from the Development Envelope.

Additional SRE survey was undertaken by Spectrum in 2023 on the pipeline route, solar farm area and a section of the haul road (Spectrum 2023a; **Appendix 11g**). A total of 69 invertebrate specimens were collected from 10 invertebrate taxa, which included seven potential SRE taxa. The potential SRE taxa included one scorpion, three pseudoscorpions, two isopods and one snail. The majority of the specimens were collected from Mulga Woodland habitat, with the remainder in Drainage Line/Floodplains, Stony Spinifex Plains and Hillslopes and Alluvial Clay Plain.

The majority of the collected OTUs across the surveys were assessed as having limited ranges determined SREs based on lack of available information. The habitats which supported these SREs within the Development Envelope are not fragmented and SRE records indicate dispersal from the eastern most section to past the Mulga West Borefield (no longer part of the Proposal). As the same habitat has been found to extend beyond the Development Envelope it is expected that the SREs are capable of dispersal. Many of the specimens were found at multiple sites, demonstrating dispersal capability.

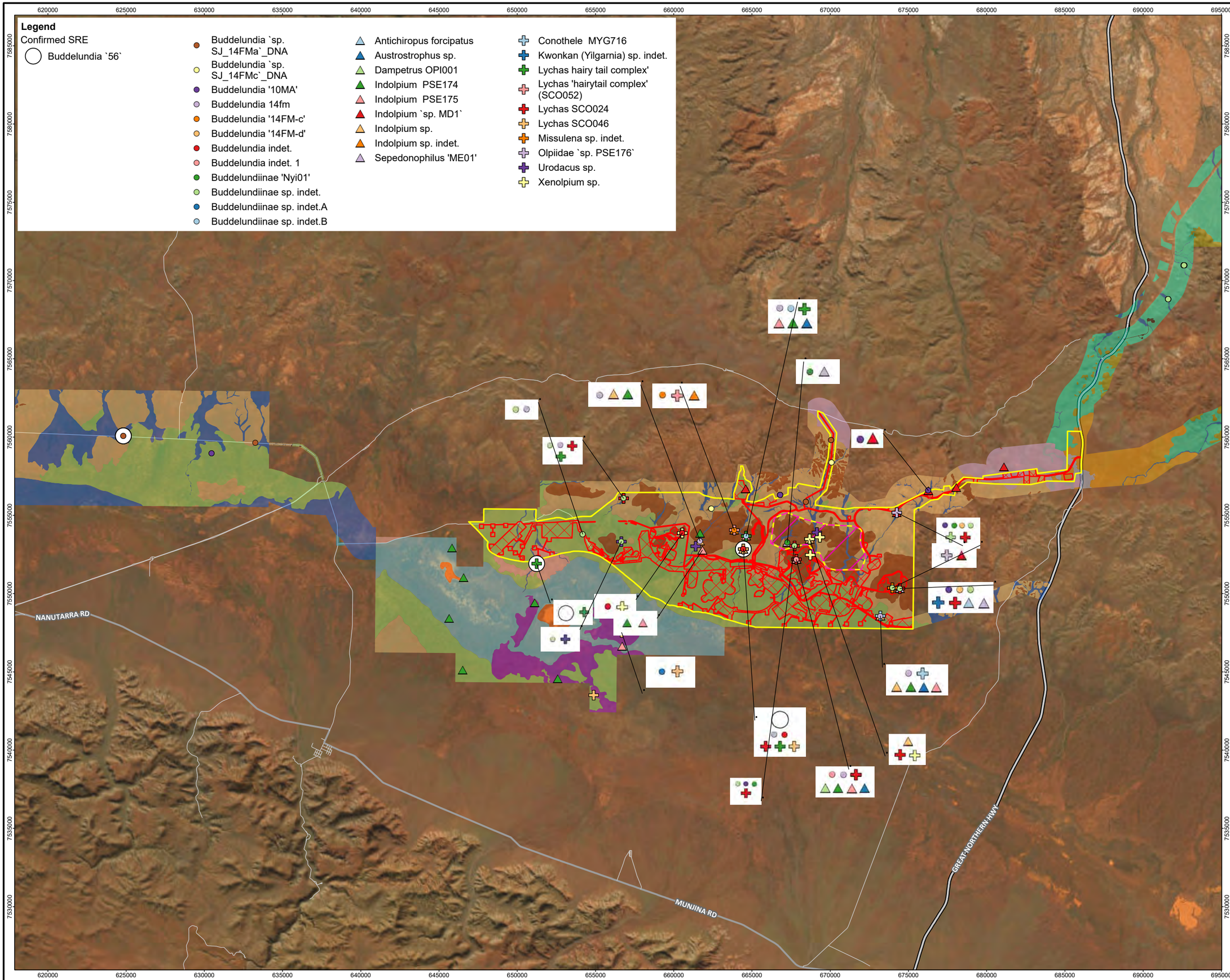
The consolidated outcomes of the SRE surveys undertaken within the Development Envelope are provided in **Table 10-11**. Full taxon/OTU lists are provided in the reports in **Appendix 11**. A consolidation of the Confirmed and Potential SREs within the Development Envelope and Indicative Footprint is presented in **Table 10-11.**

Table 10-11: SREs (confirmed and potential) located within the within the Development Envelope. Data is a consolidation of all SRE records following DNA Barcoding. Taxa are presented as OTUs (operational taxonomic units)

Taxon/OTUs	SRE Status	Development Envelope	Indicative Footprint	Total in Survey Area
***Buddelundia* `sp. SJ_14FMa`_DNA**	Potential	3	0	3
***Buddelundia* `sp. SJ_14FMc`_DNA**	Potential	2	0	2
***Buddelundia* '10MA'/ SJ_10MA_DNA**	Potential	4	0	6
***Buddelundia* 14fm**	Potential	4	1	6
***Buddelundia* '14FM-c'**	Potential	1	0	1
***Buddelundia* '14FM-d'**	Potential	1	1	2
***Buddelundia* 56**	Confirmed	1	0	14
***Buddelundia* indet.**	Potential	1	1	2
***Buddelundia* indet. 1**	Potential	0	1	1
***Buddelundiinae* 'Nyi01'**	Potential	0	1	3
***Buddelundiinae* sp. indet.**	Potential	3	1	142
***Buddelundiinae* sp. indet.A**	Potential	1	0	1
***Buddelundiinae* sp. indet.B**	Potential	1	0	1
***Conothele* MYG716**	Potential	1	0	1
***Kwonkan* (Yilgarnia) sp. indet.**	Potential	1	0	1
***Lychas* hairy tail complex'**	Potential	5	0	6
***Lychas* 'hairytail complex' (SCO052)**	Potential	2	0	2
***Lychas* SCO024**	Potential	4	3	9

Taxon/OTUs	SRE Status	Development Envelope	Indicative Footprint	Total in Survey Area
***Lychas* SCO046**	Potential	1	0	5
***Missulena* sp. indet.**	Potential	0	1	1
***Olpiidae* `sp. PSE176`**	Potential	6	1	11
***Urodacus* sp.**	Potential	2	0	3
***Xenolpium* sp.**	Potential	0	7	17
***Antichiropus* forcipatus**	Potential	2	0	2
***Austrostrophus* sp.**	Potential	2	1	3
***Dampetrus* OPI001**	Potential	0	1	1
***Indolpium* PSE174**	Potential	9	1	17
***Indolpium* PSE175**	Potential	7	1	10
***Indolpium* `sp. MD1`**	Potential	4	0	21
***Indolpium* sp.**	Potential	4	0	5
***Indolpium* sp. indet.**	Potential	1	0	38
***Sepedonophilus* 'ME01'**	Potential	3	0	3

Figure 10-21: Location of confirmed and potential SRE taxa



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LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000 7547000

Legend

Confirmed SRE

- Buddelundia `56`
- Buddelundia `sp. SJ_14FMc`_DNA
- Buddelundia 14fm
- Buddelundia indet.
- Buddelundiinae sp. indet.
- Buddelundiinae sp. indet.A
- Indolpium PSE174
- Indolpium PSE175
- Indolpium sp.
- Lychas hairy tail complex'
- Lychas SCO024
- Lychas SCO046
- Urodacus sp.
- Xenolpium sp.

Legend

- Development Envelope
- Indicative Footprint

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 04-Aug-2025
Drawn By: jcrute	Checked By: MD

Scale 1:56,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 2 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Legend

Confirmed SRE

- Buddelundia `56`

- Buddelundia `sp. SJ_14FMa`_DNA
- Buddelundia `sp. SJ_14FMc`_DNA
- Buddelundia '10MA'
- Buddelundia 14fm
- Buddelundia '14FM-c'
- Buddelundia '14FM-d'
- Buddelundia indet.
- Buddelundia indet. 1
- Buddelundiinae 'Nyi01'
- Buddelundiinae sp. indet.
- Buddelundiinae sp. indet.B
- Antichiropus forcipatus
- Austrostrophus sp.
- Dampetrus OPI001
- Indolpium PSE174
- Indolpium PSE175
- Indolpium `sp. MD1`
- Indolpium sp.
- Indolpium sp. indet.
- Sepedonophilus 'ME01'
- Conothele MYG716
- Kwonkan (Yilgarnia) sp. indet.
- Lychas hairy tail complex'
- Lychas 'hairytail complex' (SCO052)
- Lychas SCO024
- Lychas SCO046
- Missulena sp. indet.
- Olpiidae `sp. PSE176`
- Urodacus sp.
- Xenolpium sp.

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 04-Aug-2025
Drawn By: jcrute	Checked By: MD

Scale 1:56,000 at A3

0 1 2 Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 3 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Legend

- Buddelundia `sp. SJ_14FMa`_DNA
- Buddelundia `sp. SJ_14FMc`_DNA
- Buddelundia '10MA'
- Buddelundia 14fm
- Buddelundia '14FM-d'
- Buddelundiinae 'Nyi01'
- Buddelundiinae sp. indet.
- Antichiropus forcipatus
- Austrostrophus sp.
- Indolpium PSE174
- Indolpium PSE175
- Indolpium `sp. MD1`
- Indolpium sp.
- Sepedonophilus 'ME01'
- Conothele MYG716
- Kwonkan (Yilgarnia) sp. indet.
- Lychas SCO024
- Missulena sp. indet.
- Olpiidae `sp. PSE176`

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 04-Aug-2025
Drawn By: jcrute	Checked By: MD

Scale 1:56,000 at A3

0 1 2 Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 4 of 4

File Name: C:\Users\jcrute\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.5.3 Habitat Types

As with the vertebrate fauna habitat types (refer to **Sections 10.3.4.1** and **10.3.4.2**). Habitat assessment and mapping was undertaken across the Development Envelope following detailed SRE desktop assessments. Seven broad SRE habitats were mapped based on aerial imagery, previous survey data and then confirmed during the surveys (**Figure 10-21**). The broad scale mapping, continuity of habitat types and the habitat naming conventions reflect those previously mapped in the adjacent areas of the Development Envelope. The habitats defined as suitable for SREs within the Development Envelope are:

- Stony Spinifex Plains and Hillslopes;
- Rocky Hills;
- Drainage Line/Floodplain;
- Mulga Woodland;
- Chenopod/Cracking Clay Floodplain; and
- Rocky Plains and Footslopes.

Potential terrestrial SRE taxa were recorded in most habitat types, though Snakewood had little prospect and other habitat types which after rain were readily inundated. The most prospective SRE habitat is associated with mesic environments including breakaways and small gorges within the Rocky Hills and Drainage Lines/Floodplains.

Mulga Woodland and Calcrete Stony Plain and were considered moderately likely to promote short range endemism, followed by Stony Spinifex Plains and Hillslopes and Chenopod/Cracking Clay Floodplain which were given low to moderate habitat suitability rankings. The most common habitat types (Mulga Woodlands, Stony Spinifex Plains and Hillslopes) were identified to be generally continuous swathes of similar habitat and widespread in a regional context.

Isopod and scorpion specimens from SRE target groups were collected from all habitat types surveyed. Habitat preferences for target SRE groups were highly variable, with different invertebrate groups exhibiting habitat preferences likely to be associated with variations in microhabitat requirements. Drainage Lines/Floodplains were found to support the greatest diversity of scorpions. Rocky Hills provided the greatest diversity of pseudoscorpions and millipedes, and the Mulga Woodland habitat supported isopods and harvestmen.

Sheltered, isolated, and often relictual mesic habitats have an increased likelihood of hosting short-range endemic (SRE) invertebrates. The gradual aridification of the Australian continent that began in the early Miocene has resulted in the contraction and isolation of mesic habitats and by association those relictual faunal groups that utilise them (Harvey 2002).

In arid landscapes such as the ranges of the Pilbara region, permanently moist, shaded, and sheltered microhabitats as associated with SREs are typically limited and isolated by barriers of exposed, dry habitat not conducive to the dispersal SRE species. This isolation restricts or eliminates gene flow between populations and may result in speciation via selective pressures, genetic drift, and mutation. Even where speciation has not yet

occurred, the geographical distribution of these species has severely contracted and fragmented. Isolated gorges and gullies that host complex microhabitats (heavy vegetation, deep leaf litter beds and varied rock cover) and protect relictual mesic habitat characteristics are more likely to host SRE taxa than simple widespread habitats exposed to climatic extremes. Isolated freshwater habitats associated with springs are also likely to provide conditions suitable for SRE taxa. Regionally extensive and exposed habitat types with high connectivity such as spinifex grassland are unlikely to host SRE taxa (Durrant, 2011).

Vegetation, geological, land system, and topographic mapping as well as aerial imagery may be used as surrogates to estimate habitat connectivity and distributional boundaries of potential SRE species. This is to be considered in circumstances where further survey is deemed unlikely to yield more specimens and further taxonomic or distributional information is not available via the museum and subject matter specialists (EPA 2016b).

These habitat types occur on a broader scale outside of the Development Envelope as detailed in **Section 10.3.4.2.** As shown in **Table 10-7** these habitats are extensive.

10.3.6 Aquatic Invertebrates

A desktop assessment (using a 40 km radius from within the Development Envelope) was completed by Biologic Environmental Pty (Biologic 2023) (**Appendix 24**). The desktop provided an overview of the aquatic ecology of the freshwater claypans which lie within the Fortescue Valley south of the Development Envelope. The desktop includes a synopsis of taxa of significance and assess the threats and potential impacts of the Proposal to the freshwater claypans. The ecological requirements of resident and transient biota were considered and summarised.

Two of the larger claypans of the system, Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan, are located immediately to the south of the Development Envelope. The claypans support a diverse and highly unique aquatic invertebrate assemblage. The claypans considered in the Biologic (2023) Desktop Assessment Search Area may contain over 50% of the aquatic invertebrate taxa known from the Fortescue Valley (including the Fortescue Marsh), while at the regional scale, the claypans of the Fortescue Valley are likely to support more than half of the aquatic invertebrate species that occur across the Pilbara region. This includes a high richness of aquatic crustacean and rotifer taxa, which are considered sensitive receptors for the claypan systems.

In total, five significant invertebrate taxa were recorded during the database search and literature review. The significant invertebrates were new to science and therefore potentially restricted to claypans in the Biologic (2023) Desktop Assessment Area. These included:

- *Asplancha* n. sp. (Rotifera);
- *Pleurata* n. sp. (Rotifera);
- *Unionicola* n. sp. (Acarina);
- *Mesochra* n. sp. (Copepoda); and
- *Anisops* n. sp. (Notonectidae).

10.4 Potential Impacts

A preliminary assessment of the potential direct and indirect impacts of the Proposal to terrestrial fauna values in consideration of the EPA objectives is provided below.

10.4.1 Direct Impacts

Potential direct impacts as a result of the Proposal include:

- Loss of fauna individuals (collision and entrapment) resulting from ground disturbance, vehicle strike (including heavy haulage vehicles), machinery, infrastructure and mining operations.
- Loss of fauna habitat resulting from clearing for ore extraction, construction and operation (mining infrastructure) – this includes clearing of vegetation and removal of landforms (caves, ridges).

10.4.1.1 Loss of Fauna Individuals

Due to the direct interface between vehicle and machinery movement and fauna habitats, vertebrate fauna would be most at risk of death or injury during clearing activities. The risk of injury/mortality from vehicle strike and vehicles and machinery during construction and operation of the Proposal.

Fauna most at risk from vehicle strike are nocturnal species. Ghost Bats have been known to collide with mine SUVs as they attracted by the light. Visibility driving at night is impeded with the likelihood of collision higher. The risk of vehicle strike for raptors is higher with increased carrion availability. Large raptors require more time to take flight which often places them in direct path of travelling vehicle.

Fauna may also become trapped in large containers, uncapped drill holes, trenches, excavations or water storage structures. They are unable to escape and may be either injured or die. A trapped animal can become stressed leading to injury or death, overheat if trapped during the day, drown or at greater risk of becoming prey.

Dispersal is an affective survival strategy however it is costly especially in arid environments. Many species burrow and may not be visible. Death can be cause by burrow collapse or blocking of the entrance/exit to burrows or dens.

The level of impact to significant habitat or populations of SRE taxa from mining activities in a particular area can be assessed by considering the taxa recorded for an area and the level to which significant habitats have been surveyed.

Clearing, earthworks and excavation activities can also lead to the loss of SRE invertebrates including the mygalomorphs burrows.

10.4.1.2 Loss of Fauna Habitat

This section presents the indicative loss of vegetation based on the Indicative Footprint; however, the final location of Proposal elements within the Development Envelope may change through the detailed design phase.

The Proposal will require the clearing of up to 4,339.16 ha of native vegetation across eight of the nine fauna habitat types within the Development Envelope (**Table 10-12**). This will result in a reduction of available habitat for terrestrial fauna, including SREs.

Based on the Indicative Footprint, the habitat type that will be subject to the largest area of clearing is Mulga Woodland. The Proposal will result in the loss of 34.44% of Mulga Woodland mapped within the Development Envelope, followed by Gibber Cracking Clay (22.00%), Rocky Hills (19.59%), Stony Spinifex Plains and Hillslopes (17.11%), Chenopod/Cracking Clay Floodplain (16.94%), Drainage Line/Floodplain (13.63%), Cracking Clay (12.9%) and Snakewood (8.33%). While present in the Development Envelope, the Proposal will not directly impact Rocky Plains and Footslopes habitat from clearing.

All habitat types were found to extend outside of the Development Envelope (refer to Figure 10-20). The percentage impact to the local mapped extent from surveys undertaken for the Proposal to each habitat type is shown in **Table 10-12**. No more than 6.48% of the total local mapped extent any fauna habitat types will be impacted as a result of the Proposal.

Table 10-12: Loss of Terrestrial Fauna Habitat

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
Chenopod/Cracking Clay Floodplain	• Scorpions • Snails • Isopods	Foraging only: • Night Parrot (EN) – in proximity to mature spinifex only. • Priority 5 foraging habitat for Pilbara Leaf-nosed Bat (VU).	983.20	15.72	92.78	0.55	16.94	1.60
Rocky Hills	• Scorpions • Isopods • Pseudoscorpions • Millipedes • Snails	Shelter, denning and roosting habitat: • Northern Quoll (EN) • Pilbara Leaf-nosed Bat (VU) • Ghost Bat (VU) • Pilbara Olive Python (VU) Foraging Habitat: • Peregrine Falcon (OS)	11,982.01	520.80	2,658.23	15.78	19.59	4.35
Mulga Woodland	• Mygalomorphs • Scorpions • Millipedes • Snails • Pseudoscorpions	Potential nesting/roosting habitat: • Bilby (VU) • Night Parrot - in areas of mature spinifex only. Foraging only: • Bilby (VU) • Priority 5 foraging habitat for the Pilbara Leaf-nosed Bat (VU).	43,575.10	2,824.74	8,202.43	48.69	34.43	6.48

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
Stony Spinifex Plains and Hillslopes	• Scorpions • Isopods • Mygalomorph spiders • Pseudoscorpions • Millipedes • Snails	Potential roosting habitat: • Night Parrot - in areas of mature spinifex only. Foraging only: • Ghost Bat (VU) • Priority 5 foraging habitat for the Pilbara Leaf-nosed Bat (VU). • Northern Quoll (EN) • Western Pebble-mound Mouse (P4) • Grey Falcon (VU) • Night Parrot (CEN) in proximity to mature, unburnt samphire only.	62,690.54	813.97	4,758.15	28.24	17.11	1.30
Drainage Line/Floodplain	• Scorpions • Pseudoscorpions • Isopods • Mygalomorph spiders • Millipedes • Snails	Potential roosting habitat: • Night Parrot - in areas of mature spinifex only. Foraging only: • Ghost Bat (VU) • Priority 5 foraging habitat for the Pilbara Leaf-nosed Bat (VU). • Peregrine Falcon (OS) • Grey Falcon (VU) Dispersal and foraging:	34,141.21	71.26	522.64	3.10	13.63	0.21

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
		• Northern Quoll (EN) • Gane's Blind Snake (P1)						
Gibber Cracking Clay	• Scorpions • Pseudoscorpions • Isopods • Mygalomorph spiders	Foraging only: • Ghost Bat (VU) • Peregrine Falcon (OS) • Grey Falcon (VU) Breeding, foraging and dispersal habitat: • Short-tailed Mouse (P4) • Western Pebble-mound Mouse (P4)	3,556.27	56.48	257.69	1.53	21.92	1.59
Cracking Clay	Not considered suitable habitat	This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby	5,529.69	28.10	217.84	1.29	12.90	0.51
Snakewood	Not considered suitable habitat	This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon;	731.62	8.04	96.55	0.57	8.33	1.10

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
		• Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby.						
Rocky Plains and Footslopes	• Scorpions • Pseudoscorpions • Isopods • Mygalomorph spiders • Millipedes • Snails	This habitat type has the potential to support foraging for: • Northern Quoll • Western Pebble-mound Mouse; • Gane's Blind Snake; • Grey Falcon; • Brush-tailed Mulgara; • Greater Bilby; • Night Parrot (however no suitable breeding habitat was known nearby and the area was recently burnt); and • foraging habitat for the Ghost Bat and Peregrine Falcon	32,444.58	0.00	37.75	0.22	0.00	0.00
Cleared / Disturbed			771.02	0.04	3.47	0.02	1.15	0.01
Total			**184,423.23**	**4,339.15**	**16,848.53**	**100**		

Caves

In addition to the broad habitat types, the Proposal will also impact caves. A total 82 caves were assessed in the Survey Area of which 51 were identified as having characteristics required as Category 4 (nocturnal roosts) Caves. The remaining 31 caves were not identified as Category 4 caves as they lacked the characteristics required.

In respect to the Pilbara Leaf-nosed Bat, of the 51 Category 4 caves, 36 will remain in the FHEZ. The FHEZ will not be developed as it is not in the Development Envelope. An additional six Category 4 caves are located in the FHEZ Corridor and will also be avoided.

In respect to the Ghost Bats, 23 of the 51 Category 4 caves were found suitable as Ghost Bat roosts of which 8 are located within the Development Envelope with 5 of these in the Indicative Footprint. The remaining 15 Category 4 caves are located within the FHEZ and as such will remain as available caves.

All caves located within the Development Envelope that have been identified as suitable for either species were assessed as Category 4 caves (nocturnal refuge) which are not considered critical habitat but are important for persistence in the local area. No Category 1, 2 or 3 caves were identified during surveys (as summarised in *ecologia* 2023).

In total, a minimum 42 caves found suitable for the Pilbara Leaf-nosed Bat and/or Ghost Bat will be preserved (**Table 10-8**).

The caves in the FHEZ and FHEZ Corridor also support habitat critical for the survival of the Northern Quoll, of which caves are important to this species.

The implications of impacts to caves for relevant conservation significant species are discussed in **Section 10.6**.

10.4.2 Indirect Impacts

Potential indirect impacts to terrestrial fauna as a result of the Proposal may include:

- A decline or change in health/composition of fauna habitat arising from:
    - Deposition of dust during construction and operation of the mine and use of saline water for dust suppression;
    - Altered hydrological and hydrogeological regimes;
    - Impacts (i.e. cave collapse) from blasting/vibrations;
    - Introduction and spread of weeds; and
    - Altered fire regimes.
- Disruption of natural foraging and breeding patterns of terrestrial fauna due to:
    - Fragmentation;
    - Noise, light, vibration and vehicle movements; and
    - Increased feral animals.

10.4.2.1 A decline or change in health/composition of fauna habitat.

Dust and Use of Saline Water for Dust Suppression

The Proposal has the potential to indirectly impact on terrestrial fauna habitat through the generation of dust during clearing, constructions of roads, vehicle movement and the transport and handling of ore during operation. There is the potential for the Proposal to indirectly impact terrestrial fauna habitat from the use of saline water for dust suppression during the construction and operation of the Proposal. This can result in vegetation mortality, or an increase in soil salinity leading to a decline in vegetation and flora, and subsequently habitat, health.

Altered Hydrological and Hydrogeological Regimes

Diversion of surface water flows, abstraction of groundwater and the reinjection of mine dewater via MAR will result in changes to the natural hydrological regime which could result in altered or degraded fauna habitat. Relevant mechanisms which will cause these changes are:

- Groundwater drawdown caused by orebody dewatering;
- Groundwater mounding caused by the reinjection of surplus water via a MAR bore network; and
- Surface catchment modifications resulting in changed surface water regimes (flows and levels) and surface water quality, in particular reduced inflows to portions of the valley environment.

Given that the vegetation is inferred to be disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. Therefore, changes to groundwater as a result of drawdown is not expected to impact fauna habitat.

As discussed in **Section 8,** the principal change risk to vegetation, and therefore fauna habitat, is groundwater mounding as a result of MAR. As dewatering exceeds water demands, excess water will be disposed of by MAR through re-injection within the Development Envelope. Without management practices in place, there is the potential for detrimental impacts to fauna habitat resulting from changes to groundwater levels and / or quality as a result of MAR).

The presence of water within the drainage lines in the Pilbara is temporary/ephemeral and flows only in response to rainfall events. Permanent pools are present throughout the Pilbara, however within the Development Envelope they have not been found. During operations, Surface water flows along the drainage/creek lines will be diverted as a result of mine pits, waste rock dumps, borrow pits, airport, haul and access roads, pipelines, and other infrastructure associated with the Proposal. These diversions will be constructed to a design appropriate for the life of the operations.

Upon cessation of operations, non-permanent diversion structures will be removed, and the surface will be re-shaped to blend into adjacent ground levels, reinstating natural drainage lines where feasible. Some permanent diversion and water management structures may remain post closure. Such permanent structures will be designed with consideration of an agreed future rainfall intensity scenario and final landform features, at least 5 years prior to the end of mine

The receptors which may potentially be impacted by the Proposal are fauna habitat (vegetation and cave microclimates) and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools, which could be altered or degraded from indirect impacts.

Additionally, where mine development areas block drainage paths, there is a risk of increased inundation on the upstream side of the development area. The increased inundation may lead to vegetation death due to water logging and changes to vegetation composition with more water tolerant vegetation species (including weeds) potentially taking over in these areas (AQ2 2024b).

Impacts (i.e. cave collapse) from blasting/vibrations

Construction, operation activities (including blasting) which result in noise and vibrations can affect the integrity/characteristics (microclimate) of caves that may support conservation significant species such as Pilbara Leaf-nosed Bat and Ghost Bat.

Introduced Weeds

Clearing, vehicle and machinery movements have the potential to increase the spread and/or introduce weed species. Weeds are often able to rapidly invade locations due to disturbance, land clearing and/or altered hydrological regimes. Weed species recorded within the Development Envelope are discussed in **Section 9.3.7**.

Alteration Fire Regimes and Increased Fire Risk

Altered fire regimes can damage fauna habitat, resulting in the loss of fauna species. Fires too early in the year can prevent the establishment of resilient seed banks which are resistant to periods of fire, characteristic of the Pilbara and other arid zones. Frequent fires also lead to an increase of some weeds species, which can result in the loss of foraging habitat and habitat becoming more bushfire prone.

10.4.2.2 Disruption of natural foraging and breeding patterns of terrestrial fauna

Fragmentation

Fragmentation of habitat from land clearing can reduce the ability for individuals of a species to move freely across a landscape. This can result in the isolation of populations and reduce gene flow. Habitat fragmentation has the potential to exacerbate other threats, such as predation by feral species, by providing improved access into habitats which were previously difficult to access.

Noise, Light, Vibration and Vehicle Movements

Construction, operation activities which result in an increase in light, noise and vibrations which can affect the foraging and breeding behaviours of native species, resulting in a decline in local populations.

Light spill caused by lighting of the Proposal and vehicle movements at night has the potential to cause disturbance to light sensitive species or cause other behavioural changes, e.g. changes in prey item distribution and aggregation for insectivorous species, resulting in changes to foraging behaviour.

Noise has the potential to cause behavioural changes in fauna, with fauna likely to avoid loud areas. Species using audible cues for breeding such as birds may experience disruption to breeding cycles or reduced breeding success.

Vibration from blasting can disrupt foraging behaviour and force an early exit from a cave exposing the bats to dehydration. Blasting also has the potential to generate higher concentrations of NOx which can impact bats roosting in Category 4 caves.

Feral Animals

Construction of infrastructure is known to increase the movement of feral predators such as cats, foxes and wild dogs, all which have been recorded in the Development Envelope. Construction can force native fauna into areas where they are at greater risk of predation. Presence of waste materials can also attract feral animals that are predators to native fauna as well as competing for resources.

10.4.3 Cumulative Impacts

The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, will have a cumulative impact on terrestrial fauna at a regional scale through:

- The loss and fragmentation of terrestrial fauna habitats, including that of SREs, from clearing; and
- The fauna individuals as a result of the clearing activities.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in **Section 17**.

10.5 Mitigation

HPPL has applied the mitigation hierarchy of avoid, minimise, and rehabilitate during the Proposal design to reduce the potential impacts to terrestrial fauna.

The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since its referral in 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal on fauna and fauna habitat. Overall, there has been a total reduction in the Development Envelope and Indicative Footprint of 23,804.97 ha and 5,288.84 ha, respectively.

Since the referral of the Proposal HPPL has applied avoidance as the main mitigation to reduce potential impacts to fauna. HPPL has identified two areas within the Development Envelope which will not be developed:

- Fauna Habitat Exclusion Zone (FHEZ) - comprising an area of 1,320.82 ha which was removed from the Development Envelope under section 43A of the EP Act.
- FHEZ Corridor - comprising an area of 991.45 ha within the Development Envelope. No permanent mining activities will be undertaken within this corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor.

These areas have been identified as 'exclusion zones' as they exclude activities associated with the Proposal. The purpose of these is exclusion zones is to mitigate impacts to the conservation significant fauna. The FHEZ is 1,320.82 ha of high value Rocky Hills, Drainage Line/Floodplains and Stony Spinifex Plains and Hillslopes habitats. The value of the FHEZ is enhanced and maintained by the inclusion of the FHEZ Corridor which comprises 991.45

ha of similar and supporting habitats. The purpose of the FHEZ Corridor is to ensure connection of the high value habitat within the FHEZ to habitat outside of the Development Envelope to allow for the dispersal of fauna from the FHEZ to the Chichester Ranges and preventing fragmentation of terrestrial fauna habitat for species such as the Northern Quoll. The area also comprises habitat which is considered high value SREs.

A summary of mitigation measures applied to address the key potential impacts on terrestrial fauna is provided in **Table 10-13.** A Conservation Significant Fauna Management Plan (CSFMP, **Appendix 12**) has also been developed for the Proposal to outline HPPL's approach to managing potential impacts on conservation significant terrestrial fauna.

Table 10-13: Mitigation Measures for Terrestrial Fauna

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts			
Loss of fauna individuals (in particular individuals of fauna of conservation significance)	Establishment of the FHEZ and FHEZ Corridor exclusion areas.	Implementation of the CSFMP (Appendix 12).	Implementation of the CSFMP (Appendix 12).

Loss of fauna habitat.	• Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of fauna habitat (including native vegetation). • Establishment of FHEZ Corridor which both avoids and minimises impact within 991.45 ha of habitat (including native vegetation) • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided which provide important habitat for migratory species • Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor. • Freshwater Claypans of the Fortescue Valley P1 PEC is outside the Development Envelope. This is habitat for Migratory species when inundated and foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat, Northern Quolls and potentially the Night Parrot.	• Utilise areas of existing disturbance before clearing of new ground where possible. • Where possible Proposal elements have been located to avoid impacts on environmental factors. • Removal of Mulga West Borefield from the Development Envelope which reduces the extent of clearing and associated impacts. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with a Ground Disturbance Permit). • No more than 4,339.16 ha of clearing within a Development Envelope of 16,848.53 ha. • Where possible Proposal elements have been located to minimise impacts on environmental factors. • Phase the works to enable progressive clearing and rehabilitation. • Manage construction and operational works through an Environmental Management System (EMS). • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • No permanent mining activities will be undertaken within the FHEZ corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal. • Clearing will be managed as outlined in the CSFMP.	• Implementation of the CSFMP (Appendix 12). • Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout life of mine. • Decommissioning and rehabilitation of disturbed areas at the end of LoM. Consultation with Banjima to determine which species are ideal for seed collection, as informed by the ethnobotanical surveys.

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Indirect Impacts			
A decline or change in health/composition of fauna habitat arising from: Deposition of dust during construction and operation of the mine and use of saline water for dust suppression; Altered hydrological and hydrogeological regimes; Altered structural integrity of caves from vibration impacts Introduction and spread of weeds; and Altered fire regimes.	• Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor.	• Implement the CSFMP (Appendix 12). • Implement the Water Management Plan (Appendix 6) • Appropriate permits will be obtained under the RiWI Act. • Blasting requirements will be designed to meet vibration thresholds of susceptible caves. • All machinery and vehicles shall be cleaned down of all soil and vegetation material prior to arriving or entering on site. Any soil and vegetation removed from machinery or vehicles during clean down upon arrival, but prior to entry on site shall be collected and disposed of offsite; • All vehicles and machinery mobilised to site shall be inspected prior to entry to site and issued with a Weed & Soil Hygiene Certificates; • Imported fill or other potential weed mediums to be certified by the supplier as being free from weed free sources prior to arrival on site; • Areas of known weed-infestation will be identified and managed separately to weed free areas; • Where areas of weed-infestation are to be disturbed or cleared, material will be stockpiled/placed in windrows separately from weed-free material; • Targeted control of infestations; • An emergency management plan shall be developed and implemented and shall include methods for	• Implement the CSFMP (Appendix 12). • Implement the Water Management Plan (Appendix 6)

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
		managing major environmental incidents, including but not limited to fire • Ensure compliance with the Bushfire Act 1954; • Compliance with internal Hot Works Procedures; • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks; An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment.	
Disruption of natural foraging and breeding patterns of terrestrial fauna due to: Fragmentation; Noise, vibration, lighting and vehicle movements; and Increased feral animals.	Establishment of the FHEZ and FHEZ Corridor protecting breeding and foraging for conservation significant fauna and allowing dispersal across high value Rocky Hills Habitat.	• Implement the CSFMP (Appendix 12).	• Implement the CSFMP (Appendix 12). • Rehabilitation of areas of land utilised for construction purposes will occur upon completion of construction. • Progressive rehabilitation of temporary disturbance areas will be undertaken (such as borrow pits and temporary construction areas).

10.6 Assessment and Significance of Residual Impacts

10.6.1 Direct Impacts

10.6.1.1 Loss of Fauna Individuals

The use of vehicles and heavy machinery for the clearing of native vegetation and other construction activities can result in injury to native fauna, and there is the possibility of mortalities via collision. Nocturnal species are at greater risk from collision due to limited visual ability for machine operators.

The construction phase of the Proposal will occur predominantly during daylight hours with vegetation clearing commencing from a disturbed edge to an undisturbed area, where practicable, to encourage mobile fauna to naturally relocate into adjacent areas.

During operation, mining will be undertaken on a 24-hour basis, seven days per week. However, light vehicle movements will occur mostly during the day.

Significant fauna in the Development Envelope may be vulnerable to injury or mortality from vehicle and machinery movements, mainly when foraging or whilst warming up on roads (e.g. Pilbara Olive Python). Vehicle movements at night are predicted to be much lower than during the day.

Vehicle speed limits will be implemented during both construction and operation, reducing the potential for fauna strikes as outlined in the CSFMP (**Appendix 12**). However, it is acknowledged that individuals will be subject to direct impacts associated with mortality or injury from vegetation clearing or vehicle strike, and the loss of some individuals may be unavoidable. In the event of a fauna strike, the impact will be limited to an individual and will not result in population-wide impacts. As a result, the potential impacts on fauna from interactions with vehicles and machinery are not expected to be significant to the extent that the conservation status of any of the species present would be affected. The use of vehicles and machinery associated with the Proposal are therefore considered unlikely cause significant impact or result in the significant decline of a population of any of the conservation significant vertebrate or SRE invertebrate fauna known to occur within the Development Envelope.

Fauna also may become trapped in containers, uncapped drill holes, trenches, excavations or water storage structures resulting in injury or death. Measures will be implemented including fauna egress points and regular monitoring as outlined in the CSFMP (**Appendix 12**) to minimise the loss of fauna from entrapment.

The use of barbed wire fencing has the potential to result in entanglement of bat species (Pilbara Leaf-nosed Bat and Ghost Bat), which may result in injury or mortality of individuals. HPPL will avoid the use of barbed wire fencing where possible. Where barbed wire fencing cannot be avoided, HPPL will install reflectors to increase conspicuousness to bats.

HPPL will maintain records of any known fauna injury or mortality observed within the Development Envelope in order to inform the review and ongoing improvement of management measures. Overall, in conjunction with proposed management measures, the number of individuals potentially affected by collision or entrapment is expected to be low and not significant in terms of local populations.

The establishment of the FHEZ and the FHEZ Corridor will provide refuge for conservation significant fauna and allow for the dispersal of fauna from the high value habitat within the FHEZ to habitat outside of the Development Envelope. This reduces the potential impacts that may be caused by fragmentation. Establishment of these areas also protects 42 Category 4 caves which are nocturnal roosts for the Pilbara Leaf-nosed and Ghost Bats allowing for their movement across the regions, reducing potential loss of individuals from dehydration during their breeding season. These caves are also important refuge and breeding sites for the Northern Quoll and the Pilbara Olive Python, protecting them from predation from feral fauna such as cats.

A total of 15 Confirmed and 91 Potential SRE invertebrate taxa have been recorded within a 40 km radius of the Development Envelope. Of the potentially occurring taxa, 12 have previously been recorded within the Development Envelope. Only one confirmed SRE taxon has been recorded in any of the surveys undertaken; the Isopod *Buddelundia* 56. There was only one record of this species in the Development Envelope. This species was not found in the Indicative Footprint. There are numerous records of *Buddelundia* 56 outside of the Development Envelope recorded from the various surveys for this Proposal (Biologic 2022 a; b; *ecologia* 2021a; Spectrum 2023a) (**Appendix 11**)

Up to 31 potential/possible SREs were identified in the Development Envelope. Of these, four are only found within the Indicative Footprint (**Table 10-12**). These four are the isopods *Buddelundi*a indet. 1 and Buddelundiinae 'Nyi01'; the Arachnid *Missulena* sp. indet.; and the Arthropod *Dampetrus* OPI001.

The CSFMP **(Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes minimising incidental mortality or injury of conservation significant terrestrial fauna from clearing activities, vehicle strike or mining related activities resulting from the Proposal.

10.6.1.2 Loss of Fauna Habitat

Implementation of the Proposal will result in the clearing of fauna habitat within two Pilbara IBRA bio-subregions – the Fortescue and Chichester subregions. While Proposal includes some flexibility to alter the final location of the Proposal elements within the Development Envelope regardless of where the final footprint is implemented, no more than 4,339.16 ha of fauna habitat will be removed.

There are nine broad fauna habitat types (not including habitat classified as Disturbed/Cleared) which have been mapped across the Development Envelope of which eight will be impacted by clearing. The assessment of impacts to each fauna habitat types is discussed in **Table 10-14**.

Both the Development Envelope and Indicative Footprint for the Proposal has been modified to minimise direct impacts to high-value fauna habitat to the extent possible. Based on the Indicative Footprint, approximately 1,462.03 ha of high value habitat (comprising Rocky Hills, Stony Spinifex Plains, Hillslopes, Drainage lines/Floodplains and Gibber Cracking Clay) will be cleared for the Proposal. Detailed fauna habitat mapping has been completed for approximately 227,118.87 ha within and outside the Development Envelope.

In addition, a FHEZ and a FHEZ Corridor have been established, excluding these areas of high value habitat from development and from mining activities. These areas comprise habitat types that are considered high value for conservation significant fauna, including Rocky Hills, Drainage Line/ Floodplains, and Stony Spinifex Plains and

Hillslopes habitats. These habitats provide foraging habitat proximal to the Category 4 nocturnal roosts for the Pilbara Leaf-nosed Bat and Ghost Bat. The FHEZ supports 36 Category 4 Nocturnal Roosts for the Pilbara Leaf-nosed Bat and 15 for the Ghost Bat, in addition to high quality foraging habitat for the bats. The FHEZ also protects habitat for the Northern Quoll and the Pilbara Olive Python as well as potential foraging habitat for the Night Parrot. The FHEZ has also been found to support numerous Western Pebble-mound Mouse mounds which will not be impacted by the Proposal.

Potential impacts to the conservation significant fauna recorded from within the Development Envelope are discussed in **Table 10-15**.

The likely SRE groups and any confirmed SREs and their supporting habitats are listed in **Table 10-12** and the extent of impact (clearing) shown as the Indicative Footprint in all figures.

Table 10-14: Fauna Habitat – Assessment of Impacts

Habitat Type	Assessment of Impacts
Mulga Woodland	The Proposal will result in the removal of approximately 2,824.74 ha of Mulga Woodlands habitat, representing 34.44% of the mapped habitat within the Development Envelope and 6.48% of the extent mapped during surveys associated with the Proposal. This habitat is generally considered low value for conservation significant fauna and is widespread and common throughout the Pilbara region. However, it is habitat considered critical to the survival of the Bilby and foraging habitat for the Northern Quoll and supports Gane's Blind Snake. The Mulga Woodland also provides non-critical foraging habitat for the Pilbara Leaf-nosed Bat. The Mulga Woodland mapped within the Development Envelope has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Given the retention of approximately 5,378.22 ha (65.56%) in the Development Envelope (and 93.52% of the local mapped survey extent) this is not considered a significant impact.
Rocky Hills	The Proposal will result in the removal of approximately 520.80 ha of Rocky Hills habitat, representing 19.59% of the mapped habitat within the Development Envelope and 4.35% of the extent mapped during surveys associated with the Proposal. This habitat is of high value as it provides shelter, denning and roosting habitat for conservation significant species and is widespread and common throughout the Pilbara region. Breakaways, gorges and gullies within the Rocky Hills habitat type are known to provide potential caves, denning and foraging habitat considered to be critical habitat for the survival of Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat. The occurrence of breakaways and caves in the Rocky Hills habitat type is relatively common at a regional level, particularly within the Chichester and Hamersley Ranges bioregions. The Rocky Hills habitat is considered common and widespread throughout the Pilbara. Within the Development Envelope, this habitat type is associated with the Newman land system. The Development Envelope contains less than 0.21% of the known extent of this land system. The Proposal will retain approximately 2,137.43 ha (80.41%) in the Development Envelope, of which 950.81 ha occurs within the FHEZ, and 95.65% of the local mapped survey extent. Given the high value of this habitat type for conservation significant species this is considered a locally significant residual impact to terrestrial fauna and environmental offsets will be provided (Section 16). The FHEZ Corridor contains 548.14 ha of this habitat.
Stony Spinifex Plains and Hillslopes	The Proposal will result in the removal of approximately 813.97 ha of Stony Spinifex Plains and Hillslopes habitat, representing 17.11% of the mapped habitat within the Development Envelope and 1.3% of the extent mapped during surveys associated with the Proposal. Stony Spinifex Plains and Hillslopes are considered of moderate value as they generally offer minimal refugia to species of conservation significance however, where they are adjacent to high value breeding habitat they are a supporting habitat. This habitat is widespread and common throughout the Pilbara region. This is primarily habitat for the Western Pebble-mound Mouse, the Pilbara Leaf-nosed Bat, Northern Quoll and Gane's Blind-snake. The Stony Spinifex Plains and Hillslopes habitat type provides stones of a suitable size for

Habitat Type	Assessment of Impacts
	the Western Pebble-mound Mouse to construct mounds. Several mounds were found in this habitat type in the Development Envelope. Given the retention of approximately 3,944.18 ha (82.89%) in the Development Envelope (and 99.7% of the local mapped survey extent) and 262.39 ha occurs within the FHEZ. Up to 331.16 ha of this habitat occurs in the FHEZ Corridor.
Chenopod/ Cracking Clay Floodplain	The Proposal will result in the removal of approximately 92.78 ha of Chenopod/ Cracking Clay Floodplain habitat, representing 16.94% of the mapped habitat within the Development Envelope and 1.6% of the extent mapped during surveys associated with the Proposal. Chenopod/Cracking Clay Floodplains is habitat considered critical foraging for the survival of the Night Parrot and the Bilby and as supporting habitat for the migratory birds; however, due to the condition of this habitat type within the Development Envelope, it is considered low value to species of conservation significance. Given the retention of approximately 77.06 ha (82.89%) in the Development Envelope (and 99.4% of the local mapped survey extent) this is not considered a significant impact.
Drainage Lines/ Floodplains	The Proposal will result in the removal of approximately 71.26 ha of Drainage Lines/ Floodplains habitat, representing 13.36% of the mapped habitat within the Development Envelope and 0.21% of the extent mapped during surveys associated with the Proposal. Drainage lines are of moderate conservation value as they provide foraging and dispersal habitat for fauna. They are considered high value when they are within the home range for the Northern Quoll breeding habitat. This habitat type is known to provide foraging and dispersal habitat for Pilbara Leaf-nosed Bat, Ghost Bat and the Northern Quoll. It also has the potential to support foraging and potential breeding habitat for the Grey Falcon. The FHEZ contains up to 107.62 ha of this habitat and the FHEZ Corridor will conserve a further 75 ha. Given the retention of approximately 451.38 ha (86.64%) in the Development Envelope (and 99.8% of the local mapped survey extent) and 107.62 ha occurs within the FHEZ this is not considered a significant impact.
Gibber Cracking Clay	The Proposal will result in the removal of approximately 56.69 ha of Gibber Cracking Clay habitat, representing 22.00% of the mapped habitat within the Development Envelope and 1.59% of the extent mapped during surveys associated with the Proposal. This habitat type is known to be important breeding, foraging and dispersal habitat for the Short-tailed Mouse (P4, DBCA) and Western Pebble-mound Mouse and supports non-critical foraging habitat for the Ghost Bat and Peregrine Falcon. While sporadic in nature, this habitat is considered widespread in the Pilbara. Given the retention of approximately 201.00 ha (78%) in the Development Envelope (and 99.6% of the local mapped survey extent) this is not considered a significant impact.
Cracking Clay	The Proposal will result in the removal of approximately 28.10 ha of Cracking Clay habitat, representing 12.90% of the mapped habitat within the Development Envelope and 0.51% of the extent mapped during surveys associated with the Proposal. This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. However, it may be marginally suitable as foraging habitat for the Night Parrot. Given the retention of approximately 189.74 ha (87.10%) in the Development Envelope (and 99.49% of the local mapped survey extent) this is not considered a significant impact.
Snakewood	The Proposal will result in the removal of approximately 8.04 ha of Snakewood habitat, representing 8.32% of the mapped habitat within the Development Envelope and 1.10% of the extent mapped during surveys associated with the Proposal. This habitat is of low value and is widespread and common throughout the Pilbara region. Provides potential foraging for fauna which occur on Cracking Clay habitat. Given the retention of approximately 88.51 ha (91.68%) in the Development Envelope (and 98.90% of the local mapped survey extent) this is not considered a significant impact.
Rocky Plains and Footslopes	While present in the Development Envelope, the Indicative Footprint avoids this habitat. This habitat provides potential foraging habitat in the drainage lines and grasslands and has the potential to support and number of conservation significant species.

Table 10-15: Impacts to Conservation Significant Fauna

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
Northern Quoll	High value habitat for the survival of the Northern Quoll is habitat for denning and foraging located within their home range (from 35 ha up to 100 ha during the breeding season). This includes habitat of low rocky hills – such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or tree lined creek lines (CoA, 2016). Within the Development Envelope, the Rocky Hills habitat is considered critical habitat for the Northern Quoll. Multiple patches of suitable habitat for this species were identified in the Rocky Hills habitat area which would be considered habitat critical to the survival of this species. These micro-habitats provide shelter for breeding and refuge from fire/predation. Should the cane toad invade, this habitat is considered to provide protection to the Northern Quolls (CoA, 2016). The Rocky Hills habitat is considered common and widespread throughout the Pilbara (Attexo 2023). The Drainage Line habitat provides Northern Quoll populations dispersal habitat. Foraging habitat is recognized to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of shelter habitat, or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (CoA, 2016). Potential foraging/dispersal habitat for the species within the Development Envelope consists of: ▪ Drainage Line/Floodplain; ▪ Rocky Hills; ▪ Stony Spinifex Plains and Hillslopes.	Rocky Hills	Rocky Hills	520.80	1,406.03	**Loss of habitat** The Northern Quolls were only recorded within the Rocky Hills habitat in the Development Envelope. Records were primarily adjacent to the FHEZ, which will be retained and has been expanded to include areas that support foraging habitat for the species and improve connectivity of habitat to areas within and outside the Development Envelope. Since determination of the FHEZ in 2023, no exploration activities have occurred within the area. The area does contain minimal disturbance limited to an existing access track however areas of existing disturbance and linear and not expected to fragment and impact movement of the species within the FHEZ with the inclusion of the FHEZ Corridor. This area supports high value habitat which allows continuity across the Development Envelope. The Proposal will result in the loss of a total of 520.80 ha of high value (Rocky Hills) habitat for this species, which represents 19.59% of available habitat within the Development Envelope. The Rocky Hills habitat extends outside of the Development Envelope and Drainage Line habitat which can be used for dispersal intersects the Rocky Hills. The FHEZ contains 950.81 ha of Rocky Hills habitat. Drainage lines are also important to the Northern Quoll for dispersal and the FHEZ contains 107.62 ha of Drainage Line/Floodplain habitat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. The FHEZ and the FHEZ Corridor have been found to support a high density population. Studies in the Pilbara have found that that shelters are of higher abundance in rocky-riparian and rocky habitats. These areas have been shown to provide the highest quality habitat for the Northern Quoll, especially as there is also a higher prey availability associated with the more open Stony Spinifex Plains and Hills (Hernandez-Santin et al. 2021). Connectivity across habitats is vital to the survival of species. While the FHEZ is surrounded by the Development Envelope, connectivity will be maintained with the inclusion of the FHEZ Corridor. Additionally, installation of fauna friendly culverts will allow the Northern Quoll to continue dispersal outside of the FHEZ to the north and across the other Rocky Hill habitats. This impact will be managed through the CSFMP and it will include access via culverts, reduced speed within areas which align with Northern Quoll habitat and the use of appropriate lighting as per the Lighting Guidelines. Clearing of 520.80 ha of Rocky Hills habitat will have a direct, long-term impact on the local populations of Northern Quoll within the Development Envelope. It will not impact the long-term survival of the regional Northern Quoll population as Rocky Hills habitat is considered common and widespread throughout the Pilbara (*ecologia* 2021a). While clearing of 885.23 ha of other potential foraging habitat will have a direct impact on foraging habitat for the Northern Quoll within the Development Envelope, it will not have a significant impact on foraging for regional populations as Drainage Line/Floodplain, and Stony Spinifex Plains and Hillslopes habitats, are considered widespread throughout the Pilbara. Habitat suitable for the Northern Quoll is widespread and common in the Pilbara and extends outside the Development Envelope, interconnected by drainage lines along the Chichester Range and Fortescue Valley. **Changes to surface and groundwater conditions** The Proposal will result in modified surface water flow patterns across the Development Envelope. However, the vegetation types and the corresponding fauna habitat types which may be affected by any hydrological changes do not contain critical or foraging habitat for the Northern Quoll (AQ2 2024b). The areas which may be affected by changes include Fortescue Valley floodplain areas which are not habitat for the Northern Quolls. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Stony Spinifex Plains and Hillslopes	NA	813.97		
		Drainage Line/Floodplain	NA	71.26		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
Ghost Bat	There are no species-specific policy guidelines on what constitutes high value habitat for the Ghost Bat, or what is defined as an important population; however, the conservation advice for the species indicates that persistence of the species in the Pilbara depends on the physiologically benign day roosts found deep underground in humid, temperature stable caves (TSSC 2016a). No roosting habitat has been identified within the Development Envelope for the Ghost Bat. Despite extensive surveys, no known or suspected Category 1, 2 or 3 caves for the Ghost Bat have been identified within the Development Envelope or documented within a 30 km radius. There is anecdotal evidence of a known roost occurring approximately 30 km south of the Development Envelope across the Fortescue Valley, near Wittenoom in the Hamersley Ranges (Bob Bullen pers. comm in *ecologia* 2023a). Of the 82 cave assessments undertaken, 51 cave structures within the Development Envelope are considered as Category 4 (nocturnal refuges). It is unlikely a permanent Ghost Bat roost site exists. The species has the potential to forage in all habitat types within the Development Envelope (Attexo 2023). However, given the absence of critical roosting habitat and permanent water sources in the Development Envelope, habitats present are considered to be of low value to Ghost Bats.	Rocky Hills	Rocky Hills	520.80	1462.72	**Loss of habitat** The Proposal has been designed to avoid areas of high value fauna habitat as far as practicable. The key avoidance measure for protection of Ghost Bats has been the establishment of the FHEZ and exclusion of this area from the Development Envelope to minimise impacts to habitat that is known to support conservation significant species. The FHEZ is 1,320.82 ha in total, including 950.81 ha of high value Rocky Hills fauna habitat type. The FHEZ also includes Drainage Line, and Stony Spinifex Plains and Hillslopes habitat types which provide other suitable foraging and dispersal habitat for the Ghost bat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. Based on the location of the mineral deposits and subsequent mine pits the development of the Proposal will result in the loss of up to five potential Category 4 Ghost Bat roosts. These are not considered critical habitat (Bat Call 2021a). These caves are associated with Rocky Hills habitat which is widespread throughout the Pilbara region. Further, Ghost Bat occurrence and habitation within the Development Envelope is low with only a few records of this species occurring. A lack of deep caves limits the suitability for diurnal roosting for this species within the area. After extensive survey effort, no permanent known or suspected Category 1, 2, or 3 caves have been identified within the Development Envelope, or has been documented within 30 km of the area (*ecologia* 2023a). Clearing required for the Proposal will have a local impact on the use of habitats by the Ghost Bat, but the impact to the local population will not be significant as Rocky Hills habitat is considered common and widespread throughout the Pilbara. Approximately 6,789.20 ha (82.27%) suitable habitat for this species will remain in the Development Envelope. As the Bats can travel more than 15 km at night while foraging and there are no permanent roosts within the Development Envelope, clearance of foraging habitat for the Proposal will not have a significant direct impact on the Ghost Bat. However, given the absence of critical roosting habitat and permanent water sources in the Development Envelope, habitats present are considered to be of low value to Ghost Bats. **Noise and Vibration** Noise and vibration from the Proposal will not have a significant impact on Ghost Bats, as there are no permanent or maternity caves (No category 1,2,3, caves) within the Development Envelope. As such, breeding will not be impacted by the Proposal during the maternity season, and bat colonies will not be forced to relocate roosts. A minor impact will be had on Category 4 caves for noise and vibration activities conducted at night, where Ghost Bats are likely to avoid using these caves to feed or rest. Research by Bat Call WA (2021a) indicates Ghost Bats may become accustomed to high noise levels and continue to depart from roosts and transit to foraging areas in a typical manner. LGA conducted an Environmental Noise Assessment (LGA, 2024) to determine the likely impacts of noise created by the Proposal on bats. As there are no legislated noise criteria, the noise levels were assessed based on relevant studies on the impact of noise on the Ghost Bat, specifically a study undertaken by Bullen and Creese (2014) that indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost. Applying this criterion, the noise modelling undertaken for the Proposal indicates that noise from operations to nearby caves is predicted to be below the 70 dB threshold, and it would be unlikely for the bats to cease utilising the caves. Ground vibration levels at the closest caves, within 200 m are most critical (LGA, 2024). PSM was engaged to undertake a geotechnical assessments of caves located in close proximity to Proposal activities to understand potential impacts of the Proposal as a result of blasting and operational vibration. A copy of this assessment is provided in **Appendix 28**. The assessment result in maximum vibration limits that should be achieved at caves as assessed as either high or medium susceptibility of damage from vibration Mitigation and management of medium and high-risk caves are outlined in the CSFMP (**Appendix 12**). **Changes to surface or groundwater**
		Stony Spinifex Plains and Hillslopes	NA	813.97		
		Drainage Lines/Floodplain	NA	71.26		
		Gibber Cracking Clay	NA	56.48		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
						Changes to surface and groundwater conditions resulting from the Proposal will not impact the Ghost Bat. Available data suggests that the longest distance from a roost to a permanent water source is 8.7 km (Bat Call WA 2021b). Current best practice is to consider semi- and permanent water sources within 5 km of a Category 1 or 2 roost to be important but not critical habitat for the species (Bat Call 2021a, p. 21). Considerable survey effort undertaken within the Development Envelope has failed to locate a permanent water source. Semi-permanent water sources within creek lines (small pools) may be found within the area following rain, which may persist for weeks to months. As no Category 1, 2, or 3 roots occur within the Development Envelope, and no permanent water sources have been identified within the Development Envelope (*ecologia* 2023a), changes to surface water will not impact the Ghost Bat. Further, water permanency in the claypans will not be affected by the Proposal. Karijini National Park located 10 km south of the Proposal, contains permanent surface water sources for the Ghost Bat. Changes to groundwater levels from the Proposal will not impact on local or regional populations of the Ghost Bat as there are no Ghost Bat roosts in underground mines connected to the water table within the Development Envelope. Karijini National Park located 10 km south of the Proposal, contains permanent surface water sources. There are also known Ghost Bat roosts within the Karijini National Park (Roy Hill Expansion Project,2020). Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2,** respectively.
Pilbara Leaf-nosed Bat	No habitat considered to be critical for the survival of the Pilbara Leaf-nosed Bat was identified in the Development Envelope. Habitat considered critical for this species includes gorges bounded by sheer rock walls containing water lasting weeks or months (Priority 1) typical of the Wittenoom and Karijini gorges. Rocky Hills within the Development Envelope support Priority 2 and Priority 3 foraging habitat, while Drainage Lines/ Floodplains support Priority 4 foraging habitat and Stony Spinifex Plains and Hillslopes support Priority 5 foraging habitat. These habitat types are considered widespread in the Development Envelope and in a regional context (in Attexo 2023; Spectrum 2023a). Regular detections in all seasons within the target valley indicate that the Drainage Lines are a preferred commuting and foraging area and considered critical foraging habitat (*ecologia* 2021b). This is consistent with other studies in the Pilbara (Northover et al. 2023). Considerable survey effort undertaken within the Development Envelope has failed to locate permanent water sources within the area (Priority 1 habitat). Semi-permanent water sources within creek lines (small pools) may be found within the area following rain that may persist for weeks or months (*ecologia* 2023a). Habitat considered critical for this species includes Category 1, 2 or 3 roosts, as defined in Bat Call WA (2021b). Foraging habitat within 10 km radius of Category 1, 2 or 3 caves is also considered critical as is any permanent water source within 5 km – 7 km (according to literature, refer to Northover et al 2023). Targeted surveys in the Development Envelope included 82 cave habitat assessments, 44 ARU survey sites and all rocky ridgeline habitats were searched on foot for suitable roost sites (*ecologia* 2023a). All caves with the potential to be used as a diurnal roost have been surveyed using ARUs and there is no evidence to suggest there is a Category 1, 2 or 3 diurnal roost for the Pilbara Leaf-nosed Bat within the Development Envelope or FHEZ. Thirty-two Category 4 caves were identified in the Development Envelope. The *ecologia* 2023a desktop risk assessment for this species compiles all the search data and provides a peer review of the information.	Rocky Hills	Rocky Hills	520.80	1,406.03	**Loss of habitat** The Proposal has been designed to avoid areas of high value fauna habitat as far as practicable. The key avoidance measure for protection of Pilbara Leaf-nosed Bats has been the establishment of the FHEZ and exclusion from the Development Envelope to minimise impacts to high value habitat. The FHEZ is 1320.82 ha in total, including 950.81ha of high value Rocky Hills fauna habitat type. The FHEZ also includes 107.62 ha of Drainage Line, and 262.39 ha of Stony Spinifex Plains and Hillslopes habitat types which provide other suitable foraging and dispersal habitat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. Habitat considered high value for this species includes Category 1, 2 or 3 roosts. Foraging habitat within 10 km radius of Category 1, 2 or 3 caves is also considered high value as is any permanent water source within 8.7 km of theses caves. After extensive survey effort, no permanent known or suspected Category 1, 2, or 3 caves have been identified within the Development Envelope or has been documented within 30 km of the area (*ecologia* 2023a). In addition, the Development Envelope does not contain permanent water sources. A total of 51 caves were assessed as being characteristic of a Category 4 cave (nocturnal refuge) with the potential to be used at night for resting, feeding, or other purposes within the Development Envelope. These are not considered high value habitat but are important for persistence of the species in a local area. The Rocky Hills habitat within the Development Envelope supports Priority 2 and Priority 3 foraging habitat, while Drainage Lines/Floodplains and Stony Spinifex Plains and Hillslopes support Priority 4 foraging habitat; however, in the absence of high value habitat and permanent water sources, is unlikely to be considered high value for this species. Pilbara Leaf-nosed Bat echolocation calls were recorded at 103 locations during surveys (within and outside the Development Envelope). The majority of records were located on flight paths in creek lines or in open habitats away from cave entrances indicating that the creek line is a preferred commuting and foraging area and is considered high value habitat for the species. Rocky Hills within the Development Envelope support Priority 2 and Priority 3 foraging habitat, while Drainage Lines/ Floodplains and Stony Spinifex Plains and Hillslopes support Priority 5 foraging habitat. Approximately 6532.99 ha (82.29%) suitable habitat for this species will
		Stony Spinifex Plains and Hillslopes	NA	813.97		
		Drainage Line/Floodplain	NA	71.26		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			remain in the Development Envelope. These habitat types are also considered widespread in a regional context. There is a continued presence of the Pilbara Leaf-nosed Bat within the Development Envelope, and regular detections within the target valley indicate that the Drainage Lines are the preferred commuting and foraging habitat. The loss of the above foraging habitat for this species is not considered significant and these foraging habitats are widespread within the Pilbara. The Pilbara Leaf-nosed Bat can forage up to 20 km from a diurnal roost (Bat Call 2016). Extensive survey effort did not identify any Category 1, 2 or 3 diurnal roosts to be present within the Development Envelope (*ecologia* 2023a) or within 30 km, so high value Pilbara Leaf-nosed Bat roosts are unlikely to be significantly impacted by the Proposal. The residual impact on the Pilbara Leaf-nosed Bat from the Proposal will not be significant as foraging habitats to be cleared are considered widespread within the Pilbara, no Category 1, 2 or 3 diurnal roosts critical to the Pilbara Leaf-nosed Bat were identified within the Development Envelope, and only eight of the 51 Category-4 caves occur within the Indicative Footprint and have the potential to be removed. **Noise and Vibration** Noise and vibration from the Proposal will not have a significant impact on Pilbara Leaf-nosed Bats, as there are no permanent or maternity roosts (No Category 1,2, or 3 roosts) within the Development Envelope. As such, breeding will not be impacted by the Proposal during the maternity season. Noise and vibration activities conducted at night may result in impacts to the Category 4 nocturnal roosts and bat foraging activities in nearby habitat. A study undertaken by Bullen and Creese (2014) indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost and this can be transferred to the Pilbara Leaf-nosed Bat feeding habitat. LGA conducted an Environmental Noise Assessment (LGA, 2024) to determine the likely impacts of noise created by the Proposal on bats. As there are no legislated noise criteria, the noise levels were assessed based on relevant studies on the impact of noise on the Ghost Bat, specifically a study undertaken by Bullen and Creese (2014) that indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost. Applying this criterion, the noise modelling undertaken for the Proposal indicates that noise from operations to nearby caves is predicted to be below the 70 dB threshold, and it would be unlikely for the bats to cease utilising the caves. Ground vibration levels at the closest caves, within 200 m are most critical (LGA, 2024). HPPL engaged PSM to undertake a geotechnical assessment of caves located in close proximity to Proposal activities to understand potential impacts of the Proposal as a result of blasting and operational vibration. A copy of this assessment is provided in **Appendix 28**. The assessment result in maximum vibration limits that should be achieved at caves as assessed as either high or medium susceptibility of damage from vibration. **Changes to surface and groundwater conditions** Changes to surface and groundwater conditions resulting from the Proposal will not impact the Pilbara Leaf-nosed Bat. No permanent water sources have been identified within the Development Envelope (Priority 1). Semi-permanent water sources within creek lines (small pools) may be found in the area following rain that may persist for weeks or months (*ecologia* 2023a). Water permanency of surface water within the Development Envelope will not be affected by the Proposal. Karijini National Park located 10 km south of the Proposal, contains permanent surface water sources. Changes to groundwater levels from the Proposal will not impact on local or regional populations of the Pilbara Leaf-nosed Bat as there are no Pilbara Leaf-nosed Bat roosts in underground mines connected to the water table within the Development Envelope. There are also known Pilbara Leaf-nosed Bat roosts within the Karijini National Park (Roy Hill Expansion Project, 2020). The national park also has an extensive groundwater system (Johnson and Wright 2003).

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
						An assessment on the significance of hydrological changes to fauna habitat from the Proposal found that habitat critical to the Pilbara Leaf-nosed Bat would not be affected by any changes. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
Grey Falcon	The Conservation Advice (DCCEEW 2020) identifies that Grey Falcon nests are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but Grey Falcons also nest in telecommunication towers (Marchant & Higgins 1993; Schoenjahn 2013, 2018; Falkenberg 2010). The tendency of Grey Falcons to utilise the nests of other birds (corvids and raptors) in largest eucalypts restricts suitable nesting habitat presence within the Development Envelope to one main habitat type (*ecologia* 2023b), Drainage Lines/Floodplain (522.64 ha recorded in the Development Envelope); The banks of some Drainage Lines support *Eucalyptus victrix* trees that have the potential to be used for nesting if they possess previously built nests. The remainder of the habitat types within the Development Envelope are unlikely to provide suitable nesting habitat for the Grey Falcon; however, the following habitat types may provide suitable foraging habitat: • Stony Spinifex Plains and Hillslopes; • Cracking Clay; • Snakewood; and • Rocky Plains and Slopes (not mapped withing the Indicative Footprint).	Drainage Lines/Floodplains		71.26	921.37	**Loss of habitat** Although significant avifauna survey effort has been undertaken since 2013 within the Development Envelope, this species has only been recorded on two occasions, indicating intermittent visitation which aligns with the habits of this nomadic species. The banks of some Drainage Lines support *Eucalyptus victrix* trees that have the potential to be used for nesting if they possess previously built nests. The Grey Falcon recorded by *ecologia* (2021b) was in close proximity to a drainage line in the Mulga East portion of the Development Envelope. The Proposal impacts a total of 71.26 ha of this habitat type, which is 3.3% of the mapped extent in the Development Envelope. Mapped nests which have the potential to be used by this species within the Development Envelope will be retained. The remainder of the habitat types within the Development Envelope are unlikely to provide suitable nesting habitat for the Grey Falcon however, 5,595.18 ha of potential foraging habitat is present, of which 921.37 has will be cleared 16.47%). A targeted survey undertaken in 2023 assessed 54 survey sites within suitable habitat for the Grey Falcon. A total of 46 nests across 27 trees were recoded and assessed as suitable for use by the Grey Falcon. However, none were observed during the survey and no secondary evidence of this species was found within the assessed nest sites. The majority of the nests were associated with *Eucalyptus vitrix*. Based on the results of surveys to date, is likely that the Development Envelope is used by this species on an occasional basis for foraging and potential breeding. **Changes to surface and groundwater** An ecohydrological study (AQ2 2024b**;**) was completed to investigate the claypan flats and associated stands of mesic trees comprising *Eucalyptus victrix*. Sensitivity analyses reaffirmed the overriding importance of the timing and magnitude of soil water replenishment events, rather than total annual rainfall per se, for sustaining the woodland trees.The assessment found no GDEs within the Development Envelope. Water balance modelling supported by on-ground vegetation measurements, used to estimate tree water use relative to water availability estimated that surface water inputs are sufficient to support the density of trees occurring in the Fortescue Valley *E. victrix* woodland communities. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl. If water levels rise above this threshold for prolonged periods, vegetation stress is predicted. Although the predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LoM, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time (AQ2 2024b). Impacts to fauna habitat resulting from changes in hydrology are further discussed in **Section 10.4**. Overall, the potential impacts to the vegetation are likely to be spatially restricted and transient. A Water Management Plan has been prepared to allow for the identification and management of impacts to vegetation health and vegetation resulting from hydrological changes associated with implementation of the Proposal (**Appendix 6**). Given the likely intermittent visitation of this species and the extent of habitat that will remain within the Development Envelope, impacts to this species are unlikely to be significant.
		Stony Spinifex Plains and Hillslopes		813.97		
		Cracking Clay		28.10		
		Snakewood		8.04		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
						Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
Pilbara Olive Python	The Conservation Advice for the Pilbara Olive Python does not define which habitat is considered critical for the survival of this species (DCCEEW 2008a). Defining habitat critical for the survival of the Pilbara Olive Python is acknowledged as being difficult due to a lack of research on habitat use. Likewise, sites that are important for reproduction in adults are poorly understood as only two nesting sites have ever been located in rocky hills away from river systems. DBCA have provided a default definition based on the description of common habitat characteristics where the species have been encountered (refer to Northover et al 2023). It is also known that habitat quality for this species is strongly influenced by the presence of waterholes and billabongs (Pearson 2006, DCCEEW 2008a). Based on survey information available to date, the Development Envelope does not contain deep gorges or permanent sources of water considered preferred habitat for this species (DCCEEW 2008a). As such, denning is considered to be less likely within the Development Envelope, given the absence of persistent of watering holes. Within the Development Envelope, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills (rocky outcrops, breakaways and small gorges) although it has also been known to inhabit spinifex grasslands and travel large distances. There is a record of one Pilbara Olive Python which was found at a mine camp within the Mulga Downs Iron Ore Project. This camp was located within the Stony Spinifex Plains and Hillslopes habitat type. However, this is not habitat which has been defined as habitat for the species in the most recent work by DBCA. While the Rocky Hills habitat may support the Pilbara Olive Python, it cannot be considered high value habitat this species given the absence of permanent water holes. Drainage Line habitat also provides suitable foraging habitat (*ecologia* 2021a). Rocky Hills habitat is considered common and widespread throughout the Pilbara (*ecologia* 2021a). No deep gorges or permanent sources of water considered preferred habitat for this species, have been recorded within the Development Envelope.	Rocky Hills	NA	520.80	1,406.03	**Loss of Habitat** The Pilbara Olive Python has a medium to low likelihood of occurrence within the Development Envelope. Within the Development Envelope, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills (rocky outcrops, breakaways and small gorges) although it has also been known to inhabit spinifex grasslands and travel large distances. Defining habitat critical for the survival of the Pilbara Olive Python is acknowledged as being difficult due to a lack of research on habitat use. Likewise, sites that are important for reproduction in adults are poorly understood as only two nesting sites have ever been located in rocky hills away from river systems. DBCA have provided a default definition based on the description of common habitat characteristics where the species have been encountered (refer to Northover et al 2023). It is also known that habitat quality for this species is strongly influenced by the presence of waterholes and billabongs (Pearson 2006, DCCEEW 2008a). Based on survey information available to date, the Development Envelope does not contain deep gorges or permanent sources of water considered preferred habitat for this species (DCCEEW 2008a). As such, denning is considered to be less likely within the Development Envelope, given the absence of persistent of watering holes. The Proposal will result in the loss of a total of 520.80 ha of Rocky Hills habitat, which represents 19.59% of available habitat within the Development Envelope. As such, significant areas (about 80%) of mapped potential suitable habitat for this species will remain within the Development Envelope. The Development Envelope comprises 5,280.79 ha of suitable foraging habitat (Drainage line/Floodplain and Stony Spinifex Plains and Hillslope) for the Pilbara Olive Python, of which 885.97 ha (16.78%) will be impacted by the Proposal. Significant areas of foraging habitat will therefore remain within the Development Envelope (greater than 80%). The FHEZ is 1320.82 ha in total, including 950.81ha of high value Rocky Hills fauna habitat type. The FHEZ also includes 107.62 ha of Drainage Line, and 262.39 ha of Stony Spinifex Plains and Hillslopes habitat types which provide other suitable foraging and denning habitat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. None of these habitats are restricted to the Development Envelope and are considered common on a local and regional scale. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2,** respectively.
		Drainage line/Floodplain	NA	71.26		
		Stony Spinifex Plains and Hillslope	NA	813.97		
Night Parrot	No high value habitat critical to the survival of the Night Parrot was identified within the Development Envelope. The area does not support large stands of old clumps of old, unburnt spinifex. Distribution of the spinifex stands was patchy. Water bodies, permanent or temporary, were not found in proximity to any vegetation which could be considered as potential nesting areas (Biologic 2022a). Based on the above, habitat considered suitable for the Night Parrot within the Development Envelope includes Drainage Line/Floodplain and Stony Spinifex Plains and Hillslopes (*ecologia* 2021a). In the absence of long unburned spinifex, this habitat is considered as supporting only.	Stony Spinifex Plains and Hillslopes	NA	813.97	900.95	**Loss of habitat** Habitat considered potentially suitable for the Night Parrot within the Development Envelope includes Drainage Line/Floodplain and Stony Spinifex Plains and Hillslopes, both of which are considered common and widespread throughout the Pilbara. However, in the Development Envelope these lack large clumps of unburnt spinifex. Long unburnt spinifex, preferred by the Night Parrot, is patchily distributed in the Development Envelope and restricted to the Stony Spinifex Plains and Hillslopes in the northeast of the Development Envelope.
		Drainage lines/Floodplains	NA	71.26		
		Chenopod/Cracking Clay Floodplains	NA	15.72		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
	Potential supporting (foraging) habitat for the Night Parrot is also found in Chenopod/Cracking Clay Floodplains (*ecologia* 2021a).					The Development Envelope includes 71.26 ha Drainage Line/Floodplain and 813.97 ha Stony Spinifex Plains and Hillslopes, both of which are considered common and widespread throughout the Pilbara (*ecologia* 2021a). The Rocky Hills habitat includes vegetation complexes of sparse hummock grasslands of *Triodia* spp. and sparse chenopod – both which have been identified as suitable for the Night Parrot. The Stony Spinifex Plains and Hillslopes occur interspersed between the Rocky Hills habitat. These areas were targeted during surveys as they were considered to contain habitat which may be critical or supporting. Potential supporting (foraging) habitat for the Night Parrot is found in Chenopod/Cracking Clay Floodplains; however, it is unlikely that this habitat is utilised by the Night Parrot due to degradation from long-term overgrazing and trampling by cattle (*ecologia* 2021a). **Changes to surface water and groundwater** Changes to surface water and groundwater conditions in the Development Envelope are not expected to impact the Night Parrot. This species is known to occupy chenopod shrublands near paleo drainages such as the Fortescue Valley. Night Parrot records have primarily been from near salt lakes in the arid zone. Changes to the water balance of the Gnalka Gnoona and Koodjeepindarranna Claypans is considered minimal (AQ2 2024b). Impacts to fauna habitat resulting from changes in hydrology are further discussed in **Section 10.6.2**. Dense thickets of lignum are stated as critical habitat for the Night Parrot. Lignum is well adapted to a periodic flooding regime and has strong drought and waterlogging tolerance. The predicted hydrological change to the Development Envelope is unlikely to significantly affect lignum; except that lignum recruitment could be enhanced. The Fortescue Valley vegetation types can be regarded as supporting habitat for the Night Parrot. The key structural and floristic elements of these vegetation types that are relevant for Night Parrot habitat values (e.g. perching, nesting, provision of food resources) are unlikely to be affected by the predicted hydrological change. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in Section **10.4.1** and Section **10.4.2**, respectively.
Greater Bilby	Habitat considered to be suitable for the Bilby was identified during the database searches for each of fauna surveys. Database search results indicated that Drainage Line/ Floodplain and Mulga Woodland habitats could provide suitable supporting habitat for Bilbies. Habitat which may be considered critical for the survival of the Bilby has also been defined as habitat along palaeo drainages near salt lake systems such as the Fortescue Valley (Northover et al 2023). The Drainage Line/ Floodplain and Mulga Woodland habitats in the Development Envelope can be considered habitat within the home range of paleo drainage systems for the Bilby, along with the Chenopod/ Cracking Clay Floodplain habitat. These all exist within the Fortescue Valley paleo drainage system and also includes habitat such as Mixed Eucalypt/Mulga Floodplain. Systematic fauna surveys were undertaken within these habitats. Targeted searches were undertaken using UAV. No Bilby dens or burrows were identified in any targeted surveys or systematic surveys sites undertaken within the Fortescue Valley paleodrainage system within and south of the Development Envelope. The presence of soil substrate suitable for burrow construction is critical (Dziminski and Carpenter 2016). The Mulga Woodland was found to have compacted alluvial loamy clay soils with occasional surface stones, not suitable for burrowing. The Drainage Line/Floodplain habitat is considered suitable for the Bilby and contains spinifex, samphires and Mulga complexes.	Drainage lines/Floodplains	NA	71.26	2,911.72	**Loss of habitat** Approximately 522.64 ha of Drainage Line/Floodplain, 8,202.96 ha of Mulga Woodland habitat and 92.78 ha of Chenopod/Cracking Clay Floodplain is present within the Development Envelope. Drainage Line/ Floodplain habitat and Mulga Woodland is considered common and widespread throughout the Pilbara (*ecologia* 2021a). No dens or burrows were found during surveys and therefore the home ranges for the Bilby are likely to be outside the area. The Proposal will result in clearing of up to 2,911.72 ha of habitat which has the potential to support foraging and/or dispersal activities for the Bilby, which represents a loss of 33.02% of available habitat within the Development Envelope. As such, about 66.98% of mapped potential foraging and/or dispersal habitat for this species will remain within the Development Envelope. Clearance of this habitat is not expected to have a significant impact on the survival of the Greater Bilby as no dens or primary or secondary activity has been found in this habitat. Records of the Bilby are outside the Development Envelope primarily in the north and further east. Further, Drainage Line/ Floodplain habitat and Mulga Woodland is considered common and widespread throughout the Pilbara (*ecologia* 2021a; Biologic 2022 a, b; Spectrum 2023a). This species is considered to be a visitor rather than a resident. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Mulga Woodland	NA	2,824.74		
		Chenopod/ Cracking Clay Floodplain	NA	15.72		
Peregrine Falcon		Rocky Hills	NA	520.80	648.75	

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
	This species occupies extremely diverse habitats and has the potential to occur in all the habitats present, for foraging. No suitable nesting habitat was recorded within the Development Envelope.	Drainage Line/Floodplain	NA	71.26		Approximately 2,790.02 ha (18.86%) suitable habitat for this species will remain in the Development Envelope. Given the diverse range of habitats utilised by this species and the extent of preferred habitats for this species that will remain in the Development Envelope, impacts to this species are unlikely to be significant. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Gibber Cracking Clay	NA	56.48		
Gane's Blind Snake	Gane's Blind Snake is found throughout the Pilbara bioregion, with records in conservation state, such as the Millstream Chichester National Park and Karijini National Park (noting that the location of these data points is an estimated location).	Mulga Woodland	NA	2,824.74	2,896.00	Given the retention of approximately 5,829.60 ha (66.81%) of suitable habitat for this species within the Development Envelope and the regional extent of these habitat types, the Proposal is unlikely to significantly impact the regional population or the conservation status of the species. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Drainage Area/Floodplain	NA	71.26		
Western Pebble-mound Mouse	The Western Pebble-mound Mouse almost exclusively occurs on gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs The species most likely occurs within habitats that provide suitable material for the construction of mounds, such as stony slopes of Hillcrest/Hillslope habitats.	Stony Spinifex Plains and Hillslopes	NA	813.97	813.97	Approximately 3,944.18 ha (82.90%) of this fauna habitat type will remain in the Development Envelope. This species is widespread and common in the region, and the Proposal is unlikely to significantly impact the regional population or the conservation status of the species. Suitable habitat for this species is preserved in the FHEZ Corridor and numerous mounds were recorded in this area. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in Section **10.4.1** and Section **10.4.2**, respectively.
Migratory Species Red-necked Stint Wood Sandpiper Common Greenshank	Important habitats in Australia for migratory shorebirds include those recognised as nationally or internationally important. The widely accepted and applied approach to identifying internationally important shorebird habitat has been through the use of criteria adopted under the Ramsar Convention on Wetlands (DoEE, 2017). According to this approach, wetland habitat should be considered internationally important if it regularly supports: • 1% of the individuals in a population of one species or subspecies of waterbird; OR • a total abundance of at least 20 000 waterbirds. Nationally important habitat for migratory shorebirds can be defined using a similar approach to these international criteria, i.e. if it regularly supports: • 0.1% of the flyway population of a single species of migratory shorebird; OR • 2000 migratory shorebirds; OR • 15 migratory shorebird species.	Mixed Eucalypt/Mulga Floodplain	NA	0.00	0.00	The Proposal will not impact this habitat type within the Development Envelope. This habitat type is considered widespread within the Fortescue valley and does not provide significant refugia to sustain any permanent populations. Migratory species have the potential to utilise this habitat type as foraging habitat only when inundated. **Changes to surface water and groundwater** Impacts to fauna habitat resulting from changes in hydrology are further discussed in **Section10.6.2.2**. Where changes in flood depth are predicted, in the majority of cases, the dominant species in the impacted vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change. Vegetation types dominated by mulga (*Acacia aneura* complex) are susceptible to increased waterlogging, which could cause a decline in tree health. Such areas are relatively small (circa tens of hectares) in the overall affected area. An assessment of the potential for vegetation in and around claypans to be impacted by altered hydrology is provided in **Section 10.6.2.2**. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2,** respectively.

10.6.1.3 Loss of Habitat for Short Range Endemics

Clearing, earthworks and excavation activities will unavoidably result in the loss of individual potential SRE taxa recorded within the Development Envelope. Of the 10 potential SREs identified within the Development Envelope, the majority are likely to be widespread or have distributions extending beyond the clearing boundaries.

The habitats with the greatest diversity were found to be the Rocky Hills and Drainage Lines/Floodplain. Across all SRE surveys, only one species of isopod was identified as confirmed SRE species – *Buddelundia* 56. This species were recorded from the *ecologia* Phase 2 survey within the Mulga West Borefield which has now been excluded from the Proposal.

The Proposal will remove a combined total of 592.06 ha of these high value SRE habitat types, representing 18.61% of the total extent within the Development Envelope. Mulga Woodland was also a favourable SRE habitat type. The Proposal will remove 2,824.74 ha of Mulga Woodland, representing 34.44% of the total extent within the Development Envelope. Overall, the loss of potential SRE habitat within the Development Envelope is 30.01%. Significant areas of habitat suitable for SRE's will therefore remain in the Development Envelope. The habitats within the Development Envelope are also not restricted, which indicates SRE species that occur within the Development Envelope, could also occur within the surrounding area. Extensive areas of suitable habitat for these species will therefore remain within the Development Envelope. These habitat types are also widespread in the Pilbara.

One Confirmed SRE – *Buddelundia* 56 was recorded in the Development Envelope. This species was not recorded in the Indicative Footprint and additional records were found outside the Development Envelope.

Up to 31 possible SREs were recorded in the Development Envelope. Four were only recorded in the Indicative Footprint. These four are the isopods *Buddelundia* indet. 1 and Buddelundiinae 'Nyi01'; the Arachnid *Missulena* sp. indet.; and the Arthropod *Dampetrus* OPI001 and they were collected from Rocky Hills Habitat. Over 90% of potential habitat for SREs will be retained and the habitats are widespread.

Isopod and scorpion specimens from SRE target groups were collected from all habitat types surveyed. Habitat preferences for target SRE groups were highly variable, with different invertebrate groups exhibiting habitat preferences likely to be associated with variations in microhabitat requirements. Drainage Lines/Floodplains were found to support the greatest diversity of scorpions. Rocky Hills provided the greatest diversity of pseudoscorpions and millipedes, and the Mulga Woodland habitat supported isopods and harvestmen. Survey effort demonstrates all of the mapped habitats within the Development Envelope extend beyond the Development Envelope. Significant areas of suitable habitat will therefore remain both within and outside the Development Envelope. Habitat suitable for SREs will be retained within the FHEZ and FHEZ Corridor.

The FHEZ will protect 1,320.82 ha of fauna habitat comprising of Rocky Hills (950.81 ha), Drainage Line/Floodplain (107.62 ha) and Stony Spinifex Plains and Hillslopes (262.39 ha). The FHEZ Corridor will retain 991.45 ha of suitable habitat. This includes 75 ha of Drainage Lines/Floodplains, 548.14 ha of Rocky Hills and 331.16 h of Stony Spinifex Plains and Hillslopes. Exclusion of the FHEZ and restricted development within the FHEZ Corridor therefore reduces impacts on habitat which is known to support SREs.

10.6.2 Indirect Impacts

10.6.2.1 A decline or change in health/composition of fauna habitat

Dust and Use of Saline Water for Dust Suppression

Construction and operation activities may result in an increase in dust. Dust emissions during construction can be generated through vegetation clearing and earthwork activities, including vehicle and machinery movements. Dust emissions during operations may arise from the handling of ore and movement of machinery. Dust has the potential to impact on the health of fauna habitat resulting from deposition onto the surfaces of leaves. There is also the potential of impacts to the health of fauna habitat from the use of saline water for dust suppression during the construction and operation of the Proposal. This can result in vegetation mortality or an increase in soil salinity leading to a decline in vegetation and flora health.

Matsuki et al. (2016) conducted a study examining the impacts of dust on plant health in semi-arid environments. The results of the study indicated no evidence of negative impacts on plant health as a result of dust deposition. Plants in semi-arid environments are exposed to dust within the natural environment and are less likely to suffer from short-term impacts of dust.

Clearing will be undertaken progressively. In addition, temporarily cleared areas will be progressively rehabilitated upon completion of construction. Dust emissions are expected to be minimal and localised to immediately adjacent vegetation.

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope and throughout the life of mine. The Proposal may result in a minor, temporary increase in localised dust deposition on vegetation but this is not expected to significantly impact vegetation, noting that the Pilbara is a naturally dusty environment.

Dewatered mine water will be used to suppress dust. This water will be limited to use in mine areas where vegetation has been cleared. The water will be a blend of brackish water from dewatering bores.

Even with potential elevated dust levels as a result of the Proposal, the fauna species within the Development Envelope are adapted to the dusty climate of the Pilbara, and dust emissions will not result in permanent changes to fauna habitat.

A Water Management Plan has been prepared to allow for the identification and management of impacts to vegetation health and vegetation resulting from (amongst other things) the use of saline water for dust suppression associated with implementation of the Proposal.

10.6.2.2 Altered Hydrological and Hydrogeological Regimes

Changes to surface water flows

The predicted impacts of alterations to the hydrological regime are described further in **Section 7**.

The potential impacts of hydrological change on mapped vegetation types and associated habitat attributes for MNES fauna species was qualitatively assessed, based on the key areas where predicted groundwater and surface water change may impact vegetation.

A total area of approximately 25 ha is predicted to be subject to increased flood levels comprising a mix of Mulga dominated vegetation at the base of alluvial fans and *Eucalyptus victrix* woodlands near the valley fringe. The magnitude of predicted change however is modest and the dominant species in these vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change of increased surface water inputs. Vegetation types dominated by mulga (*Acacia aneura* complex) are susceptible to increased waterlogging, which could cause a decline in tree health. Such areas are relatively small (circa tens of hectares) in the overall affected area. Although this area has also been identified as being at risk of exposure to shallow groundwater levels (from MAR), prolonged periods of groundwater mounding can be avoided with a programme of ongoing monitoring and adaptive management. Given this, the health and condition of vegetation and the fauna species these areas support are not anticipated to be significantly affected.

An additional area of approximately 310 ha is expected to experience a reduction in flood levels (>5 cm decrease maximum flood height) within the Fortescue Valley to the south of the Development Envelope. The magnitude of predicted change is modest. Water shadowing downstream of linear infrastructure (i.e., roads) is minimal due to the preliminary locations selected for the proposed culverts as captured in the model, which allow flows to continue downstream of the infrastructure. The areas likely to be affected largely comprise areas of patchy vegetation dominated by Mulga and scattered *Eucalyptus victrix*. Denser patches with high percentage cover of *Eucalyptus victrix* (vegetation type AdEvWL), have the greatest potential to experience soil water depletion and drought stress during prolonged interfloods.

The vegetation types predicted to be exposed to hydrological change are widespread across the Fortescue Valley and do not contain critical habitat for listed fauna species. Some instances of dense lignum thickets (relevant for the Night Parrot) occur further into the Fortescue Valley in association with *Eucalyptus victrix* woodland communities, but these are distant from the areas potentially exposed to hydrological change.

Given this, it is unlikely that the value of these fauna habitats to fauna species that utilise them will be significantly impacted as a result of altered hydrological regimes. Ongoing monitoring and adaptive management (i.e., redistribution of MAR) will avoid the impact of groundwater mounding on vegetation.

Cave microclimates may be influenced by proximity to surface water features, such as permanent pools which may increase humidity of the surrounding environment (Bat Call 2021b). However, as no surface water fed permanent pools were found within the Development Envelope during the surveys (*ecologia* 2023a; Biologic 2022b, Spectrum, 2023a, b), it is more likely that the microclimate of caves within the Development Envelope are influenced by factors such as cave depth and structural ability to retain humidity, and water infiltration during rainfall events through the rock above (Bat Call 2021b). Therefore, it is not anticipated that the Proposal will impact cave microclimates as a result of changes to surface water regimes. Notwithstanding, baseline and ongoing monitoring of cave humidity is included in the CSFMP (**Appendix 12**).

The Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan are located immediately to the south of the Development Envelope. The claypans support a diverse and highly unique aquatic invertebrate assemblage. This includes a high richness of aquatic crustacean and rotifer taxa, which are considered sensitive receptors for the claypan systems. In total, five significant invertebrate taxa were recorded during the database search and literature review. The significant invertebrates were new to science and therefore potentially restricted to claypans in the Biologic (2023) Desktop Assessment Area. Changes to groundwater and surface water levels, extent and quality have the potential to impact aquatic habitat within the freshwater claypans, that support regionally significant aquatic invertebrate communities, particularly during the initial filling phase of the claypans, when sensitive juvenile life-stages are likely to be present. Changes to water quality and hydrological regime may also adversely affect hatching / emergence rates of dormant invertebrate resting stages.

The claypans also provide important foraging areas for waterbirds. A number of threatened and listed migratory species have been identified as potentially utilising the claypans and habitats within the Development Envelope.

As discussed in Section 7.5, a water balance for the claypans was created to quantify the impact due to the potential loss in catchment due to the proposed mine development. The claypan water balance assessment concluded the predicted changes to inundation depths, ponding duration (hydroperiod) and water quality (TDS) of ponded water associated with the claypans are anticipated to be marginal and within the range of tolerance for associated vegetation and aquatic invertebrates (AQ2 2024b; Biologic 2023).

Monitoring and management of salinity, nutrient and metals inputs into the claypans, as well as the aquatic invertebrate communities, will be undertaken as outlined in the WMP (**Appendix 6**).

Changes to groundwater levels

Given that the vegetation is inferred to be disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. Therefore, changes to groundwater as a result of drawdown is not expected to impact terrestrial fauna. An assessment of potential impacts to vegetation from groundwater level change is provided in Section 9.4.2.4.

Changes to the groundwater level from mine pit dewatering may impact cave microclimates through a reduction in humidity in cases where cave roosts are connected to the water table (Bat Call 2021). However, the depth to groundwater within the FHEZ (which contains 36 Category 4 Nocturnal Roosts) ranges from a minimum of 20 m to greater than 50 m (AQ2 2024a). Despite considerable survey effort within the Development Envelope and FHEZ, no permanent pools which are groundwater fed have been found (*ecologia* 2023a; Biologic 2022b, Spectrum, 2023a, b) and ecohydrological studies to date have found that the vegetation is disconnected from the groundwater system, meaning a reduction in groundwater is not predicted to impact the terrestrial environment (AQ2 2024b). As there are no known direct connections with the water table and as groundwater is found, at its closest, approximately 20 m below surface level, groundwater is unlikely to influence cave microclimates within the Development Envelope and the FHEZ.

As shown in **Figure 10-22**: , the maximum modelled groundwater drawdown contour (2 m) extends outside of the Development Envelope, primarily in a south-westerly direction. Of the habitat in the drawdown area, 74.77% has been mapped, with the majority of the area mapped outside of the Development Envelope occurring to the south/south-west mapped as Mixed Eucalypt/Mulga Floodplain (16.47%). This habitat type is associated with

the Fortescue River floodplain (Spectrum 2023a). It is assumed, based on mapping undertaken to date and broad vegetation mapping, that unmapped areas south/south-west of the Development Envelope that intersect the maximum modelled groundwater drawdown contour (2m) are likely to be a continuation of the mapped Mixed Eucalypt/Mulga Floodplain and Mulga Woodlands habitat types. Neither of these habitat types are associated with fauna microhabitats, such as caves, that support bat roosting and therefore, groundwater drawdown in this area is unlikely to impact on cave microclimates. One additional area north-west of the mapped extent, seen on **Figure 10-22**: , sits within an area that may be subject to groundwater drawdown. This area is adjacent to a mapped area of Rocky Hills habitat that has been extensively searched for caves, with one cave recorded (MEC023 ~ 2.2 km east of unsurveyed area). Based on an analysis of aerial imagery, the unmapped area is likely to be a continuation of the Mulga Woodland and Drainage Line habitat types which occur directly south of the unmapped area. Based on this inference, it is highly unlikely that any caves would occur within this area of groundwater drawdown extent as all known caves sit within the Rocky Hills habitat type. Subsequently, based on groundwater drawdown impact modelling and extensive fauna surveying, the likelihood of impacts to cave microclimates from groundwater drawdown associated with the Proposal, within and outside of the Development Envelope, are negligible. Notwithstanding, baseline and ongoing monitoring of cave humidity is included in the CSFMP (**Appendix 12**). Following cessation of operations and closure of the mine, groundwater levels are predicted to recover to within 0.1 m of baseline levels, meaning negligible impacts are also temporary.

Groundwater level rise (i.e., mounding) will occur as a result of MAR. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be 2.0 mbgl. The predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LoM; however, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time.

Groundwater salinity will also change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 1,800 and 3,000 mg/L. The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM. As the intent is to avoid any water logging of the root zones, the salinity of the mounded groundwater and the tolerance of vegetation to salinity changes does not require further consideration.

In overall terms, potential impacts from groundwater mounding are likely to be spatially restricted and transient over the life of the Proposal. However, given the level of uncertainty associated with predictive modelling of groundwater levels and noting that the tolerance of vegetation to groundwater level change is site specific and not easily determined, a program of ongoing monitoring of groundwater levels and vegetation health will be undertaken. A detailed discussion of the proposed management and monitoring measures is provided in the Water Management Plan (**Appendix 6**). The key management measures are:

- Surplus water will be managed via MAR to:
    - limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater) and

  - limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.

- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality will be undertaken to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes. As the tolerance of vegetation to groundwater level change is site specific and not easily determined, baseline and operational monitoring of both groundwater levels and vegetation health is of particular importance for the areas identified as being at risk of exposure to shallow groundwater levels.
- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering rates if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes. The modelling indicates a rapid recovery of groundwater levels post-mining, with predicted groundwater levels reported to recover to within 0.1 m of pre-mining levels within 10 years of the cessation of mining, at all mining areas, MAR areas and regional simulated observation points.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

As such there is a low likelihood of impacts to fauna habitat resulting from groundwater mounding of changes in groundwater quality.

Figure 10-22: Maximum extent of groundwater drawdown across mapped fauna habitat extent

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Category 4 nocturnal refuges
- Max 2m Drawdown Extent
- Max 5m Drawdown Extent
- Max 10m Drawdown Extent
- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometres

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GROUNDWATER DRAWDOWN

FIGURE 10.22

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Image Reference: World Imagery: Earthstar Geographics

10.6.2.3 Impacts (i.e. cave collapse) from blasting/vibrations

Any bats utilising suitable caves recorded in the Development Envelope or FHEZ at the time of mining may be impacted indirectly through noise and vibration and it is possible that the bats would avoid these caves during construction and mining. However, if the structural integrity and suitable microclimate of the caves remain unchanged post mining, the caves can be considered suitable for use by the Pilbara Leaf-nosed Bat and / or Ghost Bat.

PSM (2024) was engaged to undertake geotechnical assessments of caves located in close proximity to the Proposal to understand potential impacts of the Proposal to caves that will be retained in the FHEZ as a result of blasting and operational vibration. The geotechnical assessment is provided as **Appendix 28.**

The caves to be retained within the FHEZ located closest to pits were selected for the assessment as these are considered most susceptible to vibration impacts. Caves located further away from the pits, in the FHEZ Corridor, would be expected to experience reduced vibration levels.

The assessed caves are hosted within outcropping bedrock escarpment of the Marra Mamba Iron Formation. The flat-lying orientation of these lithologies at Mulga Downs results in cave profiles that are generally relatively low and wide. They are commonly highly weathered and hydrated, with pervasive overprinting of the original rock fabric. The exposed escarpments themselves are typically 10-15 m in height.

The purpose of the geotechnical assessment was to assess the geotechnical stability of the caves in consideration of impacts from blasting and operational vibration, and to recommend maximum blast and operational vibration limits that should be achieved at the cave entrances to reduce the likelihood of collapse.

To assist in assessing appropriate blasting limits for the caves, each site was assigned a qualitative susceptibility rating based on key geotechnical features observed in the cave and/or escarpment around the cave entrance during the infield assessments:

- Identified specific potential rockfall hazard sources.
- Open/dilated defects.
- Structural controls on cave formation or stability (e.g. major joints, bedding).
- Interpreted potential for significant roof collapse events, including observations of:
    - Wide spans;
    - Flat roof profiles;
    - Persistent sub-horizontal bedding partings; and
    - Highly jointed and dilated rock mass (PSM, 2024).

Based on the assessment undertaken across 19 caves, four were considered low risk, 11 were considered medium risk and four were considered high risk. The assessment assigned to each cave is outlined in PSM (2024).

There is limited public information available in relation to the impact of mining activities on nearby caves and rock shelters, or any published vibration limits or guidelines. Based on the literature review undertaken by PSM and its experience at other Pilbara mine sites, the recommended vibration limits to reduce the likelihood of

significant damage above the natural background level of degradation that may result in changes to climatic conditions within the cave, or reduced access for fauna are:

- 75 mm/s for low to medium susceptibility caves (MEC007; MEC012; MEC013; MEC016; MEC025; MEC033; MEC049; MEC060; MEC062; MEC074); and
- 25 mm/s for high susceptibility caves (MEC003; MEC061; MEC063; MEC065) (PSM, 2024).

PSM also recommends that where blasting is within 500 m of a cave site, continued geotechnical monitoring is to be undertaken to assess the impact of the mining operations on rock mass, including:

- PPV monitoring at the cave sites;
- Geotechnical monitoring (such as crack-meters, tilt-meters, regular inspections)

The recommended vibration limits may be revised following assessment of initial monitoring data recorded during blasting.

HPPL will use the outcomes from the PSM baseline assessment to complete a blast impact assessment to determine blast design targets (both measured as PPV) that will safeguard caves from structural damage to these caves. A set of drill and blast parameters (including bench heights, hole diameters and stemming heights) will be developed to demonstrate that blasting can be conducted close to caves without causing structural damage.

To ensure that blast vibrations are managed below thresholds where structural damage to caves would be experienced, ground vibration trigger and threshold values have been set in the CSFMP (**Appendix 12**). Beyond structural monitoring and as described in the CSFMP, humidity of caves will be monitored to ensure blasting and vibrations are not impacting on cave humidity which has an impact on conservation significant fauna that utilise this microclimate. Monitoring of blasting vibration and cave integrity will be undertaken during and following construction and operations to confirm the caves can be considered suitable for use by the Pilbara Leaf-nosed Bat and / or Ghost Bat. With the development and implementation of an appropriate blasting design, aiming to ensure that ground vibration levels remain well below the limits recommended to ensure no damage, it is expected that the structural integrity of all caves will be maintained.

Monitoring of blasting vibration and cave integrity will be undertaken during and following construction and operations to confirm the long-term viability of these features for ongoing usage by bats.

10.6.2.4 Introduction and Spread of Weeds

The Development Envelope has a high number of weeds particularly along previously disturbed areas such drill lines. Increase in the spread of these weeds may result indirectly in the loss of foraging habitat. HPPL will implement established weed and hygiene management measures to reduce the risk of spreading existing weeds, or new weeds being introduced, into the Development Envelope. Any impacts are predicted to be localised to disturbed areas and will not impact the habitat of fauna in the local area**.**

The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes measures to minimise decline in habitat condition as a result of weed invasion.

As a result, no significant residual impacts on fauna habitat from spread of weeds are anticipated.

10.6.2.5 Altered Fire Regimes

Fire prevention measures (and control measures, should a fire break out) will be in place. This will also increase the capacity for fire management in the wider area through fire-fighting equipment, trained personnel and fire access. If a fire does occur as a result of the Proposal, fire response procedures and equipment will ensure that the fire outbreak is kept to a minimum and effectively controlled. Therefore, the Proposal is not considered likely to increase fire regimes.

The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes measures to minimise decline in habitat condition as a result of altered fire regimes. Several mitigation measures will be implemented in relation to minimising bushfire risk (**Table 10-13**), which are expected to effectively mitigate fire risks during construction and operation of the Proposal.

10.6.2.6 Disruption of Natural Foraging and Breeding Patterns

Fragmentation

Clearing for the Proposal has the potential to result in habitat fragmentation, which may lead to altered movement patterns, genetic isolation, increased competition for resources in remaining connected habitats and reduced species richness.

Fragmentation within the Indicative Footprint is most likely to occur in the mine pit area where Rocky Hill and Stony Spinifex Plains and Hillslopes habitats will be lost as a result of orebody extraction. The creation of the FHEZ to the north-west of the Fridge Hill and Horseshoe West pits aligns with an area of the Development Envelope which will not be cleared. These areas are intersected by Drainage Line habitat through the centre of the FHEZ and to the west (Figure 10-20). Northern Quolls, SREs, Gane's Blind Snake and the Pilbara Olive Python are known to use Drainages line to disperse. The northern most section of the Development Envelope occurs along the flanks of the Fortescue Valley where it connects to the Chichester Ranges. The Drainage Lines continue from the valley through to the Chichester Ranges. Further mitigation of impacts from fragmentation have been reduced by excluding an area of moderate to high value habitat which connects the FHEZ to habitat outside the Development Envelope. This corridor allows for the dispersion of fauna across Rocky Hills Habitat and includes a number of caves providing refuge. Fragmentation of the FHEZ, which contains fauna habitats considered moderate and high value, is avoided with the establishment of this exclusion area which is 991.45 ha.

Fauna habitat mapping was conducted over a larger area than the Development Envelope (refer to **Figure 10-2**). Habitat such as the Mulga Floodplain occur along the Fortescue Valley, an area that provides ecological connectivity. Since the Development Envelope does not intersect the Fortescue River, the Proposal will not create a barrier that would fragment the Fortescue Valley.

The FHEZ and FHEZ Corridor have been identified as areas that represent increased fauna habitat value and play a key role in maintaining fauna values within the wider region. As described in Section 2.2.3.10, The FHEZ will be an area within which no activities associated with the Proposal will occur. The FHEZ Corridor will

accommodate minor, low impact activities including an un-sealed light vehicle access road to support infrequent light vehicle access to a communications tower (which will be located approximately 200 m south of the FHEZ Corridor) and monitoring activities. Impacts to the viability of the FHEZ corridor from such activities are considered negligible as there will be no physical barrier to movement for fauna species and vehicles on the access road will be infrequent, incur speed restrictions and almost exclusively moving during day-light hours (reducing the likelihood of interaction).

The purpose of the FHEZ and FHEZ Corridor is to mitigate, through avoidance, impacts to conservation significant fauna. The value of the FHEZ is enhanced and maintained by the inclusion of the FHEZ Corridor which comprises similar and supporting habitats. The purpose of the FHEZ Corridor is to ensure connection of the habitat within the FHEZ to habitat outside of the Development Envelope, to allow for the dispersal of fauna from the FHEZ to the Chichester Ranges and preventing fragmentation of terrestrial fauna habitat which supports species such as the Northern Quoll.

An infrastructure corridor is proposed within the FHEZ Corridor however this will only be developed if the Mulga Downs Hub and Rail Spur Proposal (Assessment No. 2358) is approved. Disturbance within the FHEZ Corridor would be linear (north-south) and limited to no more than 5 ha of direct disturbance and key components include:

- A raised ore conveyor with services (electricity, water etc.) attached;
- Un-sealed service road for maintenance of the conveyor; and
- Surface water management to divert water under/around infrastructure.

It is acknowledged that any significant disturbance and activities within the FHEZ corridor would be a detriment to the FHEZ corridors intended purpose (connection of the habitat within the FHEZ to habitat outside of the Development Envelope). HPPL will look to reduce impacts from the FHEZ infrastructure corridor by minimising its potential as a barrier to fauna movement. Measures may include:

- Raising the conveyor off the ground where possible;
- Use of fauna friendly culverts;
- Limits to the number and speed for vehicles using the maintenance track during operations;
- No over-head powerlines or barbwire fences; and
- Consideration for impacts from noise, light and vibration on fauna movement.

To ensure potential activities within the FHEZ corridor are managed appropriately, HPPL is committed to updating the CSFMP (Appendix 12) to include the details for approval by the EPA prior to the commencement of construction.

10.6.2.7 Noise, Light and Vibration

Construction and operation activities which result in an increase in light, noise and vibrations can affect the foraging and breeding behaviours of native species, resulting in a decline in local populations.

Noise and vibration can potentially impact fauna species within proximity of the construction and operation activities. The increased noise and vibration during construction and operation can disturb fauna behaviour such that fauna may avoid areas of suitable habitat and reduce their foraging area. While noise impacts on people

are commonly regulated, there are no state policies or other widely accepted guidelines relating to noise levels or thresholds at which there would be an adverse effect on fauna. As with humans, an animal's response to noise can depend on a variety of factors, including noise level, frequency distribution, duration, number of events, variation over time, rate of onset, noise type, existence and level of ambient noise, time of year, and time of day. The animal's location, age, sex, and past experience may also affect their response to noise.

Despite the difficulties associated with assessing noise impacts on animals, studies have been done that can assist in drawing some general conclusions (SLR 2021b):

- In mammals, sound levels above about 90 dB are likely to be aversive to mammals and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Sound levels below about 90 dB usually cause much less aversive behaviour.
- Noise may be of more adaptive significance for nocturnal species because full use cannot be made of vision.
- Anthropogenic noise can also trigger flight and alert responses in birds and altered behaviour after the noise disturbance, which can lead to reduced breeding success, at noise levels ranging from 65- 85 dB(A).
- Some studies indicate hearing damage to some lizard species after exposure to steady noise levels above LAeq 95 dB

Noise and vibration activities conducted at night may result in impacts to the Category 4 nocturnal roosts and bat foraging activities in nearby habitat. A study undertaken by Bullen and Creese (2014) indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost and this can be transferred to the Pilbara Leaf-nosed Bat feeding habitat. LGA conducted an Environmental Noise Assessment (LGA, 2024) to determine the likely impacts of noise created by the Proposal on bats. As there are no legislated noise criteria, the noise levels were assessed based on relevant studies on the impact of noise on the Ghost Bat, specifically a study undertaken by Bullen and Creese (2014) that indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost. Applying this criterion, the noise modelling undertaken for the Proposal indicates that noise from operations to nearby caves is predicted to be below the 70 dB threshold, and it would be unlikely for the bats to cease utilising the caves (LGA, 2024). It is therefore unlikely that noise emissions from the Proposal will have a significant impact on bats utilising nearby caves.

Blast vibrations have the potential to temporarily interfere with the ability of some species to detect prey or predators; however, blasts are expected to be brief and sporadic and are not expected to result in long-term or continuous disturbance. In the event that individuals are disturbed, it is likely only to be temporary and individuals are expected to return following cessation of blasting.

Light emissions can disorient flying birds, particularly during migration, and cause them to divert from efficient migratory routes or collide with infrastructure. The Fortescue Marsh is approximately 38 km upstream of the Development Envelope and the Fortescue Valley is frequented by a number of migratory bird species when the wetlands of the Fortescue Marshes (categorised within the national Directory of Important Wetlands (DIWA) as WA066) are inundated. Migratory shorebirds may use less preferable roosting sites to avoid lights and may be exposed to increased predation where the lighting makes them visible at night (DoEE 2015).

Artificial lights may interrupt nocturnal foraging for migratory birds and mammals (i.e., attracting invertebrates), which may increase nocturnal species (Northern Quoll and Bats) and possible interactions with vehicles or

machinery. No known bat roosts (caves) are present in the Development Envelope that could be susceptible to impacts from artificial lighting. Lighting used during nighttime activities may affect bats leaving roots at night to forage.

Lighting from the Proposed Action will have a minor impact on the foraging behaviour of bats within the Indicative Footprint and immediately adjacent, as excessive lighting is known to affect foraging behaviour (Bat Call 2021a). However, Ghost Bat has persisted at Cattle Gorge, 500 metres from mining operations (Bat Call 2021a) and at other Pilbara projects, indicating impacts are likely to be minor. Atlas Iron Pty Ltd (2021) also reported that while the Pilbara Leaf-nosed Bat is thought to be attracted to light sources (Cramer et al. 2016a), long-term studies at Atlas's Mt Dove Project have, however, shown that Pilbara Leaf-nosed Bat activity is not impacted by artificial illumination). The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes minimising disturbance to native fauna from noise, vibration and lighting during Proposal implementation.

10.6.2.8 Feral Animals

Construction of infrastructure is known to increase the movement of feral predators such as cats, foxes and wild dogs, all which have been recorded in the Development Envelope. Along with habitat fragmentation, construction of infrastructure can force native fauna into areas where they are at greater risk of predation.

The Proposal is in open terrain and therefore is unlikely to change the access of feral predators significantly. Feral cats have been recorded in the Development Envelope and are considered one of the most damaging feral fauna species. Predation by the feral cat is a threatening process for several conservation significant fauna species, including the Northern Quoll and Pilbara Olive Python (DAWE 2021b). Feral cats have been recorded within the Rocky Hills habitat.

Inappropriate waste management can also attract feral predators. HPPL commits to implement appropriate waste management to prevent feral fauna attraction and to undertake feral fauna control in response to sightings within the Development Envelope to minimise the risk of increased predation.

The CSFMP (**Appendix 12**) also outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes feral animal control during Proposal implementation.

On this basis, the Proposal is not predicted to result in a significant impact to conservation significant fauna species from feral predators.

10.7 Significant Residual Impact

The significant residual impact of the Proposal to Terrestrial Fauna, after the application of the mitigation hierarchy, is:

- Loss of up to 1,406.03 ha of high value habitat for conservation significant fauna species, comprising:
  - Rocky Hills;
  - Stony Spinifex Plains and Slopes; and

- Drainage Lines / Floodplain.

Environmental offsets are proposed for the clearing of native vegetation and for high value fauna habitat and are discussed in **Section 16**. Therefore, HPPL considers the Proposal can be managed to meet the EPA's objective for terrestrial fauna.

10.8 Environmental Outcome

The proposed environmental outcome, including consideration of the proposed mitigation measures to protect environmental values associated with terrestrial fauna, are expected to meet the EPA's objective for this factor. The predicted environmental outcomes for terrestrial fauna associated with the Proposal are summarised in **Table 10-16**.

Table 10-16: Terrestrial Fauna Environmental Outcomes

Potential impact	Environmental Outcome
Direct impacts	
Loss of conservation significant fauna	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.
Loss of fauna habitat	• Clearing of up to 4,339.16 ha of fauna habitat within two Pilbara IBRA bio-subregions and across nine fauna habitat types, including: o Clearing of up to 4,095.65 ha of Fortescue Valley subregion; o Clearing of up to 243.51 ha of Chichester subregions; • Loss of up to: o 520.80 ha of Rocky Hills habitat; o Loss of up to 2,824.74 ha of Mulga Woodland habitat; o Loss of up to 813.97 ha of Stony Spinifex Plains and Hillslopes habitat; o Loss of up to 71.26 ha of Drainage Line/Floodplain habitat; o Loss of up to 15.27 ha of Chenopod/Cracking Clay Floodplain habitat; o Loss of up to 56.69 ha of Gibber Cracking Clay habitat o Loss of up to 28.10 ha of Cracking Clay habitat; and o Loss of up to 8.04 ha of Snakewood habitat. • Loss of up to 520.80 ha of Rocky Hills habitat which is the habitat where four possible SREs taxa were only recorded.
	Potential impacts to the conservation significant fauna recorded from within the Development Envelope include the loss of up to: • 1,462.72 ha of Ghost Bat (*Macroderma gigas*) (Vulnerable BC Act) foraging habitat; • 1,406.03 ha of Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (Vulnerable BC Act) foraging habitat; • 1,406.03 ha of Northern Quoll (*Dasyurus hallucatus*) (Endangered BC Act) habitat of which 520.80 ha is potential denning habitat; • 1,406.03 ha of Pilbara Olive Python (*Liasis olivaceus*) (Vulnerable BC Act) foraging habitat; • 813.97 ha of Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4, DBCA) foraging and breeding habitat.

Potential impact	Environmental Outcome
	• 2,896.00 ha Gane's Blind Snake (*Anilios ganei*) (Priority 1, DBCA) habitat; • 921.37 ha of Grey Falcon (*Falco hypoleaucos*) (Vulnerable, BC Act) habitat; • 648.75 ha of Peregrine Falcon (*Falco peregrinus*) (OS, specially protected BC Act); • 900.95 ha of potential habitat for Night Parrot (*Pezoporus occidentalis);* • 2,911.72 ha of potential habitat for Greater Bilby *(Macrotis lagotis);* • There will be no loss of Category 1, 2 or 3 roosts for Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) or Ghost Bat (Macroderma gigas). Up to 8 Category 4 roosts will be removed. • Up to 31 possible SREs and one confirmed SRE (*Buddelundia* 56) were recorded within various habitats in the Development Envelope, primarily Rocky Hills, Drainage Line/Floodplain, and Stony Spinifex Plains and Hillslopes habitats.
Indirect impacts	
A decline or change in health/composition of fauna habitat	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna. • Maintain or improve the condition of fauna habitat within the Development Envelope / FHEZ, such that predation from feral animals attributable to the Proposal does not result in a measurable increase in the mortality of conservation significant fauna. • No significant impact to vegetation health and therefore terrestrial fauna habitat
Disruption of natural foraging and breeding patterns of terrestrial fauna	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna. • To ensure potential activities within the FHEZ corridor are managed appropriately, HPPL is committed to updating the CSFMP (Appendix 12) to include the details for approval by the EPA prior to the commencement of construction.

11 Terrestrial Environmental Quality

11.1 EPA Objective

The EPA's objective for the environmental factor Terrestrial Environmental Quality is:

"To maintain the quality of land and soils so that environmental values are protected" (EPA 2016).

For the purposes of EIA, the EPA defines terrestrial environmental quality as "*the chemical, physical, biological and aesthetic characteristics of soils*" (EPA 2016).

11.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to the Terrestrial Environmental Quality environmental factor, which have informed the planning for the Proposal, are listed in **Table 11-1**.

HPPL has specifically considered these guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and its significance;
- Identification of activities which may lead to impacts to terrestrial environmental quality; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 11-1:Policy and Guidance

Reference	Title	How Policy has been considered
EP Act		
EPA 2016h	Environmental Factor Guideline: Terrestrial Environmental Quality, EPA, Western Australia.	The information provided in this chapter addresses the 'considerations for environmental impact assessment' listed in this document.
DMIRS 2020b	Environmental Objectives Policy for Mining	The information provided in this chapter acknowledges DEMIRS' regulatory framework under the *Mining Act 1978* establishes key environmental factors and objectives that can adequately regulate potential impacts to Terrestrial Environmental Quality.

Specific additional work required for assessment of the Proposal, relating to Terrestrial Environmental Quality, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered within this assessment.

11.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to the Terrestrial Environmental Quality factor, including details of the surveys and studies undertaken to support the Proposal.

11.3.1 Relevant Studies

HPPL has conducted numerous studies to inform the description of the receiving environment for the Proposal. **Table 11-2** lists the technical studies undertaken. Key studies are provided in **Appendix 16.**

Table 11-2: Completed Baseline TEQ Surveys and Studies

Author and Title	Description	Guidance/Methodology
Landloch 2009 Soil and Overburden Assessment of Murrays Hill	Baseline information on the soils within Murrays Hill and assessment of overburden materials.24 sites were inspected for soil classification with 5 test pits and 27 drill samples were sent for pH, salinity and cation exchange capacity. Landform determination, soil morphology and vegetation mapping was also conducted.	• Guidelines for mining Proposals in Western Australia February 2006 • Department of Industry, Tourism, and Resources (DITR), 2006, Leading Practice Sustainable Development for the Mining Industry: Mine Rehabilitation • McKenzie N.J., Gundy M.J., Webster R., and Ringrose-Voase A.J. 2008, Guidelines for surveying soil and land resources. 2nd edition, Volume 2 Australian Soil and Land Survey Handbook Series • Schoknecht, N., Tille, P. and Purdie, B., 2004, Soil landscape mapping in south-western Australia. An overview of methodology and outputs. • Standards Association of Australia, 2006, Australian standard: Methods of testing soils for engineering purposes. Method 3.8.1: Soil classification tests – Dispersion – Determination of Emerson class number • Van Vreeswyk A.M.E., Payne A.L., Leighton K.A. and Hennig P., 2004. An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No 92. Department of Agriculture
MWH 2013	The aim of this assessment of the Murrays Hill area at was to evaluate the potential for overburden, waste rock, and ore to produce acid rock drainage and metal leaching The study collected 44 samples for acid-base accounting (ABA) and leach testing from the Murrays Hill area.	
Mine Earth 2019a Mulga East iron Ore Project. Stage 1: Soil and Mine Waste Sampling and Analysis Plan	Sampling and Analysis Plan for soils and mine waste material.	Not applicable

Author and Title	Description	Guidance/Methodology
Mine Earth 2021 Mulga Downs Iron Ore Project. Baseline Soil and Landform Assessment **Appendix 15**	The aim of the assessment was to characterise the existing surface soil materials within the study area, to identify available soil resources and potentially problematic materials, and to develop associated recommendations for the recovery and stockpiling soil resources and for their use in rehabilitation and mine closure activities.	Australian Soil and Land Survey Guidelines (CSIRO, 2009)
Mine Earth 2023 Waste Characterisation for Mulga Downs **Appendix 16a**	The aim was to determine the environmental geochemical and erosional stability properties of key waste rock units from the Project, to develop a preliminary inventory and to provide associated recommendations for waste rock management. The study conducted a desktop review of the geological database to provide context for the geochemical assessment. • 68 Samples were analysed for ABA and 26 for leach testing, total metals, and mineralogy.	• Global Acid Rock Drainage Guide (INAP 2009) • Acid Rock Drainage Test Handbook (AMIRA 2002) • Prediction Manual for Drainage Chemistry for Sulphidic Geological Materials (Price 2009).
SRK Consulting 2024 Mulga Downs Iron Ore Project: Geochemical Assessment **Appendix 16b**	This report documents extensive additional geochemical characterisation and advanced leach testing. The study reviewed and included all drill hole assays and previous geochemical assessments completed by MWH (2013) and Mine Earth (2023). 167 samples were analysed ABA, 131 for total metals, 167 for leach testing, 25 for minerology, 5 samples had LEAF1313, 6 samples for LEAF 1314, 5 samples for LEAF1316, 7 samples were leached with synthetic groundwater, 4 samples for AMIRA long-term column leaching (1 year completed). The study assesses material properties and criteria for assessing the potential for acid and metalliferous drainage/neutral mine drainage (AMD/NMD) and contaminant leaching, as well the homogeneity of waste material across site.	Not applicable
4DG 2023 Mulga Hub and Spur Project – SP2 Ground Breaking Investigation - Hub Factual Geotechnical Report **Appendix 16c**	Along with geotechnical investigations test pits in the northern portion of the site were investigated for Potential Acid Sulfate Soils (PASS). No high water table or evidence of PASS was observed.	
JBS&G (2024) Mulga Downs Iron Ore Mine and Borefield. Asbestiform Minerals and Asbestos Containing Material, Preliminary	A Preliminary Environmental Site Assessment (PESA) relating to the potential for natural asbestiform minerals and/or anthropogenic asbestos containing material (ACM) to be present within the Development Envelope and Indicative Footprint of the proposed Mulga Downs Iron Ore Mine and groundwater borefield.	• JBS&G's Environmental Site Assessment was undertaken in accordance with the following technical guidance and methodologies:

Author and Title	Description	Guidance/Methodology
Environmental Site Assessment. **Appendix 13**	The specific objectives of the ESA were to: • Identify areas within the Development Envelope where natural asbestiform minerals may accumulate, as a result of erosion/deposition (wind, water) of natural asbestiform minerals and/or anthropogenic activity; • Identify areas within the Development Envelope where asbestos may have been imported and used based on anthropogenic activity; • Assess the potential risks relating to actual and potential asbestiform minerals and ACM within the identified areas; and • Provide information/data to allow development of an appropriate Asbestos Management Plan (AMP) to minimise the asbestos disturbance, possible distribution or spreading of asbestiform minerals and ACM throughout the implementation of the Proposal.	• "Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia" (Department of Health [DoH], 2021); • National Environmental Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 • WA Department of Water and Environmental Regulation (DWER) • Contaminated Sites Guidelines, as amended 2021 • Relevant Australian Standards (AS4482.1- Guide to the investigation and sampling of sites with potentially contaminated soil (non-volatile and semi-volatile compounds) and AS4482.2 – Guide to the sampling and investigation of potentially contaminated soil (Part 2: volatile substances).
Senversa (2023) **Appendix 14**	Senversa (2023) Voluntary Auditors Report (VAR)	Senversa (2023)

11.3.2 Soil and Landforms

Soil and landform assessments were undertaken over the majority of the Development Envelope by Landloch, 2009 and Mine Earth, 2021. Four soil-landform associations were identified within the Development Envelope namely 'Low hills / rises', 'Alluvial plains, 'Floodplains' and 'Calcareous flats' (**Table 11-3; Figure 11-1**).

Table 11-3 Soil and Landform Associations across the Development Envelope.

Landform	Soil Association
Low Hill / rises	• Shallow, skeletal soils over fractured / weathered and competent rock. • High percentage of competent rock fragments through the surface soil profile. • Non-saline, non-sodic, not dispersive (in natural state), low nutrient status, moderately slow drainage class and low to moderate water holding capacity.
Alluvial plains	• Deep alluvial soils, well structured topsoils over massive subsoil horizons. • Moderate percentage of competent rock fragments through the surface soil profile. • Non-saline, topsoils classified as sodic, with highly sodic subsoils, minor dispersion of clay fraction upon saturation of some samples, low to moderate nutrient status, moderate drainage class and low to moderate water holding capacity.
Floodplains	• Deep alluvial soils, well structured topsoils over massive subsoil horizons. • Relatively low percentage of competent rock fragments through the surface soil profile. • Moderately saline, topsoil and subsoils classified as highly sodic, with minor dispersion of clay fraction upon saturation of some samples, low to moderate nutrient status, moderately slow drainage class and moderate water holding capacity.

Calcareous flats:	• Moderate percentage of competent rock fragments through the surface soil profile, increasing with depth. Some outcropping calcrete present in some areas. • Classed as alkaline and slightly saline, topsoil and subsoils classified as sodic, however soil in natural state is not dispersive, with only minor dispersion of clay fraction upon severe disturbance of some samples, low to moderate nutrient status, moderately slow drainage class and high water holding capacity.

11.3.3 Acid Sulfate Soils

Acid sulfate soils (ASS) are naturally occurring soils and sediments that contain iron sulphides, predominantly in the form of pyrite. The disturbance of ASS and exposure to oxygen results in sulfuric acid being formed, which can lead to the release of metals, nutrients and acidity into the soil and groundwater system (DER 2015).

Acid sulfate soils includes potential acid sulfate soils (PASS) and actual acid sulfate soils (AASS). PASS are soils or sediments which contain sulphides that have not been oxidised, and AASS are soils or sediments which contain sulphides that have undergone some oxidation (DER 2015).

Acid sulfate soils risk mapping has been developed by DWER and is available for the Pilbara coastline and other limited areas within the Pilbara. The Proposal is not located within an area that is delineated as having ASS risk from this DWER mapping dataset (**Figure 11-2**). It is noted however, that this risk mapping provides a broad scale desktop overview of the potential ASS risk, rather than a site-based sampling and analysis approach.

Additional ASS probability mapping is available from the CSIRO Atlas of Australian Acid Sulfate Soils (Fitzpatrick, Powell and Marvanek 2011). This mapping is a provisional ASS classification inferred from national and state soils, hydrography, vegetation and landscape coverages, mapped at a base scale of 1:2.5 million. The CSIRO mapping is very broad scale and has not involved any ground-truthing. This mapping indicates there is a Low (Class B) to Extremely Low (Class C) probability of ASS in the area of the Proposal (Fitzpatrick, Powell, & Marvanek, 2011). An area to the southwest, outside of the Development Envelope, in the Fortescue Valley is classified as High probability but it will not be subject to direct disturbance by the Proposal (**Figure 11-3**).

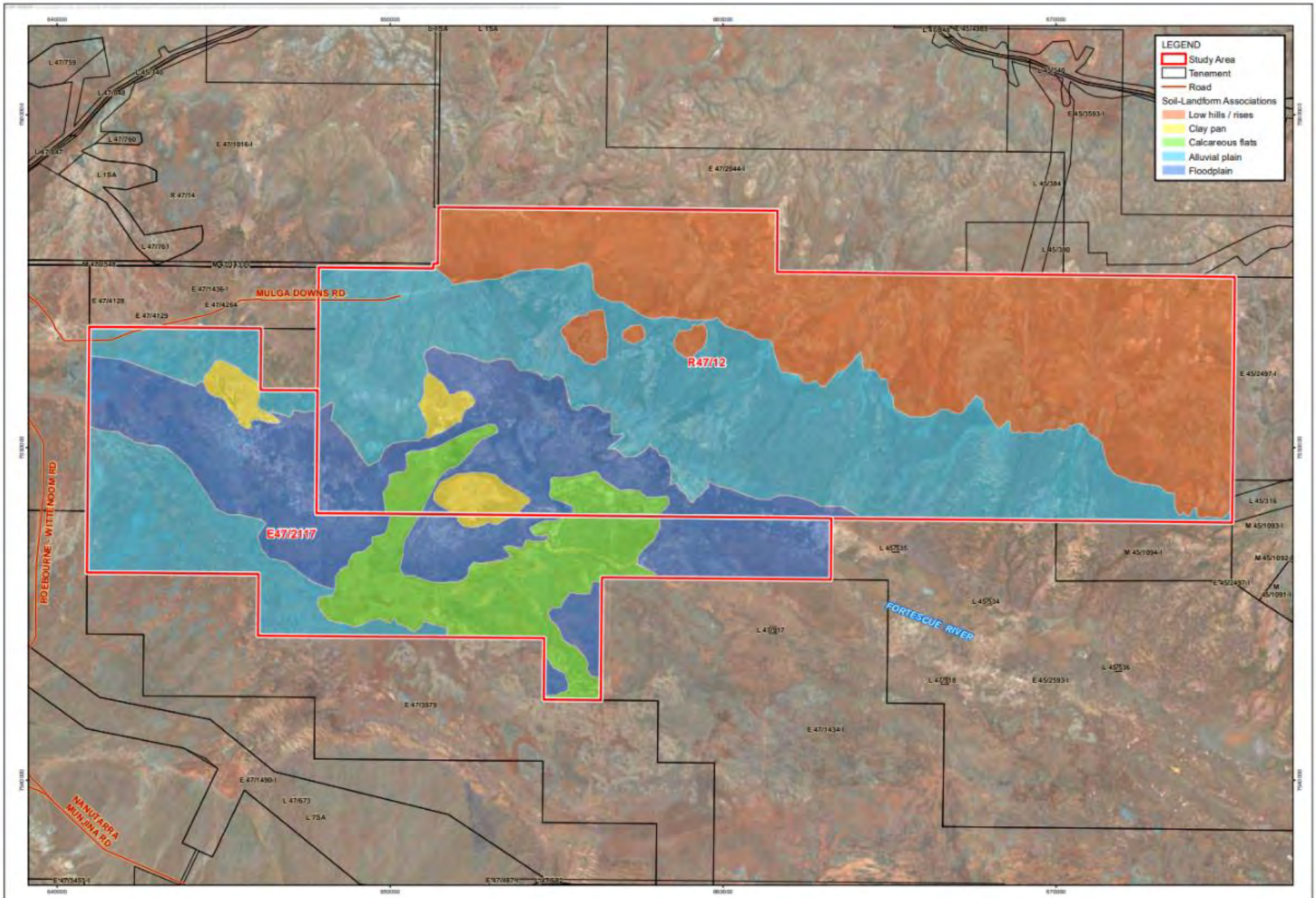
There are certain landform conditions that increase the risk of ASS occurring generally (DER 2015). Of those areas, the following are present within the Development Envelope (Mine Earth, 2023):

- Floodplains;
- Wetland-dependent vegetation such as reeds and paperbarks;
- Areas where the highest known watertable level is within three metres of the surface;
- Any areas where a combination of all the following pre-disposing factors exist:
    - Organic matter;
    - Iron minerals;
    - Waterlogged conditions or a high watertable; and
    - Sulphidic minerals.

Test pitting undertaken in the northern portion of the Development Envelope included observations for PASS and found none of the above evidence that would be indicative of PASS (4DG 2023). Further in-field testing is

planned during geotechnical works, with the results utilised within the Mining Proposal which will be prepared for the Proposal.

Figure 11-1: Soil-landform Mapping across the Development Envelope



MINE EARTH

Soil-Landform Associations

Figure 14

Figure 11-2: ASS Risk Mapping (DWER) (Source: Mine Earth, 2023).

*Note the Disturbance Envelope reflected in this figure is consistent with the Proposal as referred to DCCEEW under the EPBC Act and excludes Murray's Hill (LoA – do not assess 2013). This difference is explained in Section 1044.3.

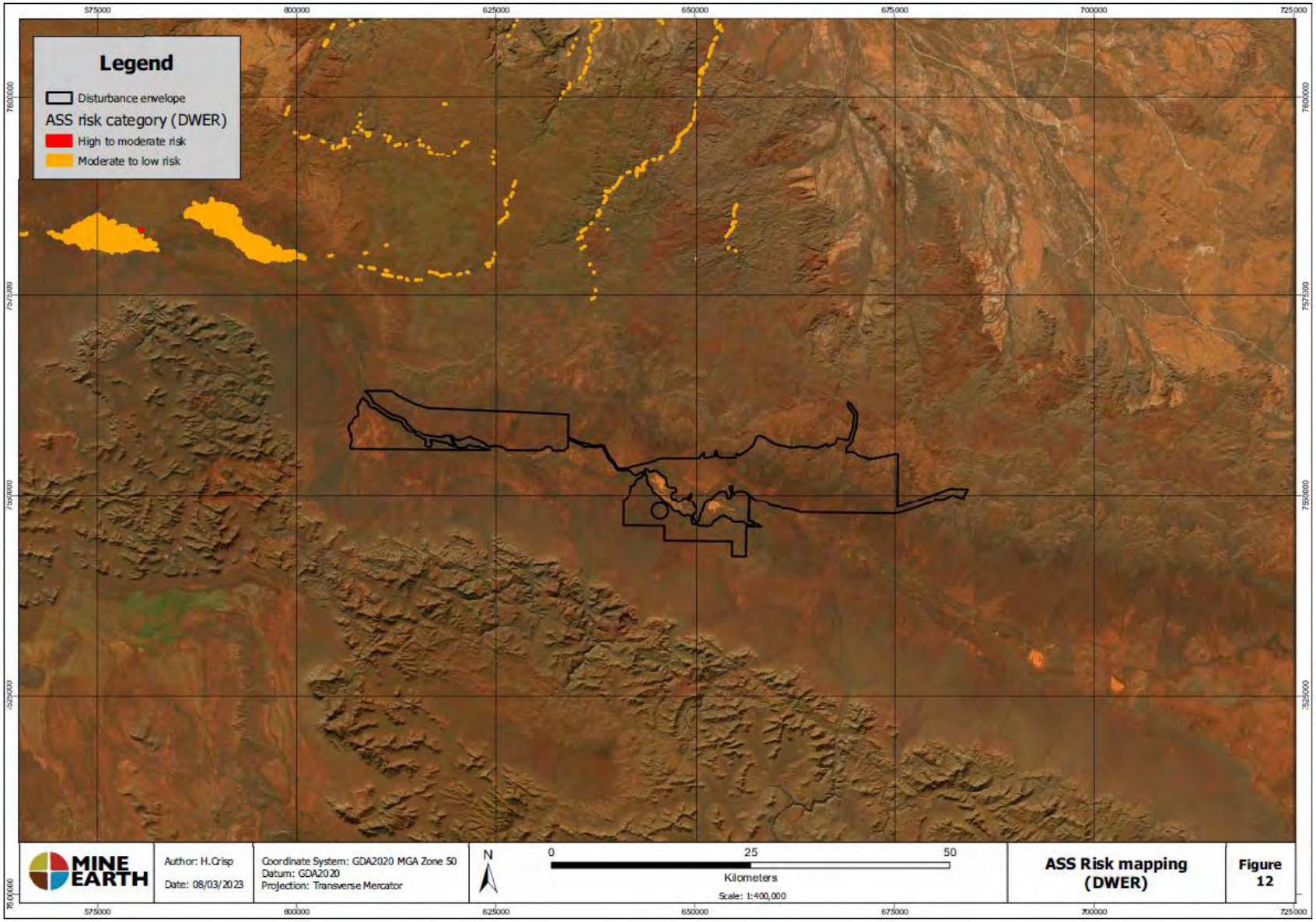
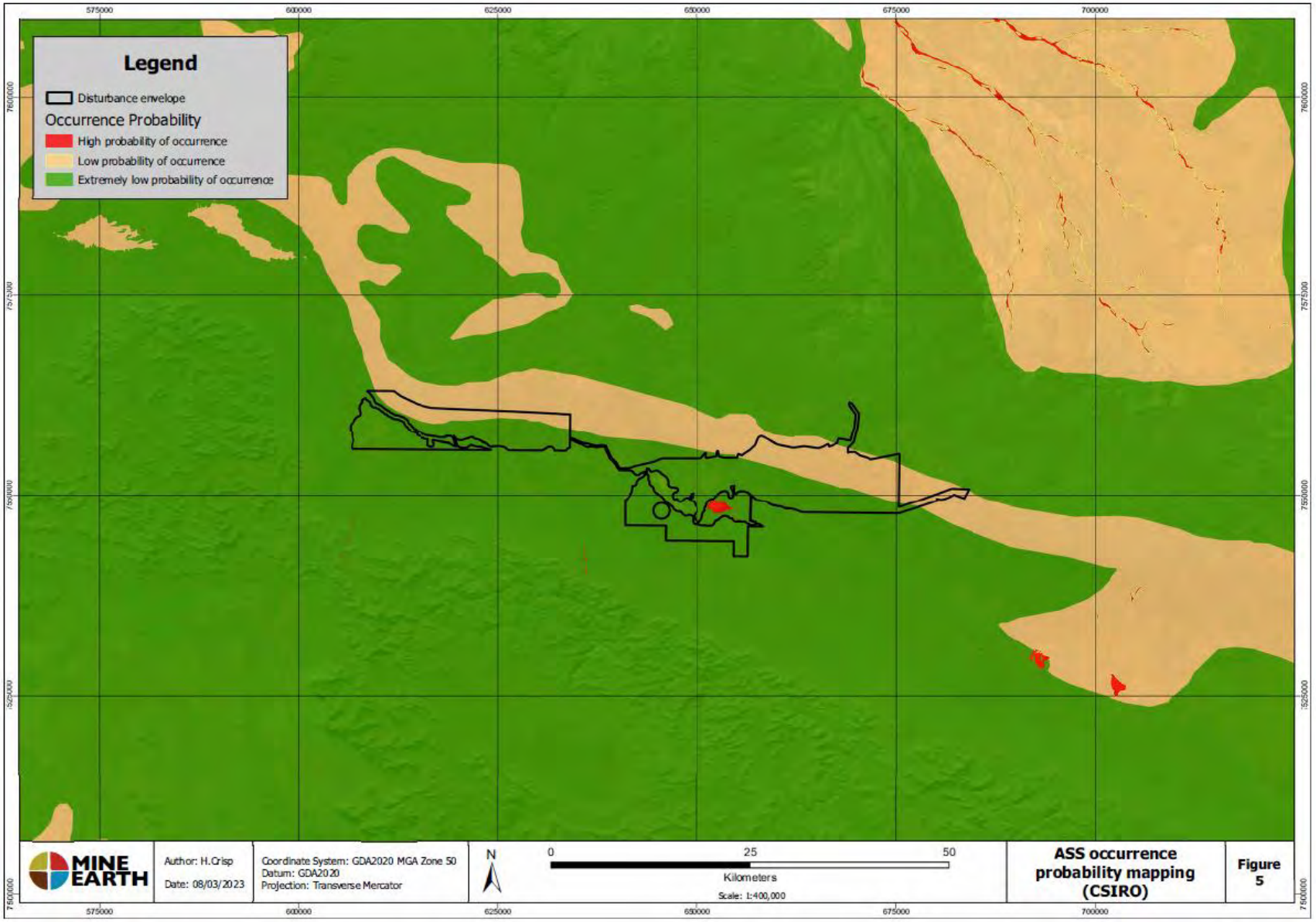

Legend
Disturbance envelope
ASS risk category (DWER)
High to moderate risk
Moderate to low risk
575000
600000
625000
650000
675000
700000
725000
7600000
7575000
7550000
7525000
7500000
MINE EARTH
Author: H.Crisp
Date: 08/03/2023
Coordinate System: GDA2020 MGA Zone 50
Datum: GDA2020
Projection: Transverse Mercator
N
0
25
50
Kilometers
Scale: 1:400,000
ASS Risk mapping (DWER)
Figure 12

Figure 11-3: ASS occurrence Probability Mapping (CSIRO) (Source: Mine Earth, 2023)

*Note the Disturbance Envelope reflected in this figure is consistent with the Proposal as referred to the Commonwealth under the EPBC Act. The Proposal being assessed by the EPA does not include the Murray's Hill Project which forms part of the Proposal under assessment by DCCEEW. This difference is explained in Section 1044.3.


Legend
Disturbance envelope
Occurrence Probability
High probability of occurrence
Low probability of occurrence
Extremely low probability of occurrence
575000
600000
625000
650000
675000
700000
7600000
7575000
7550000
7525000
7500000
MINE EARTH
Author: H.Crisp
Date: 08/03/2023
Coordinate System: GDA2020 MGA Zone 50
Datum: GDA2020
Projection: Transverse Mercator
N
0
25
50
Kilometers
Scale: 1:400,000
ASS occurrence probability mapping (CSIRO)
Figure 5

11.3.4 Characterisation of Waste Rock Material

A number of geochemical assessments have been completed for the Proposal (MWH 2013 and Mine Earth 2023; refer to (**Table 11-2**). These assessments have and continue to follow a staged approach in accordance with DEMIRS guidance:

- Phase 0: Geological interpretation;
- Phase 1: Acid Base accounting;
- Phase 2: Leach Testing;
- Phase 3 – Water balance and modelling; and
- Phase 4 – Kinetic testing.

This staged process is followed for every new batch of samples collected and the database of geochemical information is built on previous studies.

11.3.4.1 Geochemical Characterisation

Initial assessments focussed on geological interpretations combined with total element assays performed on samples obtained from early exploration and resource evaluation programs (Phase 0 and 1). The key geochemical characterisation findings of Mine Earth (2023) Waste Characterisation study of the Proposal are summarised below.

The geological assay database across the regional area, which is not only confined to the mining pits, comprises almost 230,000 analyses for sulfur and calcium. An assessment of this database indicates that only 10% of the sulfur assays are greater than 0.1% sulfur, while approximately 4.4% contain greater than 0.3% sulfur and 3.2% are greater than 0.5% sulfur (**Table 11-4**).

Table 11-4: Distribution of sulfur percentage for entire assay database

Stratigraphy	Percentage of all assays in regional database			Number of samples for geochemical analyses
	>0.1%Sulfur	>0.3% Sulfur	>0.5% Sulfur	
Alluvium (CzD3)	3.5%	0.7%	0.1%	112
Channel Iron Deposits (CzD2)	0.3%	<0.03%	<0.03%	36
Marra Mamba – Newman Member	0.1%	<0.03%	<0.03%	5
Marra Mamba – Macleod Member	0.3%	0.1%	0.1%	43
Marra Mamba – Nammuldi Member	3.4%	1.7%	1.3%	127
Jeerinah Formation – Roy Hill Shale Member	2.0%	1.7%	1.5%	11
Other	0.6%	0.1%	0.1%	11
Upcoming analyses (2025)				100
Total	**10.2%**	**7.6%**	**3.2%**	**445**

The mass of waste rock has been reduced by 80% through the redesign of the pits mine and no potentially acid-forming Jeerinah Formation material is present. The majority of waste material is represented by alluvium and surficial Nammuldi member units, with the Fridge Hill and Fridge West areas generating the majority of the material.

The 125 drill holes sampled for geochemical analysis during all waste characterisation studies across the mine development area are displayed in **Figure 11-4.**

Figure 11-4: Distribution of all sampled drillholes across the Proposal

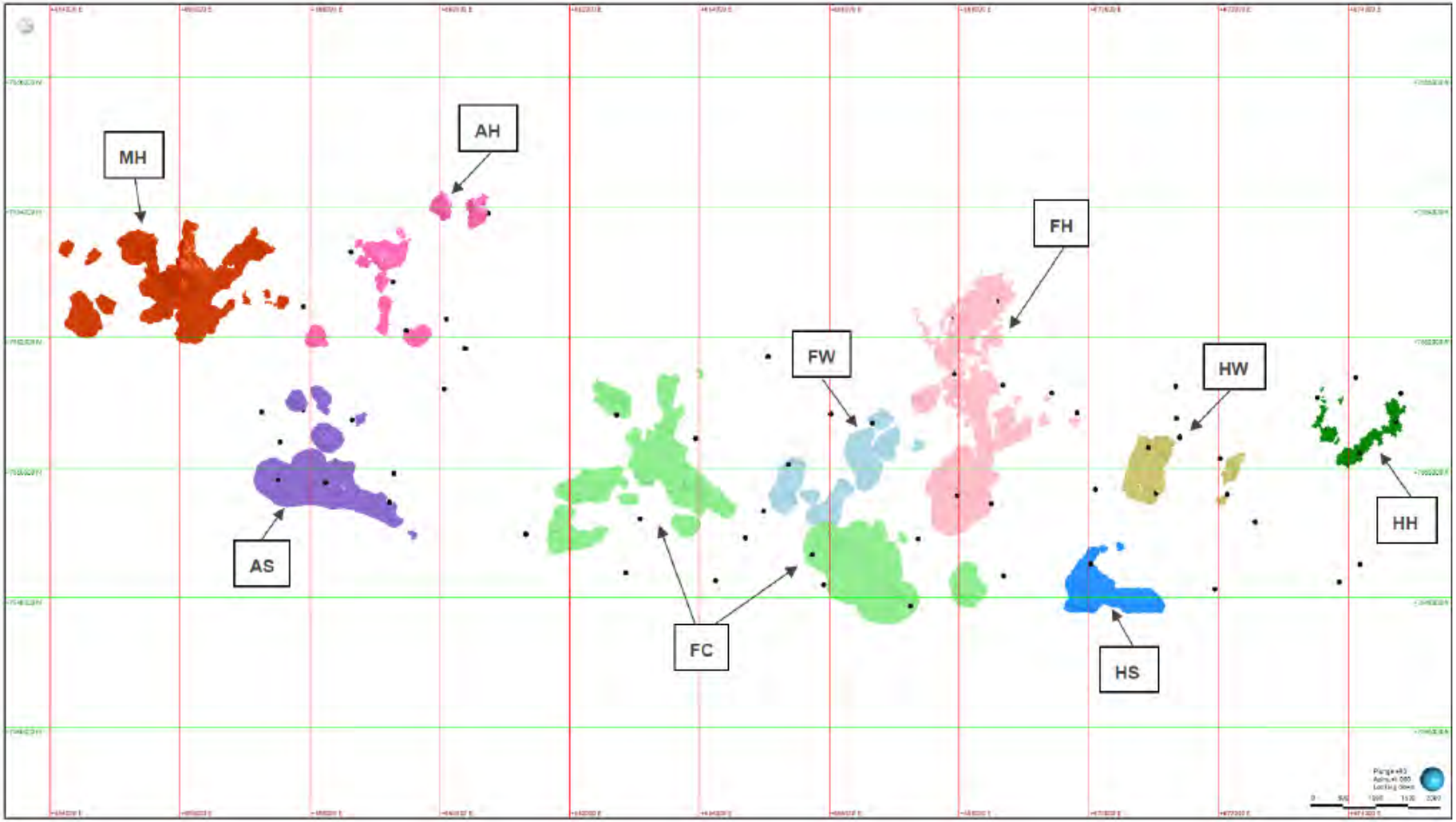

MH
AH
AS
FH
FW
HW
HH
FC
HS

Table 11-5: Stratigraphy of waste per pit (Mt)

Pit	Alluvium	Detrital	Mt Newman Member	Macleod Member	Nammuldi Member	Jeerinah Formation	Total Mass (Mt)	%
Murrays Hill	5.9	0.095	1.6	6.5	9.1	0	23	15
Anticline Hill	1.0	-	0.31	5.0	3.5	0	9.8	6.6
Fridge Central	0.9	-	1.5	1.2	-	0	3.6	2.4
Fridge Hill	10	1.0	0.22	4.8	39	0	55	37
Fridge West	18	-	12	4.9	0.003	0	35	24
Horseshoe Hill	-	-	0.01	2.3	1.0	0	3.4	2.3
Horseshoe West	6.2	3.5	1.3	5.4	2.6	0	19	13
Total mass (Mt)	42	4.6	17	30	56	0	150	100
%	28	3	11	20	37	0	100	

The SRK (2024) study extensively details the classification options and acid-base accounting results for all samples and determined the conservative classification given in **Table 11-6**. This table indicates that 95% of the waste material is non-acid forming and the remainder may be easily managed as it is distributed in small volumes across pits. The risk of acidic mine drainage is low.

Table 11-6: Acid potential classification of waste by acid-base by pit (Mt)

Pit	Non-Acid Forming (NAF)	Uncertain- (UC)	Potentially Acid Forming (PAF)	Total Mass (Mt)	%
Murrays Hill	21	1.9	0.29	23	15
Anticline Hill	8.8	0.68	0.37	9.8	6.6
Fridge Central	3.6	0.039	-	3.6	2.4
Fridge Hill	55	0.61	-	55	37
Fridge West	35	0.56	-	35	24
Horseshoe Hill	3.4	0.015	-	3.4	2.2
Horseshoe West	16	2.1	0.65	19	13
Total mass (Mt)	143	6.0	1.3	150	100%
%	95	4.0	0.87	100%	
Classification: NAF=<0.1 %, UC=0.1 % ≤ S <0.25 %, PAF S ≥ 0.25%					

Potential contaminant leaching was determined by deionised water leach extracts by a range of contact ratios, saline leach tests, 'synthetic' groundwater leach tests and LEAF testing (1313, 1314 and 1316): where a series of batch tests to determine leachability as a function of pH or volume are conducted. Additionally, AMIRA column testing has been conducted over 12 months to determine the long-term leaching potential of waste.

Leachate pH is a primary control on contaminant solubility. Under the neutral pH conditions expected for most of the waste rock, leaching is expected be limited and the risk of metalliferous drainage is low.

11.3.4.2 Physical Characterisation

Landloch (2009) and Mine Earth (2023) tested material for cation exchange capacity (CEC) exchangeable sodium percentage (ESP) and sodicity adsorption ratio (SAR), as well as potential for dispersion. The erosional stability of lithologies were estimated based on mineralogy and a visual assessment of the competency of core. Calcrete, mineralised waste, dolomite displayed moderate to high erosional stability, while oxide and shale material on the surface was estimated to have low erosional stability.

The majority of lithologies tested were non-sodic with calcrete, hematitic CID and mangniferous alluvium showing minor sodicity. All material was Emerson[3] Class 5 which has no potential for dispersion (Mine Earth, 2023).

11.3.5 Asbestiform Minerals and Asbestos Containing Materials

Asbestiform minerals are widely distributed in Western Australia. Amphibole and serpentine minerals are major components of mafic and ultramafic rocks found in Western Australia's "greenstone belts". In the Pilbara, amphibole minerals may be encountered in the BIF of the Hamersley Basin (DMP 2015). More specifically crocidolite (the source of "blue" asbestos) is typically associated with the Dales Gorge Member of the Brockman Iron Formation (Grubb 1971). A thin (5 mm) band of crocidolite has also previously been identified in the Marra Mamba Iron Formation in the western Fortescue Valley (Barnett & Commander 1986).

On the basis the ore body is located within the Marra Mamba Iron Formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, intersection of natural asbestiform minerals onsite (i.e. within the Brockman Iron Formation) during mining operation is considered to be low. The iron ore mineralisation at Mulga is located in highly oxidised material which reduces the risk of fibres material occurring. Drilling personnel are trained to identify any asbestos intersections and occurrences are recorded and treated according to safe working practice. The Mulga Downs area has been extensively drilled and to date no Asbestiform Containing Materials have been detected (confirmed by SEM analysis) at the Mulga East tenement.

Review of the DWER Contaminated Sites Database under CS Act identified the previous Development Envelope for the Proposal included areas classified as '*Contaminated – Remediation Required'.* (JBS&G 2022; **Appendix 13**). Following the s43A application to amend the Proposal in September 2024, no classified contaminated site is located within the amended Development Envelope for the Proposal.

Planning for the Proposal identified the potential for natural asbestiform minerals and anthropogenic Asbestos Containing Materials (ACM) to be present within the Development Envelope, based on the proximity of the Development Envelope to the Wittenoom Asbestos Management Area (WAMA) (**Figure 13-1**).

In a meeting with HPPL on 13 July 2022, DWER indicated that the boundary of the WAMA should not be considered a 'hard' boundary, as it was based on cadastral boundaries, and that ACM could be present on the Mulga Downs Pastoral Station due to known and suspected use of asbestos material sourced from historical mining locations in the Wittenoom, Yampire and other gorges in the vicinity of the Development Envelope.

[3] The Emmerson Aggregate test (Emmerson, 1967) classifies the structural stability of soil aggregates under rainfall to inform management of dispersion.

In addition to the potential presence of ACM, DWER indicated an assessment of asbestiform minerals was also required due to the possibility of natural erosion/dispersion (e.g., water dispersal in drainage lines and air dispersal downwind of historical mine and tailing facilities) of material from the Wittenoom, Yampire and other gorges.

Section 3.9 and **Section 3.11** summarises the geology and hydrology of the Development Envelope with respect to potential deposition of natural asbestiform within and surrounding the Development Envelope.

A registered asbestos-contaminated site listed on the DWER Contaminated Sites Database is located to the south of the Development Envelope and is associated with abandoned infrastructure of the Mulga Downs Pastoral Station (Parcel ID 73903). The Mulga Downs Homestead (Parcel ID 20175) is also listed as an asbestos-contaminated site, which is located outside of, but immediately north of, the Development Envelope (**Figure 11-5** and **Figure 13-1**).

Primary sources of ACM are from the known registered contaminated areas located outside of the Development Envelope and surrounds. Secondary sources are from anthropogenic activities within the Development Envelope, including use of ACM within anthropogenic built forms (other than those already recorded as registered contaminated sites), and from miscellaneous historical dumping of ACM tailings.

Primary sources of natural asbestiform within the Development Envelope include unintended surfacing resulting from on-site exploration drilling program and deposition of natural asbestiform within the Lower Fortescue River Valley via surface water runoff from the Hamersley Ranges. Secondary sources of natural asbestiform within the Development Envelope include deposition of natural asbestiform via airborne migration. As the ore body is located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, intersection of natural asbestiform minerals onsite during mining operation is considered to be low.

Following consultation, DWER confirmed with HPPL that the presence of ACM on the Mulga Downs Pastoral Station is the result of known and suspected anthropogenic utilisation of asbestos material sourced from historical mining locations in the Wittenoom, Yampire and other gorges in the vicinity of the Development Envelope. In addition, DWER indicated an assessment of asbestiform minerals was required, due to the possibility of natural erosion/dispersion (e.g., water dispersal in drainage lines and air dispersal downwind of historical mine and tailing facilities) from the gorges, as well as from potential miscellaneous dumping of tailings.

The WAMA covers an area of 46,840 ha of land and includes the former townsite, mining areas, Wittenoom Gorge and Joffre Floodplain. This entire area has been classified by DWER in 2008 as a contaminated site under the CS Act. The area was declared by DWER and the Department of Health to be not suitable for any form of human occupation or land use (DPLH, 2022).

The location of the Development Envelope and Indicative Footprint relative to the WAMA and DWER registered contaminated sites is detailed in **Table 11-7** and shown in **Figure 11-6.**

Table 11-7: DWER Online Contaminated Sites Database Search

Property Description	Location and Address	Classification	Distance from Development Envelope	Reason for Classification
Located within, or immediately adjacent to, the Development Envelope				
Portion of Lot 5418 on DP404418 as shown on certificate of title LR3165/155	Mulga Downs Homestead Mulga Downs Pastoral Station, Mulga Downs Road	Contaminated – remediation required (01/08/2018) (ID 20175)	Immediately north of the Development Envelope	The site was first classified under section 13 of the *Contaminated Site Act 2003* based on information submitted to DWER in October 2008. The site was originally reported as a result of the identification of free asbestos fibres and asbestos fibre bundles in surface soils around the station homestead and buildings. The asbestos was brought to the site in asbestos contaminated tailings material sourced from the former Wittenoom mine site area. Some remediation of the site was undertaken including the removal of 120 tonnes of asbestos contaminated soil from various areas at the site and the off-site disposal of the impacted soil. The resultant excavation voids were backfilled with soils excavated from a "borrow pit" located 2km from the site. Further investigations in 2018 noted additional contamination present and remediation required. The DWER records do not detail where the asbestos contaminated soil was taken to. Identified concentrations of contaminants exceed adopted assessment levels. The site is therefore not suitable for occupation until further remedial measures have been undertaken. Remediation is required to mitigate the potentially unacceptable risk to human health. This area is fenced and signposted to prevent any unauthorised access. An exclusion fence line managed by Hancock is located around the homestead. The fence was installed by Hancock and is still in place with signage identifying the potential risk of asbestos at the entry points.
Portion of Lot 5418 on DP404418 as shown on certificate of title LR3165/155	Abandoned Infrastructure Area. Mulga Downs Homestead Mulga Downs Pastoral Station, Mulga Downs Road	Contaminated – remediation required (01/08/2018) (ID 73903)	250m south of the Development Envelope	This site comprises an area approximately 2.5 km south of the Mulga Downs Homestead station (ID 73903) which is detailed above. The site is used for the storage of old infrastructure has also been included in the classification of the larger Mulga Downs parcel. In April 2018 DWER were informed that exposed asbestos fibre bundles were again visible on the surface of the soils around the abandoned infrastructure to the south of the Homestead station. Identified concentrations of contaminants exceed adopted assessment levels. The site is therefore not suitable for occupation until further remedial measures have been undertaken. Remediation is required to mitigate the potentially unacceptable risk to human health. This area is fenced and signposted to prevent any unauthorised access.
Not located within the Development Envelope				
Portion of Lot 5418 on DP404418 (Subject M1 and M2)	External extent of the WAMA, extending west into Mt Florance and Mt Hooley Pastoral Stations. Mulga Downs, WA, 6751	Contaminated – remediation required (28/01/2008) (ID 80831 and 80832)	Outside of the Development Envelope to the west and south (Parcel ID 80831; Parcel ID 80832)	These two sites relate to the eastern and northern extent of the WAMA. The Development Envelope no longer intersects the WAMA.
Unallocated Crown Land and numerous discrete parcels of land	Southern extent of the WAMA, including Wittenoom and surrounding areas Wittenoom, WA, 6751	Contaminated – remediation required (28/01/2008) Numerous	Various	The WAMA comprises the Wittenoom Town site, Wittenoom Airfield, Wittenoom Gorge, Yampire Gorge and the Joffre Creek flood plain between the Wittenoom Townsite and the Fortescue River. The site was reported due to the presence of Free Crocidolite (blue asbestos) fibres in soils across the town and in mine tailings which were used extensively to replace sand in the construction of housing, airfield, roads and infrastructure and facilities at Wittenoom. In addition, mine tailings containing free asbestos fibres are present near the Colonial, Eastern Gorge and Yampire mines. Free asbestos fibres are present in the Joffre Creek and floodplain and in the Fortescue River near its confluence with Joffre Creek. The site was reported to the Department of Environment and Conservation (DEC) as per reporting obligations under section 11 of the Contaminated Sites Act 2003, in March 2008. The report identified the presence of free asbestos fibres within the asbestos processing waste tailings dumps near the Colonial, Eastern Gorge and Yampire mines. It was found that subsequent erosion of the tailings dumps by wind and water have transported free asbestos fibres to Wittenoom Gorge, Joffre Creek and across the floodplain to the Fortescue River. Free asbestos fibres were also detected in the airstrip and in all developed areas of the Wittenoom town site. The report documents the findings of a semi-quantitative human health Risk Assessment. The risk assessment concluded that based on the current levels and types of occupation and land use and the concentrations of asbestos contamination, the Colonial, Eastern Gorge and Yampire mines (including their respective tailings dumps), the Wittenoom Gorge (Joffre Creek) and floodplain, and the Wittenoom town site are of "high risk" to human health. The report further concluded that the Wittenoom Airstrip was of "medium risk" to human health. The report was the subject of a non-statutory independent review by a Contaminated Sites Auditor which was submitted to DEC on 31 March 2008. Based on the information provided, and as the Site is known to have free asbestos fibre contamination in soils that present an unacceptable risk to human health, the Site including the Wittenoom town site and surrounding gorges and floodplain area are classified as 'Contaminated - remediation required'. A memorial stating the Site's classification has been placed on the Certificates of Title.
Section of Rail Maintenance Track within part of Lot 116 on	Koodaideri Railway Wittenoom, WA, 6751	Contaminated – remediation required (25/05/2021)	13 km	The site consists of a portion of a rail maintenance track that intersects the WAMA. The site was reported in 2020 due to the identification of asbestos fibres in soils of the rail corridor during construction of the maintenance track, including bags of asbestos material, and diffuse contamination found in stream channels. Asbestos contaminated fill is also known to have been used for construction projects in the local area.

Property Description	Location and Address	Classification	Distance from Development Envelope	Reason for Classification
DP220191 and part of Lot 5418 on DP404418		(ID 78799)		The site is currently managed under the environmental conditions required by Ministerial Statement 999. Further investigations and remediation are required.

Figure 11-5: Location of Site with Asbestos in relation to the Proposal

620000 625000 630000 635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000

7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000 7525000 7520000

Mungaroona Range Nature Reserve

NANUTARRA RD

Wittenoom Asbestos Management Area (WAMA)

Karijini National Park

MUNJINA RD

MUNJINA-ROY HILL RD

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve

Asbestos mine locations (JBS&G, 2022)

- Colonial mine, mill & tailings
- Conceptual layout
- Development envelope
- Floodplain
- Wittenoom Asbestos Management Area
- Yampire mine & mill

DWER registered contaminated sites (DWER-059)

- Contaminated - remediation required
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 07-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:200,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SITES WITH ASBESTOS IN RELATION TO THE PROPOSAL

FIGURE 11.5

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

HPPL commissioned JBS&G Australia Pty Ltd (JBS&G) to prepare a Sampling and Analysis Quality Plan (SAQP) and Preliminary Environmental Site Assessment (PESA) to assess the asbestos contamination status of the Proposal (JBS&G 2023a and 2023b; **Appendix 13**).

The overarching objectives of the SAQP and PESA were to assess the potential presence or absence of natural asbestiform minerals resulting from both natural erosion and deposition and imported asbestos (e.g., ACM) from anthropogenic activity within the Development Envelope. The results of the assessment will enable appropriate management throughout construction and operational activities.

The specific objectives of the PESA were to:

- Identify areas within the Development Envelope where natural asbestiform minerals could accumulate because of erosion, deposition and anthropogenic activity;
- Identify areas within the Development Envelope where asbestos may have been imported and used based on anthropogenic activity;
- Assess the potential risks relating to actual and potential asbestiform minerals and ACM within the identified areas; and
- Provide information to allow the development of an appropriate Asbestos Management Plan to minimise the asbestos disturbance and possible distribution or spreading of asbestiform minerals and ACM throughout the implementation of the Proposal.

The PESA involved a site inspection, sampling of building material suspected of containing asbestos, a detailed desktop assessment designed to identify areas where the erosional deposition may have occurred, and sampling selected areas where the deposition was considered most likely. The site inspection did not include an assessment of the classified asbestos-impacted area outside the Development Envelope, however HPPL supplied photographs of this area and some additional details.

The PESA identified asbestos impacts were likely limited to:

- Building materials within ancillary structures in the Development Envelope, such as tank stands and bore infrastructure;
- The existing and classified asbestos-contaminated area (registered ID 73903) associated with the former Mulga Downs homestead;
- The possible deposition of asbestos from the Wittenoom mine area because of erosion; and
- The potential importation of asbestos into the Development Envelope (including as a construction base for infrastructure or as dumped waste).

The PESA investigation found that:

- A single loose fibre bundle of crocidolite in the soil was detected in a single sample (sample ID 10_0.1); however, the asbestos concentration in the sample, and every other sample, was below the laboratory Limits of Reporting (LOR) and adopted assessment criteria; and
- Limited site structures contained ACM.

ACM is understood to have been dumped deliberately or as an accident within locations close to the Development Envelope. No ACM (including bags of tailings) or other consolidated waste storage areas were observed during the site investigation.

It is unlikely the area is impacted by asbestos from erosional deposition, and the selected sampling did not identify evidence of this to the extent that represented a potential risk.

The PESA concluded that there is a low risk of asbestos from existing structures, ground contamination (in-situ or from erosional deposition) or unexpected finds causing human health impacts at receptors through an inhalation pathway, as follows:

- On the basis that the Proposal ore body is located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley where the Brockman Iron Formation is absent, the intersection of natural asbestiform minerals (i.e., within the Brockman Iron Formation) during construction and operation of the Proposal is low;
- The potential for erosion and deposition of natural asbestiform minerals from the Wittenoom, Yampire and other gorges north of the Lower Fortescue River is considered low;
- Given the relatively small size and scale of the observed infrastructure, the amount of asbestos that could be released in the event of disturbance is likely to be minor. The potentially unacceptable risk to site receptors from ACM within site structures is low; and
- While the potential for unidentified historical dumping couldn't be discounted, the currently available information indicates that the unacceptable risk receptors from miscellaneous dumping of ACM is low.

The SAQP and PESA were subject to independent audit, including producing a Voluntary Auditor's Report (VAR) (**Appendix 14**), which was prepared in accordance with the CS Act and relevant DWER guidance. The auditor concluded that the SAQP and PESA provided adequate characterisation of the forms of asbestos previously identified and suspected within the Development Envelope

In summary, potential impacts due to inhalation of fibres from asbestiform minerals and ACM in structures, the ground or air is limited to people in the Development Envelope, such as HPPL construction and operations workers, contractors and visitors. Given the large separation distances to residential receptors (the closest is the Wirrilimarra Community 12.2 km east of the Development Envelope), it is unlikely that these communities would be at risk.

An Asbestos Management Plan (**Appendix 17**) has been prepared to prevent the release of fibres from site structures during operation and detail the appropriate procedures for decommissioning and removal of the structures from the site. The management plan is intended to apply to areas outside of the identified contaminated sites within the Development Envelope, noting that the areas within the registered contaminated sites are managed under specific management plans. An unexpected finds procedure is included in the Asbestos Management Plan, detailing the management measures to be implemented if tailings or other asbestos containing waste materials are observed in the Development Envelope.

HPPL considers that the residual impacts can be managed by implementing industry-standard dust control measures and the Asbestos Management Plan.

Figure 11-6: Anthropogenic Sample Locations (JBSG 2024 – Asbestos Management Plan)

PACM 1
- Hancocks
Bore

PACM 2 - Two
Mile Bore

PACM 3 - Old
Station Bore

PACM 4 -
Macros Bore

PACM 5 - East
Wooley Bore

PACM 6
- Murray's
Well

PACM 7
- Calamina
Well

PACM 8 -
Vegas Bore

Legend

- Development Envelope
- Indicative Footprint
- Anthropogenic sample

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 31-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:49,152 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

ANTHROPOGENIC SAMPLE LOCATIONS (SOURCE JBSG ASBESTOS MP)

FIGURE 11.6

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Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

11.4 Potential Impacts

A preliminary assessment of the potential direct and indirect impacts of the Proposal to Terrestrial Environmental Quality values in consideration of the EPA objectives is provided below. There are no identified direct impacts relating to Terrestrial Environmental Quality.

11.4.1 Indirect Impacts

The potential indirect impacts to Terrestrial Environmental Quality from implementation of the Proposal, prior to mitigation, include:

- Contamination of soils, surface water and groundwater.
- Redistribution of ACM that is present from historical anthropogenic activities.

Contamination of Soils, Surface Water and Groundwater

Contamination of soils, surface water and groundwater is a potential indirect impact associated with the following:

- Generation of Acid and/ or Metalliferous Drainage (AMD) from mine voids during operation, waste rock dumps, waste rock material backfilled in pits below the water table, run-of mine pads and/or low-grade ore stockpiles;
- Acidification of groundwater, wetlands and drainage lines from oxidation of ASS, particularly if ASS material is used for construction of surface water levees or drainage lines;
- Erosion from waste rock dumps increasing sediment volume to downstream soils and drainage lines;
- Failure, leaks or seepage from saline water pipelines and/or water storage dams;
- Spillage of chemicals and hydrocarbons; and
- Seepage of landfill leachate.

11.4.1.1 Generation of Acid and/ or Metalliferous Drainage

AMD is formed by the oxidation of sulfide minerals when exposed to air and water. Activities that involve the excavation of rock with sulfide minerals, such as mining, accelerate the process. The drainage produced from the oxidation process may be neutral to acidic, and contain elevated concentrations of heavy metals or metalloids, but always contains sulfate. AMD results from a series of reactions and stages that typically proceed from near neutral to more acidic pH conditions (INAP, 2009).

AMD may lead to contamination of soil, surface water and groundwater with metals or metalloids and low pH conditions, potentially leading to adverse impacts to ecosystem services and other land and water users.

11.4.1.2 Acidification from ASS

Acid sulfate soils contain iron sulfides similarly to acid rocks. Iron sulfides are micro-crystalline minerals such as pyrite that have formed by biological processes reducing dissolved sulfates in shallow groundwaters under low oxidation conditions usually in soils where long-term water-logged conditions occur such as estuaries, wetlands and shallow groundwater in deep sands.

When exposed to air by drainage, lowering of water-tables or excavation, oxidation of the sulfides creates sulfuric acid which can trigger a range of flow-on effects, including acidification of groundwater, wetlands and waterways (DWER, 2015). In contrast to acid rock oxidation this process can occur very quickly, however ASS volumes are much lower.

The Proposal has the potential to result in acidification of groundwater, wetlands and drainage lines from the oxidation of ASS via excavation or mine dewatering activities lowering the natural water table.

11.4.1.3 Erosion from Waste Rock Dumps

Erosion of WRDs may occur where wind and/or water come into contact with soil and rock material on WRD slopes, surfaces and embankments. Without adequate management, eroded material from WRDs has potential indirect impacts to Terrestrial Environmental Quality by increasing sediment volume to the environment downstream of these waste structures.

The presence of potentially dispersive clay minerals may additionally lead to increased turbidity of surface water and breakdown of soil aggregates and structure.

11.4.1.4 Failure, leaks or seepage from saline water pipelines and/or water storage dams

The Proposal will include saline water storage dams and saline water pipelines as part of mineral processing and dewatering operations. Without adequate management, saline water and water storage dams have the potential to indirectly impact Terrestrial Environmental Quality through failure, leaks or seepage releasing saline water to the environment. Release of this material may lead to changes in surface water and/or groundwater quality.

11.4.1.5 Spillage of chemicals and hydrocarbons

The Proposal will involve the use a range chemicals and hydrocarbons that have the potential to adversely impact Terrestrial Environmental Quality if spills of these substances aren't adequately managed. Potential indirect impacts of spillages include localised contamination of soil, surface water and groundwater.

11.4.1.6 Seepage of landfill leachate

The Proposal will include a landfill facility that has the potential to generate leachate (water generated from decomposition of organic matter within landfills and external water sources that have come into contact with landfills). If landfill leachate is not managed, there is a potential for indirect impacts such as localised contamination of soil, surface water and groundwater.

11.4.1.7 Redistribution of Asbestos Containing Material that is present from historical anthropogenic activities

As outlined in **Section 11.3.5**, ACM is known from, and suspected to be present in parts of the Development Envelope from historical anthropogenic activities associated with the nearby Wittenoom asbestos mining area. Clearing, earthworks, construction and mining activities have the potential to inadvertently redistribute ACM that is present in the Development Envelope.

11.4.2 Cumulative Impact

The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, may have a cumulative impact on Terrestrial Environmental Quality through:

- Contamination of soils, surface water and groundwater; and
- Redistribution of ACM that is present from historical anthropogenic activities.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in **Section 17.**

11.5 Mitigation

HPPL has applied the mitigation hierarchy (avoid, minimise and rehabilitate) during Proposal design to reduce the potential impacts to Terrestrial Environmental Quality.

Avoidance measures include designing the Proposal to avoid mining stratigraphic units that pose the greatest AMD risk, avoiding impacts to areas prone to ASS where practicable, and avoiding ground disturbance in areas known or suspected to contain ACM, where practicable. The Waste Rock Management Plan (Appendix 35) will also be implemented which outlines management of potential contamination areas and procedures to be applied if asbestos or suspected asbestos materials are located.

A summary of mitigation measures applied to address the key potential impacts on Terrestrial Environmental Quality is provided in **Table 11-8**.

Table 11-8: Mitigation Measures for Terrestrial Environmental Quality

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Indirect impacts:			
Contamination of soils, surface water and groundwater	• As a result of the AMD risk posed by elevated sulfur material at depth, HPPL purposely designed the pits to exclude basal Nammuldi Member subunits and Jeerinah Formation (Roy Hill Shale).	• The Proposal has been designed to avoid direct impacts to areas prone to ASS, such as wetlands. • Surface water diversions have been designed to ensure surface water flows avoid contact with waste rock dumps. • Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Appropriate siting of landfill facilities to avoid interaction with surface drainage. • If PAF is encountered during mining, PAF material will be managed according to the Waste Management Plan to ensure final landform is non-acid forming. • Ongoing waste characterisation studies. • Ongoing waste characterisation during mining. • Waste rock material will be used as pit backfill to minimise the need for surface waste rock landforms. • Low stability or material the Uncertain or PAF classification waste rock material will not be placed on waste rock landform surfaces. • Competent waste rock material will be used to armour waste rock dump surfaces.	• If unexpected PASS is encountered, disturbed soils or low pH waters will be neutralised prior to discharge. • Excavation or dewatering will cease until suitable management measures are employed. • If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria. • Monitoring of surface and groundwater quality in accordance with a Water Management Plan to detect any adverse changes in water quality between the mine and sensitive receptors, with 'early response' criteria, 'trigger' criteria and 'threshold' criteria. • Progressive rehabilitation to be undertaken in accordance with a Mine Closure Plan assessed and approved by DEMIRS, as per requirements under the Mining Act. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Pipelines, water storage dams and landfills will be appropriately decommissioned and disturbed areas rehabilitated, unless there is a specific agreement in place with a third party to take ownership and responsibility of the infrastructure post mining. The

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
		• Waste rock landform design, including heights, slope lengths, batter angles and surface water control structures account for physical and chemical properties of waste rock. • Design landforms and infrastructure to contain sedimentation where possible. Toe bunds and sediment basins will direct and contain sediment runoff to prevent excessive scour and increased sediment volumes to the downstream environment. • Adherence to Dangerous Goods licence conditions and Australian Standards. • Adherence to EP Act Part V licence conditions with respect to bulk chemical storage and landfill management. • Disposal of waste to landfill will be a last resort. Materials will be repurposed or recycled where practicable.	requirements will be regulated as per a Mine Closure Plan to be assessed and approved by DEMIRS, in accordance with the Mining Act. • All chemical and hydrocarbon storage areas will be appropriately decommissioned and closed as per DEMIRS requirements of the MCP, in accordance with the Mining Act.
Redistribution of ACM that is present from historical anthropogenic activities	• The Development Envelope avoids the WAMA. • The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access.	• Adherence to the Asbestos Management Plan. • The Proposal has been designed to avoid impacts to areas where ACM has been confirmed or is suspected, where practicable.	• ACM-contaminated areas will be rehabilitated where appropriate, and asbestos management will be subject to monitoring through the AMP.

11.6 Assessment and Significance of Residual Impacts

11.6.1 Indirect Impacts

Contamination of Soils, Surface Water and Groundwater

To mitigate the risk of AMD impacts to soil, surface water and groundwater, HPPL has purposely designed the mining pits to exclude basal Nammuldi Member subunits and Roy Hill Shale. Waste material characterisation conducted to date shows elevated sulfur material at depth within these units, posing the highest AMD generation risk. Excluding these material types notably lowers the risk of AMD from waste rock dumps, in-pit backfill, exposed mine pit walls, ore on RoM pads and low-grade ore stockpiles.

The majority of waste material 95% (**Table 11-6**) is classified as NAF with less than 1% being classified as PAF by a very conservative measure. Any probability that significantly acid generating material will occur in waste material stored in landforms or backfilled below water table has been almost completely avoided.

Broad-scale mapping indicates the Proposal has a generally low ASS risk and site-based observations have not identified any areas of PASS.. In the event that unexpected ASS is encountered, mitigation measures will be employed. If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria.

Physical waste rock characterisation work undertaken by Mine Earth (2023) has identified the erosional stability of the key lithologies within the various stratigraphic units summarised as follows:

- Fresh chert, BIF and mineralised waste rock should display moderate-high erosional stability and should be suitable for placement on final landform slopes. Moderate-high stability waste rock may provide a useful source of durable rock armour.
- Calcrete and silcrete waste rock should display moderate to moderate-high erosional stability and should be suitable for placement on final landform slopes.
- Fresh dolomite and transitional chert, BIF and mineralised waste rock should display moderate erosional stability. These rock types may not be suitable for placement on final landform slopes (to be verified during mining).
- Fresh shale and transitional dolomite and shale waste rock should display low-moderate to low erosional stability and should not be placed on final landform slopes.
- The oxide component of all rock types can be expected to low erosional stability and should not be placed on final landform slopes.

The findings of this work will be used to inform more detailed test work and waste rock handling and placement procedures that will ensure low erosional stability waste rock is not placed on final waste rock landform slopes, and high erosional stability rock armouring materials is used. Based on projected waste rock volumes by stratigraphic unit, there will be sufficient quantities of competent material to cover less stable material. The nature of the geology also results in the less competent oxide waste rock being mined first, with more competent material encountered at depth to encapsulate low stability waste rock.

Whilst WRDs are active and prior to progressive rehabilitation, standard mitigation measures will be used to manage sediment dispersal from waste dump slopes at angle of repose. Measures include sediment basins to direct and contain any sediment runoff, preventing dispersion to the downstream environment.

The risk of high sediment load from WRDs impacting downstream soils and drainage lines can be adequately managed to meet the EPA's objectives for Terrestrial Environmental Quality. HPPL notes that risks to Terrestrial Environmental Quality associated with high sediment volumes from waste rock dumps can be adequately regulated by DEMIRS, under the provisions of the Mining Act. Through the Mining Proposal and Mine Closure Plan assessment and approval process, environmental objectives and performance criteria will be established to ensure mining operations meet DEMIRS environmental objectives for mining, which include land and soil and water resources as key environmental factors.

Any impacts to Terrestrial Environmental Quality arising from spillage of reagents, chemicals and hydrocarbons and pipeline failures, leaks/seepage from saline water storage facilities are likely to be localised and minor, and unlikely to result in significant environmental impacts. The Proposal will be subject to regulation under the Mining Act, which will also regulate impacts to the environment arising from spillage of reagents, chemicals and hydrocarbons and pipeline failures, leaks/seepage from saline water storage facilities via setting appropriate environmental outcomes and performance criteria relating to land and soils and water resources.

The DG Act reduces the risk to the environment from dangerous goods (transport, storage, use and disposal) by regulating the user and ensuring correct use and adherence to standards.

The provisions of the DG Act allows DEMIRS, through the licencing process, to regulate mining activities and meet the EPA's objectives for Terrestrial Environmental Quality.

Adherence to Dangerous Goods licence conditions, EP Act Part V licence conditions with respect to bulk chemical storage, relevant Australian Standards and the use of industry-standard mitigation measures for the transport, storage use and disposal of dangerous goods will ensure there are no significant residual impacts to Terrestrial Environmental Quality from the Proposal.

The EP Act Part V process, through the completion of the works approval, associated commissioning works and licence, will provide adequate regulation of emissions and discharges from the Proposal. The provisions of Part V of the EP Act will meet the EPA's objectives for Terrestrial Environmental Quality.

Redistribution of asbestos containing material

Based on the findings of the SAQP completed by JBS&G (2023), it is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM.

As part of the SAQP, soil sampling was targeted towards areas where the potential for the deposition of asbestiform minerals was considered to be highest. A single loose fibre bundle of crocidolite in the soil was detected in a single sample, however, the asbestos concentration in the sample, and every other sample, was below the laboratory LOR and adopted assessment criteria. In the absence of any asbestos detections or exceedances, the potential risk to site receptors is considered to be low (JBS&G, 2024).

Limited historical site structures at Mulga Downs have confirmed the presence of ACM, however given the relatively small size and scale of the observed infrastructure, the amount of asbestos release in the event of disturbance is likely to be minor. Other unidentified site structures within the Development Envelope could potentially contain ACM. However, the potential for unacceptable risk to Terrestrial Environmental Quality from ACM within site structures is considered to be low and can be managed via the implementation of an Asbestos Management Plan (AMP), including procedures for the safe decommissioning and removal of these structures from site (JBS&G, 2024).

ACM is known to have been historically dumped near the Development Envelope. However, no ACM (including bags of tailings) or other consolidated waste storage areas were observed during the site investigation. While the potential for unidentified dumping can't be completely discounted, the current available information indicates that the unacceptable risk to site receptors from miscellaneous dumping of ACM tailings is low and can be managed via the preparation and implementation of an unexpected finds procedure within the AMP (JBS&G, 2024).

Prior to implementing the above-stated management plans and procedures, HPPL has implemented a number of avoidance measures to minimise risks of encountering anthropogenic ACM. These include:

- The Development Envelope avoids the WAMA.
- The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access.

Based on the above, the risk of ACM to Terrestrial Environmental Quality is considered low and manageable.

11.7 Significant Residual Impact

The residual impacts of the Proposal to Terrestrial Environmental Quality are not considered significant. Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with Terrestrial Environmental Quality meet the EPA's objective for this factor.

11.8 Environmental Outcome

The predicted environmental outcomes for Terrestrial Environmental Quality are summarised in **Table 11-9**.

Table 11-9: Terrestrial Environmental Quality Environmental Outcomes

Potential impact	Environmental Outcome
Indirect impacts	
Contamination of soils, surface water and groundwater	• The risk of contamination of soils, surface water and groundwater from AMD is significantly reduced from HPPL's strategy of purposely designing pits not to intersect basal Nammuldi and Roy Hill Shale/ Member of the Jerrinah Formation stratigraphic units, as these have been shown to have the highest sulfur levels and are most likely to lead to the generation of AMD. • SRK (2024) confirms that the AMD potential is, in general, low. • The potential for leaching is expected to be limited given the neutral pH conditions expected for the majority of waste rock.

Potential impact	Environmental Outcome
Indirect impacts	
	• Other regulatory processes such as DEMIRS' Mining Proposal and MCP will ensure waste structures such as waste rock dumps are designed, operated, decommissioned and closed to meet the EPA's objectives for Terrestrial Environmental Quality. • Any contamination of soils, surface water and/or groundwater arising from failure, leaks or seepage from saline water pipelines, or water storage dams is likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts. • Similarly, impacts associated with spillage of chemicals and hydrocarbons and landfill leachate or also are likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts.
Redistribution of asbestos containing material (ACM) that is present from historical anthropogenic activities	• It is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM. • The implementation of, and adherence to, an Asbestos Management Plan, including procedures for the safe decommissioning and removal of ACM structures and an unexpected finds procedure can adequately manage ACM risks to Terrestrial Environmental Quality to ensure the EPA's objective for this environmental factor can be met.

12 Greenhouse Gas Emissions

12.1 EPA Objective

The EPA's objective for the environmental factor Greenhouse Gas (GHG) Emissions is:

"To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable." (EPA 2024).

12.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1,** specific policy and guidance relevant to the key environmental factor Greenhouse Gas Emissions that have informed the planning for the Proposal are listed in **Table 12-1**.

Table 12-1: Greenhouse gas policy and guidance

Reference	Title	How policy and guidance has been considered
State		
EPA, 2024	Environmental Factor Guideline: Greenhouse Gas Emissions (the GHG Guideline)	The information provided in this chapter addresses the considerations for environmental impact assessment' listed in this document.
GoWA, 2019a	Greenhouse Gas (GHG) Emissions Policy for Major Projects	Considered in the assessment of GHG emissions. In particular: *"Where the greenhouse gas emissions of a major Proposal assessed under Part IV of the Environmental Protection Act 1986 (WA) (EP Act) will be subjected to alternative regulatory measures, the State will no longer apply conditions to reduce net greenhouse gas emissions."* *"The EP Act requires the EPA to identify and consider key environmental factors as part of its statutory assessment functions. Acknowledging the EPA's duties to assess Proposals lawfully and in a manner it considers appropriate, the State Government expects that in line with this policy, there is no need to assess emissions dealt with by other regulatory measures."*
GoWA, 2020	Western Australian Climate Change Policy	Sets out the WA Government's plan for a climate-resilient community and a prosperous low-carbon future; also underscores the commitment to adapting to climate change and working with all sectors of the economy to achieve net zero greenhouse gas emissions by 2050.
Commonwealth		
Commonwealth Government, 2007	National Greenhouse and Energy Reporting Act 2007 (NGER Act)	Under the NGER Act, companies are obligated to report on their GHG emissions in accordance with statutory requirements (CER 2021). The NGER Act provides a single national framework for the reporting and dissemination of information relating to GHG emissions, energy production and energy consumption in Australia governed by the Clean Energy Regulator (CER).
Commonwealth Government, 2008	National Greenhouse and Energy Reporting (Measurement) Determination 2008	Considered in the GHG emissions assessment.

Reference	Title	How policy and guidance has been considered
Commonwealth Government, 2022	Climate Change Act 2022	Requires the Commonwealth Government to consider the advice regarding the Net Zero Plan and 2035 target.
Commonwealth Government, 2023	National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (as amended 2023)	The objectives of the Act as set out in are: (1) To establish a unified national reporting framework for greenhouse gas emissions, projects, energy consumption, and production by corporations, aimed at informing government policy, the public, meeting international obligations, supporting government programs, and avoiding redundant state and territory reporting requirements. (2) To help achieve Australia's greenhouse gas emissions reduction targets by ensuring that emissions from large facilities do not exceed set baselines, total net safeguard emissions remain within specified limits from 2020 to 2030, and decline to zero by 2050, while providing incentives for facilities to reduce their emissions. Pursuant to the Australian Government's Safeguard Mechanism Rule, if a facility is anticipated to emit more than 100,000 t CO2-e of Scope 1 emissions per financial year (i.e., the 'safeguard threshold'), it qualifies as a safeguard facility and is required to keep its net emissions levels at or below its emissions baseline set by the CER. The reforms are intended to put facilities on a broad trajectory to meet net zero in 2050, consistent with EPA requirements. Together with the reporting obligations under the NGER Act, the safeguard mechanism provides a National framework for Australia's largest emitters to measure, report and manage their emissions. Whilst the Proposal is not currently expected to be a safeguard facility, there some factors, which are not yet finalised, that may impact this position: The emissions are an estimate only, these estimates may change as the project and operational conditions develop.

HPPL acknowledges the Commonwealth Government's commitment has been updated (June 2022). The former commitment to an interim GHG reduction target of 26% to 28% below 2005 levels by 2030 has been superseded by a more ambitious target of 43%; incorporated through legislation via the Commonwealth Climate Change Bill 2022, which was passed in September 2022 and formalised as the target for the updated Nationally Determined Contribution under the Paris Agreement (Commonwealth Government 2023).

Information required for the assessment of impacts from GHG emissions in accordance with the EPA, 2024 GHG Guideline is included in this section.

12.3 Safeguard Mechanism Confirmation

The Proponent is unlikely to be classified as a Safeguard Facility under the Safeguard Mechanism. Consistent with other operations in the Pilbara—such as those managed by Atlas Iron—road haulage and mining activities are treated as separate facilities under the National Greenhouse and Energy Reporting Scheme (NGERS). Under

NGERS, facilities are defined and reported based on operational control, which is determined by the entity with the authority to make key decisions regarding safety, employment, and operational procedures.

For road haulage, operational control rests with the road haulage contractor, who is responsible for the trucks, drivers, and associated safety and operational systems. The Proponent does not intend to have ultimate authority over the management or operation of these vehicles or personnel. In contrast, for mining activities, operational control is held by the entity listed with the Department of Energy, Mines, Industry Regulation and Safety (DEMIRS) as having responsibility for safety on the mining lease—it is intended that this will be the Proponent.

Accordingly, emissions from road haulage and mining are reported separately under NGERS, and only the facility under the Proponent's operational control (i.e., the mining activities) would be considered in any Safeguard Mechanism assessment. Based on current and forecasted emissions, the Proponent's mining facility is not expected to exceed the Safeguard Mechanism threshold.

In addition, the Proponent will not exceed 100,000 t CO2-e of overall project emissions due to the application of the mitigation hierarchy.

12.3.1 Application of Mitigation Hierarchy

Application of the mitigation hierarchy for greenhouse gas (EPA 2023d) is as follows:

- Avoid – avoid emissions through best-practice design;
- Reduce – reduce emissions over the project life; and
- Offset – offset some or all residual emissions.

A summary of mitigation measures applied to address the key potential impacts of GHG emissions against the mitigation hierarchy for greenhouse gas (EPA 2023d) of avoid, reduce and offset is described below and provided in Table 12 2.

12.3.1.1 Avoided emissions

The EPA's mitigation hierarchy has been considered throughout the planning of the anticipated construction and operational periods of the Proposal. HPPL has incorporated best practice measures to minimise and avoid GHG emissions at Proposal implementation with subsequent long-term reduction strategies outlined.

The power network for the Proposal has been designed to avoid employing diesel generators wherever practicable. Electrical loads will be connected to the electricity distribution network and supplied from the central power station. The central power station incorporates LNG engines, a battery and solar PV. Exceptions include the reinjection and dewatering bores and the gate house. For these use cases, hybrid solar microgrids will be considered. The difference in emissions intensity between diesel generators (as are typically deployed in a mine of this size and type) and the LNG battery and solar power station is 572,761 t-CO2-e over the life of the Project.

The commitment to implementation and scale up of the use of solar power as a renewable energy source is based on forecasts of what is achievable during the lifetime the Proposal. It is possible that technology

associated with PV solar, BESS and associated management systems will evolve beyond current expectations during the Proposal lifetime. Should this occur, HPPL will consider the feasibility of implementing a larger percentage of renewable energy sooner.

Further, the proposed transport solution (hauling ore via road train to Hillside siding to be loaded onto the train) compared to the alternative (hauling ore via road train to Utah Point) avoids another 607,756 t-CO2-e over the life of the Project.

12.3.1.2 Potential Reduction Projects

Other GHG avoidance and minimisation initiatives, to be implemented at Proposal commencement, include optimisation of mine layout to minimise haulage distances, gradients and use of multiple ROM pads. This mine layout has meant the litres per total material movement (TMM) is equivalent to that of Roy Hill, which is the fourth best mine in the Pilbara from an emissions intensity perspective (from a total of 19 mines) (refer to data from the CER: https://cer.gov.au/markets/reports-and-data/emissions-intensity-determination-data-safeguard-facilities). This ensures that best practice mining operational practices are incorporated from the commencement of Mulga Downs.

During operations, HPPL will look to introduce a number of energy efficiency initiatives if they are feasible and beneficial to do so, this will be informed by learnings from those initiatives deployed at other group operations, such as:

- Specifying fuel efficient HME.
- Use of diesel fuel additive such as the Caltex Active Tec product. This has been shown to reduce fuel consumption by 3.9% across the operations.
- Engine tuning optimisation, which have shown to have improved emissions by up to 7% for single HME.
- Use of lighter trays in the HME. The associated diesel efficiency improvement is yet to be quantified in other operations, but is estimated to reduce the diesel L per TMM by up to 10% for a single HME using that tray.
- The Anti-Idle technology has been trailed and is being further developed in consultation with OEM partners. This technology targets periods of the HME operations where the vehicle is at stationary idle by turning off the engine but maintaining the power to the aircon and other systems the operator requires. The amount of addressable idle time varies due to asset class and operational factors however HPPL are targeting a 1-2% annual fuel saving.
- Renewable and/or Hybrid Diesel stationary power system used in place of small field generators, communication trailers and lighting trailers. These have been trialled and deployed where suitable in operations a predicted fuel saving of 40 to 60%.
- Fuel Active is a product that prevents contaminants in the fuel tanks from entering HME engines. This allows the engine to achieve a cleaner burn and could offer approximately a 1.5% fuel saving per asset, but this is yet to be validated.
- Smaller electric equipment, investigate the deployment of smaller and commercially available electric equipment where it is economically and operationally feasible to do so.

Subsequent emission reductions, via hydrocarbon displacement, can only be realised by gradual electrification of the mining fleet and progressive increased renewable penetration into the power network. The timing of increasing of both electrification and renewable penetration are dependent on technology maturity and

availability. HPPL have allocated land to enable the solar field and electrical assets to be expanded to support increased electrification.

12.3.1.3 Offset Projects

The Proponent will apply the mitigation hierarchy to ensure that total or net emissions stay within the limits shown in Figure 12-1. This includes using offsets as a last resort in the event that other mitigations are not successful. Should the Proponent need to use offsets, they will be offsets that are issued under recognised carbon offset programs. Such programs include:

- Australian Carbon Credit Units issued under the Carbon Credits (Carbon Farming Initiative) Act 2011 (Cth).
- Safeguard Mechanism Credits issued under the Safeguard Mechanism (Crediting) Amendment Act 2023.
- Verified Emission Reductions issued under the Gold Standard program.
- Verified Carbon Units issued under the Verified Carbon Standard program.
- Carbon offsets issued under the Climate Action Reserve program.
- Carbon offsets issued under the American Carbon Registry program.
- Other offset units that are issued under similarly recognised programs.

The Proponent has reviewed the availability of carbon offsets that may be required to meet emissions limits should other mitigation measures prove insufficient. Based on recent advice from financial institutions and carbon market intermediaries, there is a well-established and liquid market for Australian Carbon Credit Units (ACCUs), Safeguard Mechanism Credits, and a range of internationally recognised offset units, including those issued under the Gold Standard, Verified Carbon Standard, Climate Action Reserve, and American Carbon Registry programs. For example, for just the ACCU market, in 2024 there was 50 million ACCUs in the market, with 18.8 million being issued that year.4 This more than meets the potential amount of offsets that the Proponent would need to buy.

Offsets from these programs are widely accepted and recognised for compliance purposes in Australia and internationally. The Proponent has previously purchased ACCUs to meet compliance obligations and, based on current market advice, expects that sufficient supply will be available to meet future requirements. Should offsets be required, the Proponent will purchase units from these recognised programs.

The Proponent understands that offsets purchased from the above-mentioned programmes—such as Australian Carbon Credit Units (ACCUs), Safeguard Mechanism Credits, Gold Standard Verified Emission Reductions, Verified Carbon Units under the Verified Carbon Standard, Climate Action Reserve credits, and American Carbon Registry credits—are issued under established regulatory frameworks and are subject to an assessment processes. These programmes are recognised for their robust governance, transparency, and independent third-party verification.

Offsets from these schemes are designed to meet key integrity principles, including additionality (ensuring emissions reductions are above business-as-usual), permanence, avoidance of double counting, and regular

[4] https://cer.gov.au/markets/reports-and-data/quarterly-carbon-market-reports/quarterly-carbon-market-report-december-quarter-2024/safeguard-and-australian-carbon-credit-unit-accu-schemes#:~:text=Overall%20ACCU%20market%20liquidity%20looks,Supplementary%20figures

monitoring and reporting. In Australia, the Clean Energy Regulator and the Emissions Reduction Assurance Committee oversee the integrity of ACCUs, while international standards such as Gold Standard and Verra (VCS) are governed by respected non-profit organisations with strong reputations for environmental and social safeguards.

Accordingly, the Proponent understands that purchasing offsets from these recognised programmes provides assurance that the units are consistent with the relevant offset integrity principles as required by the EPA and other regulatory bodies.

12.3.1.4 Benchmarking

Emissions intensity data has been used to benchmark GHG emissions from the Mulga Down Project against other iron ore mines, i.e. tonnes of GHG emitted per tonne of iron ore mined. The iron ore mines considered for benchmarking are similar facilities located in the Pilbara region with publicly available information about their Scope 1 emissions.

Emissions intensity is calculated by:

Appendix A Emissions intensity = Scope 1 emissions / Production rate

- Forecast Mulga Down annual Scope 1 emissions (those emissions emitted within the mining lease) = 84,449 tCO_2-e5
- Forecast Mulga Down iron ore production per annum = 12,000,000 tpa
- Mulga Down emissions intensity = 0.007037 tCO_2-e/t iron ore.

The calculated emissions intensity of the Mulga Down Project compared with other iron ore mines currently operating in the Pilbara region is outlined in Table 12-2.

Table 12-2 Emissions intensity

Project	Ore production (t) per annum	Total scope 1 emissions* (tCO_2-e) per year	Emissions Intensity (tCO_2-e/t ore)	Source
Mulga Down	12,000,000	84,449	0.007037	
Roy Hill Iron Ore Mine (Revised Proposal)	59,100,000	450,000	0.0076	Roy Hill Greenhouse Gas Management Plan
BHP Mining Area C	150,000,000	1,200,000	0.0080	Public environmental review document (BHP, 2017)
BHP Jimblebar	50,673,195	414,000	0.0082	Public environmental review document (BHP, 2019)
FMG Solomon	39,650,000	324,651	0.0082	Eliwana Project referral document (Fortescue, 2018)*

[5] The average of annual emissions from FY29 to FY 2042. The first and last year of production were excluded so no to skew the data.

Project	Ore production (t) per annum	Total scope 1 emissions* (tCO_2-e) per year	Emissions Intensity (tCO_2-e/t ore)	Source
Rio Tinto West Angelas	35,000,000	315,825	0.0090	Public environmental review document (Rio Tinto, 2018)
West Australian iron ore industry	-	-	0.0098	Published journal paper (Norgate T. and Haque N., 2010)**

12.3.1.5 Summary of the Application of Best Practice

The EPA's mitigation hierarchy has been considered throughout the planning of the anticipated construction and operational periods of the Proposal. HPPL has incorporated best practice measures to minimise and avoid GHG emissions at Proposal implementation with subsequent long-term reduction strategies outlined.

The power network for the Proposal has been designed to avoid employing diesel generators wherever practicable. Electrical loads will be connected to the electricity distribution network and supplied from the central power station. Exceptions include the reinjection bores, which run intermittently so can prioritise periods of solar generation from a local photovoltaic (PV) system, and the gate house which will also use electricity from a local solar PV system equipped with a diesel generator for periods when solar generated electricity is not available. The difference in emissions intensity between diesel generators (as are typically deployed in a mine of this size and type) and the current solution is ~62%.

Implementation of a hybrid central power station, integrating power generation from gas rather than diesel, and a solar panel farm, will provide the primary GHG reductions. Initially the solar generation capacity will provide 38% of the mine base load requirements, resulting in a reduction in emissions of 25,507 t CO_2-e per annum compared to servicing the base load requirements from a 100% gas fired power station.

Other GHG avoidance and minimisation initiatives, to be implemented at Proposal commencement, include optimisation of mine layout to minimise haulage distances, gradients and use of multiple ROM pads. This mine layout has meant the litres per total material movement (TMM) is equivalent to that of Roy Hill, which is the fourth best mine in the Pilbara from an emissions intensity perspective (from a total of 19 mines) (refer to data from the CER: https://cer.gov.au/markets/reports-and-data/emissions-intensity-determination-data-safeguard-facilities). This ensures that best practice mining operational practices are incorporated from the commencement of Mulga Downs.

During operations, HPPL will look to introduce a number of energy efficiency initiatives if they are feasible and beneficial to do so, this will be informed by learnings from those initiatives deployed at other group operations, such as:

- Specifying fuel efficient HME
    - Use of diesel fuel additive such as the Caltex Active Tec product. This has been shown to reduce fuel consumption by 3.9% across the operations.
    - Engine tuning optimisation, which have shown to have improved emissions by up to 7% for single HME.

  - Use of lighter trays in the HME. The associated diesel efficiency improvement is yet to be quantified in other operations, but is estimated to reduce the diesel L per TMM by up to 10% for a single HME using that tray.
- The Anti-Idle technology has been trailled and is being further developed in consultation with OEM partners. This technology targets periods of the HME operations where the vehicle is at stationary idle by turning off the engine but maintaining the power to the aircon and other systems the operator requires. The amount of addressable idle time varies due to asset class and operational factors however HPPL are targeting a 1-2% annual fuel saving.
- Renewable and/or Hybrid Diesel stationary power system used in place of small field generators, communication trailers and lighting trailers. These have been trialled and deployed where suitable in operations a predicted fuel saving of 40 to 60%.
- Fuel Active is a product that prevents contaminants in the fuel tanks from entering HME engines. This allows the engine to achieve a cleaner burn and could offer approximately a 1.5% fuel saving per asset, but this is yet to be validated.
- Smaller electric equipment, investigate the deployment of smaller and commercially available electric equipment where it is economically and operationally feasible to do so.

Subsequent emission reductions, via hydrocarbon displacement, can only be realised by gradual electrification of the mining fleet and progressive increased renewable penetration into the power network. The timing of increasing of both electrification and renewable penetration are dependent on technology maturity and availability. HPPL have allocated land to enable the solar field and electrical assets to be expanded to support increased electrification.

The commitment to implementation and scale up of the use of solar power as a renewable energy source is based on forecasts of what is achievable during the lifetime the Proposal. It is possible that technology associated with PV solar, BESS and associated management systems will evolve beyond current expectations during the Proposal lifetime. Should this occur, HPPL will consider the feasibility of implementing a larger percentage of renewable energy sooner.

Application of the mitigation hierarchy for greenhouse gas (EPA 2023d) is as follows:

- Avoid – avoid emissions through best-practice design;
- Reduce – reduce emissions over the project life; and
- Offset – offset some or all residual emissions.

A summary of mitigation measures applied to address the key potential impacts of GHG emissions against the mitigation hierarchy for greenhouse gas (EPA 2023d) of avoid, reduce and offset is provided in **Table 12-3**.

Table 12-3: Summary of Mitigation Measures for Greenhouse Gas Emissions

Mitigation			
Potential impact	**Avoid**	**Reduce**	**Offset**
Direct contribution to climate change from Scope 1 emissions generated by the Proposal	Vegetation clearing minimised to no more than 4,339.16 ha of clearing within a Development Envelope of 16,848.53 ha. Power provided by hybrid power station with natural gas fired generators, avoiding diesel-fired generators. Hybrid power station installed with solar and BESS to provide 38% of power demand, avoiding gas fired generation. Power remote infrastructure and equipment with solar and BESS where possible, avoiding need for diesel fired generators. Adopt energy efficient infrastructure and equipment. Location of infrastructure and haul roads designed to minimise haul distances. Haul roads designed to minimise gradients and stop/start points. Transport of ore by rail (subject to approvals) in place of road transport.	Where economic and possible to do so incrementally increase renewable penetration through increased sourcing of electricity from solar and other sources. Incremental electrification of equipment as technology becomes economically and commercially available. Regular planned equipment maintenance to ensure fuel efficiency is optimised. Implement fuel reduction strategies such as changes in modes of operation, duration of engine idle time, type of fuel used, engine management system optimisation and other initiatives as listed in section 12.3.1.2. Connect infrastructure and equipment to distributed electricity network where possible, avoiding need for diesel fired generators.	Carbon offsets will be used where emissions exceed emission reduction commitments and target as listed in section 12.3.1.3.
Indirect contribution to climate change from Scope 2 emissions generated by the Proposal	Scope 2 emissions, associated with electricity or other energy commodities sourced from a third party, have been avoided where possible. Electricity will be source	NA	NA

Mitigation			
Potential impact	**Avoid**	**Reduce**	**Offset**
	from on-site infrastructure (hybrid gas/solar power station or diesel generators).		
Indirect contribution to climate change from Scope 3 emissions generated by the Proposal	Replace transport of ore by road with rail (subject to approvals).	Replace diesel locomotives with electric ones	Define and refine scope 3 emissions estimates through the life of the Proposal to identify mitigation measures.

12.4 Estimate of Emissions

Three distinct classes (Scopes) of GHG emissions are described in various national and international GHG reporting standards that delineate sources and associated responsibilities. The Scopes of GHG emission classes are defined (EPA, 2023a) as:

- Scope 1 emissions are those released to the atmosphere as a direct result of an activity, or a series of activities, which are part of a Proposal being considered by the EPA;
- Scope 2 emissions are those from the independent consumption of an energy product by the Proposal; and
- Scope 3 emissions are indirect GHG emissions other than Scope 2 emissions that are generated in the wider community. Scope 3 emissions (both upstream and downstream) occur as a consequence of the activities of a Proposal, but from sources not owned or controlled by HPPL as part of the Proposal.

12.4.1 Scope 1 (as defined by the EPA)

12.4.1.1 Mine Emissions

Fuel consumption forecasts were informed by data from existing operations and detailed Proposal specific studies. Emission estimates are based on construction commencing in FY 2027 with operations commencing during FY 2028. Forecasting is based on mining operations ceasing by the end of FY 2041 (ore will be stockpiled for transportation to Port Hedland). From FY 2042, trucks and excavators are forecast to be largely employed for closure activities, including backfilling and rehabilitation.

Emissions estimates, as tonnes carbon dioxide equivalent (t CO2-e), have been made using “Method 1” from the National Greenhouse and Energy Reporting (Measurement) Determination 2008, incorporating the National Greenhouse and Energy Reporting (Measurement) Amendment (2023) Determination 2023, which employs default emission factors in the estimation of emissions.

Scope 1 emissions associated with the Proposal will occur from/are associated with:

- Combustion of diesel fuel during construction phase for:
  - Vegetation removal (mobile equipment);
  - Earthmoving, heavy haulage vehicles and other related equipment
  - Mine pits and tailings storage facilities;
  - Installation of mine infrastructure including processing plant, mine roads, culverts, airport, accommodation camp, fuel corridor, power station and power lines, solar farm, and ancillary infrastructure (e.g., water management infrastructure, explosives storage, offices, landfill etc.);
  - Vehicles for transporting construction workers and ancillary vehicles including light vehicles (LV), goods vehicles; and
  - Diesel generators to meet electricity requirements for construction of the Proposal infrastructure, power station and accommodation camp.
- Combustion of fuel during the operational phase for:
  - Mining of ore;

- On-site ore transport, crushing, screening, wet processing and stacking;
- Mineral waste management (WRDs);
- Electricity generation for operational activities and infrastructure (through the use of a gas, battery and solar farm);
- Haul truck operation (the use of multiple ROM pads has reduced haul distances and increased fuel efficiency);
- Haulage of ore to the Proposal Boundary via road trains;
- Water carts;
- Ancillary vehicles (e.g., LVs, goods vehicles, buses); and
- Water abstraction.

12.4.1.2 Transport Emissions

The emissions associated with transport include:

- The emissions associated with road haulage to Hillside Siding.
- The emissions associated with the operation of Hillside Siding.
- The emissions associated with rail haulage from Hillside Siding to Utah Point.

12.4.1.3 Land Clearing Emissions

Emissions associated with vegetation clearing are not covered emissions for the purposes of safeguard.

Carbon sequestration loss due to biomass disturbance has been calculated using the generic methodology from Intergovernmental Panel on Climate Change (IPCC) (IPCC 2003). The calculation of GHG emissions resulting from loss of biomass associated with the Proposal is based on the following conservative assumptions and exclusions:

- Vegetation was mature without any disturbance;
- Above and below ground biomass in the Development Envelope will be cleared progressively;
- The above ground biomass estimate derived from the average biomass density inside the Proposal area to be cleared in the Maximum Above Ground Biomass (also known as M) spatial layer developed for the Full Carbon Accounting Model (FullCAM) is representative of vegetation, including all plants and debris, in the Development Envelope;
- A root to shoot ratio of 2.8 derived from Intergovernmental Panel on Climate Change (IPCC guidance) for shrubland [6] is representative of the vegetation in the Development Envelope;
- The default IPCC value of carbon fraction of biomass dry matter of 0.5 is representative;
- All carbon in biomass removed conservatively assigned as if will be released as CO_2 in the year of clearing;
- Soil carbon loss was not accounted for; and
- Restoration of carbon sequestration via progressive revegetation, where practicable, is not accounted for.

[6] Table 3A.1.8 shrubland IPCC 2003 https://www.ipcc- nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

- The carbon loss from vegetation clearing ($\Sigma E_v \text{t } CO_2 - e$) was estimated from the following formula[7]:

$$\Sigma E_v \text{t } CO_2 - \text{e} = \text{A} \times \text{AGB x } (1 + \text{R}) \text{ x CF x CD}$$

Proposal specific parameters are described in **Table 12-4**.

Table 12-4: Parameters for calculation of carbon sequestration loss due to biomass disturbance

Parameter	Description	Value	Source
A	area to be cleared in hectares	Up to 4,339.16 ha	Project team
AGB	above ground biomass	6.9 t dry matter/ha	Maximum Above Ground Biomass (also known as M) spatial layer 2019
R	root to shoot ratio to estimate below ground vegetation biomass	2.83	Table 3A.1.8 shrubland IPCC 2003 Good Practice Guide for Land Use, Land Use Change and Forestry
CF	IPCC default carbon fraction of biomass	0.5	IPCC Guidelines for National Greenhouse Gas Inventories
CD	ratio of the molecular weight of carbon dioxide to carbon	3.67	Molecular weight CO_2 (44) / Molecular weight C (14)

It is anticipated there will be 210,421 t CO_2-e as a result of carbon sequestration loss due to biomass disturbance from the Proposal.

[7] IPCC 2006 equation 2.14

12.4.1.4 Scope 1 Emissions Profile

The emission profile is shown below in Figure 12-1. To note:

- Total Unmitigated Emissions - This represents what the emissions of the Proposal would have been without the application of the mitigation hierarchy.
- Total Mitigated Emissions - This represents the total Proposal emissions after application of the mitigation hierarchy, which do not exceed 100,000 t CO_2-e.
- Vegetation Clearing - This portion of the clustered column represents the emissions that are not measured under the Safeguard facility, namely vegetation clearing which results in loss of biosequestration.
- Emissions – Mine Facility - This portion of the clustered column represents the emissions associated with the mine facility and includes emission from diesel associated with mining and the emissions associated with the power generation.
- Emissions – Transport - This portion of the clustered column represents the emissions associated with transporting the ore to the port (road haulage and rail haulage).
- Avoided Emissions - This portion of the clustered column represents the avoided emissions achieved through the use of a hybrid renewable/LNG power station and using a rail system (described in further detail below).
- Emissions abated through Reduction/Offsets - This portion of the clustered column represents a reduction or offsetting of emissions that the Proponent commits to achieving.

Also shown in Figure 12-2 accompanying numerical data to Figure 12-1 and Figure 12-3 which is the annual breakdown of emissions from the five highest sources.

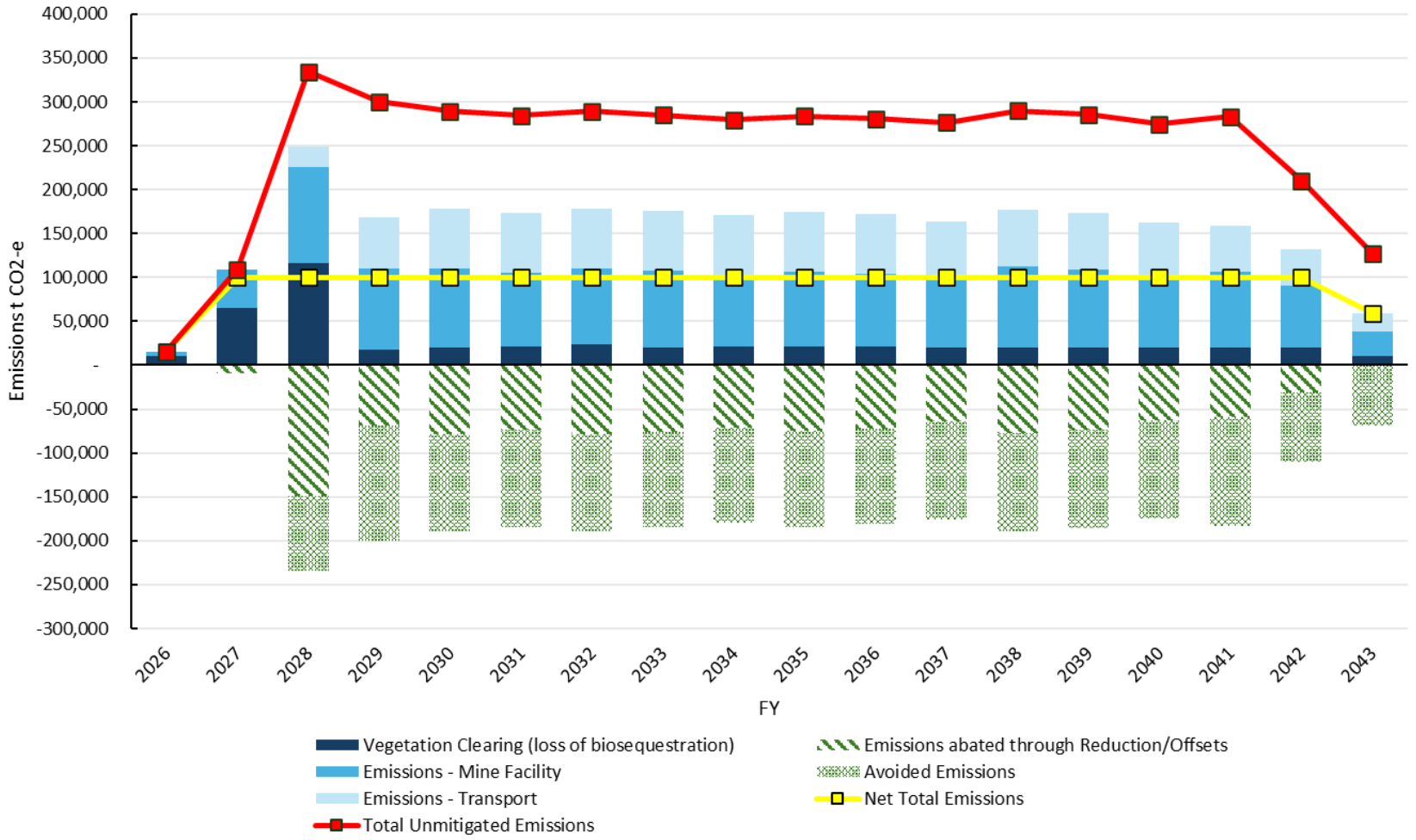


Figure 12-1: Scope 1 emissions profile for the Proposal

Table 12-5 Numerical Data for Figure 12-1

Item	Units	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Emissions - Mine Facility	t -CO2e	5329.397	44545.69	108792.9	92919.61	89741.01	83065.03	85950.11	87684.01	81216.34	85798.48	82400.78	78693.03	92062.92	88481.16	77861.2	85853.79	70560.46	28721.39
Emissions - Transport	t -CO2e	0	0	23346.4	58062.92	68403.38	68403.68	68398.94	68403.68	68403.68	68403.68	68403.68	64963.12	64973.5	64988.21	65015.35	52444.67	41060.48	20530.24
Vegetation Clearing (loss of biosequestration)	t -CO2e	9948.601	64962.42	116614.4	17364.75	20168.76	21780.75	24035.41	19959.71	21297.56	20797.12	21297.56	20621.22	20424.52	19932.57	19959.71	20317.71	19959.71	9979.857
Emissions abated through Reduction/Offsets	t -CO2e	0	-9508	-148754	-68347	-78313	-73249	-78384	-76047	-70918	-74999	-72102	-64277	-77461	-73402	-62836	-58616	-31581	0
Avoided Emissions	t -CO2e	0	0	-85887.5	-131909	-111230	-111201	-111239	-108947	-108947	-108947	-108947	-112145	-112262	-112390	-112178	-124906	-78549.7	-68424.5
Net Total Emissions	t -CO2e	15278	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	59231
Total Unmitigated Emissions	t -CO2e	15278	109508.1	334641.2	300256.1	289542.8	284450.5	289623	284994.8	279865	283946.7	281049.4	276422	289722.5	285791.9	275014.2	283522.6	210130.3	127656

Table 12-6 Emissions breakdown of the five key scope 1 emission sources. The units are tonnes of CO2 equivalent.

Year	Mine Facility - mine operation emissions (haul trucks and ancilliary) (t - CO2e)	Road Haulage Emissions (t - CO2e)	Power Station on Mine Facility (t - CO2e)	Rail Haulage Emissions (t - CO2e)	Vegetation Loss (t - CO2e)
2026	-	-	-	-	9,949
2027	29,760	-	-	-	64,962
2028	47,746	23,346	10,332	-	116,614
2029	52,463	48,444	20,665	9,619	7,746
2030	55,608	48,444	20,665	19,959	209
2031	48,608	48,444	20,665	19,960	1,821
2032	51,523	48,444	20,665	19,955	4,080
2033	53,082	48,444	20,665	19,960	-
2034	46,791	48,444	20,665	19,960	1,338
2035	51,679	48,444	20,665	19,960	837
2036	47,891	48,444	20,665	19,960	1,338
2037	44,365	45,003	20,665	19,960	662
2038	57,023	45,056	20,665	19,918	507
2039	53,442	45,056	20,665	19,933	-
2040	42,816	45,056	20,665	19,960	-
2041	44,406	32,485	20,665	19,960	358
2042	32,834	21,101	20,665	19,960	-
2043	-	10,550	10,332	9,980	-

Table 12-7 Offsets that may need to be purchased if reduction projects are unsuccessful

Year	Number of Offsets	Baseline	Offsets as a % of Baseline
2026	0	100,000	-
2027	9508	100,000	10%
2028	148754	100,000	149%
2029	68347	100,000	68%
2030	78313	100,000	78%
2031	73249	100,000	73%
2032	78384	100,000	78%
2033	76047	100,000	76%
2034	70918	100,000	71%
2035	74999	100,000	75%
2036	72102	100,000	72%
2037	64277	100,000	64%
2038	77461	100,000	77%
2039	73402	100,000	73%
2040	62836	100,000	63%
2041	58616	100,000	59%
2042	31581	100,000	32%
2043	0	100,000	-

12.4.2 Scope 2

Scope 2 emissions, associated with electricity or other energy commodities sourced from a third party, are not currently anticipated. Electricity will be source via on-site infrastructure (hybrid gas/solar power station or diesel generators).

12.4.3 Scope 3

The Scope 3 emissions associated with the Proposal will be greater than 100,000 t CO_2-e. The following information has been provided in this section:

- The estimate of scope 3 emissions.
- Activities to reduce scope 3 emissions.
- Where scope 3 emissions will be emitted.

Estimate of Scope 3 emissions

Scope 3 (indirect) emissions associated with the Proposal include GHG emissions associated with the supply of materials for construction of infrastructure and ongoing maintenance, fuel and energy related activities, transport and handling of ore through to the port, onward international transport via sea, and emissions associated with steel production.

Scope 3 emissions associated with the mining of ore have been considered against the 15 Scope 3 categories defined by the World Resources Institute (WRI 2013) in **Table 12-8**. Where requirements and logistics are uncertain at the current stage of Proposal development, emissions cannot be reasonably estimated at this time (detailed as "Not estimated" in the table below).

Table 12-8: Description and Boundaries of Scope 3 Categories

Category	Description	Relevance to Proposal	Emission Estimate (t CO2--e)
1. Purchased goods and services	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year	Upstream emissions associated with goods and services relevant to the operation and maintenance of the mine – requirements not yet fully determined.	Not estimated.
2. Capital goods	Extraction, production, and transportation of capital goods purchased or acquired by the reporting company in the reporting year	Upstream emissions associated with the supply of materials, plant and equipment for mine construction and operation– not determined in sufficient detail to derive and estimate.	Not estimated.
3. Fuel- and energy related activities (not included in scope 1 or scope 2)	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the reporting year, not already accounted for in scope 1 or scope 2, including: a. Upstream emissions of purchased fuels (extraction, production, and	Extraction, production and transportation of purchased gas and diesel to site – logistics not yet determined.	Not estimated

Category	Description	Relevance to Proposal	Emission Estimate (t CO2--e)
	transportation of fuels consumed by the reporting company)		
4. Upstream transportation and distribution	Transportation and distribution of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers and its own operations (in vehicles and facilities not owned or controlled by the reporting company). Transportation and distribution services purchased by the reporting company in the reporting year, including inbound logistics, outbound logistics (e.g., of sold products), and transportation and distribution between a company's own facilities (in vehicles and facilities not owned or controlled by the reporting company).	Transportation of purchased goods to site – logistics not yet determined. Emissions associated with ore handling at the port.	Not estimated. 12,000 t CO2-e/annum
5. Waste generated in operations	Disposal and treatment of waste generated in the reporting company's operations in the reporting year (in facilities not owned or controlled by the reporting company)	Disposal of mixed solid waste and wastewater will be limited to that generated by the administration and accommodation camp to be disposed of at facilities within the Proposal boundary. Third party waste disposal would be limited to disposal of speciality wastes such as hydrocarbons and are not expected to lead to significant quantities of Scope 3 emissions.	Not estimated
6. Business travel	Transportation of employees for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company)	Not reasonably quantifiable at this time.	Not estimated
7. Employee commuting	Transportation of employees between their homes and their worksites during the reporting year (in vehicles not owned or operated by the reporting company)	Not reasonably quantifiable at this time.	Not estimated
8. Upstream leased assets	Operation of assets leased by the reporting company (lessee) in the reporting year and not included in scope 1 and scope 2 – reported by lessee	No upstream leasing of assets expected at this time.	-
9. Downstream transportation and distribution	Transportation and distribution of products sold by the reporting company in the reporting year between the reporting company's operations and the	Shipping of 12 Mtpa at an intensity of 0.017 t CO_2-e/t iron ore (assuming a distance of 3,154 km and using the production variable default of 0.00000539 t CO_2-e/ net tonne km).	Sea freight: 204 000 t CO_2-e/annum

Category	Description	Relevance to Proposal	Emission Estimate (t CO2--e)
	end consumer (if not paid for by the reporting company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company)		
10. Processing of sold products	Processing of intermediate products sold in the reporting year by downstream companies (e.g., manufacturers)	Emissions from the use of 12 Mtpa of iron ore for steel production have been estimated assuming 1.6 t of iron ore are required to yield 1.0 t of steel[8], with an associated CO_2 emissions of 1.89 t CO_2-e[9].	14.38 Mt CO_2-e/annum
11. Use of sold products	End use of goods and services sold by the reporting company in the reporting year	Beyond the scope of current knowledge.	-
12. End-of-life treatment of sold products	Waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life	Beyond the scope of current knowledge.	-
13. Downstream leased assets	Operation of assets owned by the reporting company (lessor) and leased to other entities in the reporting year, not included in scope 1 and scope 2 – reported by lessor	No downstream leasing of assets expected at this time.	-
14. Franchises	Operation of franchises in the reporting year, not included in scope 1 and scope 2 – reported by franchisor	Not applicable.	-
15. Investments	Operation of investments (including equity and debt investments and project finance) in the reporting year, not included in scope 1 or scope 2	Not applicable.	-

Reduction of scope 3 emissions

Steelmaking

HPPL is exploring opportunities to collaborate to reduce upstream scope 3 emissions and partnering with key customers, collaborating with industry and engaging in research. This includes:

- A partnership with the Heavy Industry Low Carbon Transition (HILT) Cooperative Research Centre (CRC) (HILT CRC). By participating in collaborative research, we can expect to achieve better results than if we were acting independently. The HILT CRC brings together some of Australia's best and brightest researchers and like-minded industry partners to explore innovative new technology concepts. Roy Hill (a related party)

[8] https://worldsteel.org/steel-topics/raw-materials/
[9] https://worldsteel.org/publications/policy-papers/climate-change-policy-paper/

has joined HILT CRC as a Core Partner, which means not only have we made a financial commitment to support the CRC, but we're also lending some of our expertise.

- HPPL has partnered with the University of Melbourne regarding development of a new technology called Carbelec TM. CarbelecTM is an innovative technology that utilises electrolysis at low temperature to convert carbon dioxide (CO2) into reusable carbon and oxygen. The technology is applicable to existing blast furnaces, cement plants, other applications (e.g. Direct Air Capture).

Other initiatives:

HPPL has put in place the following initiatives with respect to their Scope 3 emissions

- Transport of ore via rail (from Hillside siding to Port Hedland) rather than the rail (subject to approvals) will lead to avoidance of Scope 3 emissions.
- Recycling materials and equipment from other site, including:
  - The crushing circuit is recycled from another site, meaning that no new steel had to be smelted for the construction of the plant.
  - Depending on the timing of construction of Mulga and decommissioning of other projects, the Proponent is considering the recycling equipment and material from other projects such as the electrical equipment associated with remote generation (transformers and switch gear).

Where scope 3 emissions will be emitted

As shown above, the majority of emissions are incurred the smelting of iron ore into steel. HPPL have yet to engage customers for the product from the Proposal. However, all the product will be exported to overseas market. A list of likely countries that would import the product and whether or not the party has signed up to the Paris Agreement or legislated carbon reduction (Table 12-5). If a party has done either, we are assuming it is reasonably likely that the scope 3 emissions will be subject to scope 1 or 2 emission reduction requirements.

Table 12-9: List of likely countries that would import the product

Country	Paris Agreement or legislated carbon reduction
Japan	Paris Agreement Signatory
China	Paris Agreement Signatory
Vietnam	Paris Agreement Signatory
India	Paris Agreement Signatory
Taiwan	Non party to Paris agreement Implemented Greenhouse Gases Emission Reduction and Management Act in July 2015 which has greenhouse gas reduction targets.
Korea	Paris Agreement Signatory
Malaysia	Paris Agreement Signatory

13 Air Quality

13.1 EPA Objective

The EPA's objective for the environmental factor Air Quality is:

"To maintain air quality and minimise emissions so that environmental values are protected" (EPA 2023a).

For this assessment, air quality is defined as *"the chemical, physical, biological and aesthetic characteristics of air"* (EPA 2020d).

13.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to this environmental factor that have informed the assessment of the Proposal are summarised in **Table 13-1**.

HPPL has specifically considered this guidance in the following ways:

- Completion of analyses to describe the receiving environment and its significance;
- Identification of activities that may lead to impacts on Air Quality; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 13-1: Relevant Policy and Guidance

Reference	Title	How policy and guidance has been considered
State		
Department of Environment and Conservation (DEC) (now DWER), 2011	Guideline for managing the impacts of dust and associated contaminants from land development sites remediation and other related activities.	This guideline has been used to develop the Asbestos Management Plan (**Appendix 17**) to mitigate potential impacts.
Department of Health, 2021	Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia.	This guideline has been used in the assessment of potentially asbestos-contaminated land within the Development Envelope and for the management of the potential impacts.
Department of Mines and Petroleum (now DMIRS), 2015	Management of Fibrous Minerals in Western Australian Mining Operations.	This document was used to develop the Asbestos Management Plan (**Appendix 17**) to mitigate potential impacts.
DWER, 2021a	Guideline: Managing asbestos at construction and demolition waste recycling facilities.	This guideline has been used to develop the Asbestos Management Plan to mitigate potential impacts.
DWER 2021c	Guideline: Assessment and management of contaminated sites.	This guideline informed the appropriate assessment methodology for potential asbestos impacts.
DWER, 2024b	Western Australian Contaminated Sites Auditor Scheme.	The Preliminary Environmental Site Assessment (**Appendix 13**) was subject to audit by an accredited auditor in accordance with this scheme.

Reference	Title	How policy and guidance has been considered
DWER, 2024a	Requirements for Mandatory Auditors' Reports.	The Preliminary Environmental Site Assessment **Appendix 13** was subject to a Voluntary Audit Report (**Appendix 14**)prepared following this guide.
EPA, 2020d	Environmental Factor Guideline: Air Quality	The potential impacts of the Proposal have been assessed against the EPA objective for this factor.
Work Health and Safety Commission, July 2022		
Commonwealth, 1998	National Environment Protection Measure for Ambient Air Quality (Air NEPM).	The Ambient Air Quality NEPM contains relevant criteria against which potential impacts to air can be assessed.
National Environment Protection Council (NEPC), 2013	National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM).	The ASC NEPM has been followed to assess potentially asbestos-contaminated land within the Development Envelope.
EPA (NSW), 2022	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.	The document contains relevant criteria against which potential impacts of dust deposition can be assessed.
Work Health and Safety Commission (DMIRS 2022b)	How to Safely Remove Asbestos: Code of Practice.	This document was used to develop the Asbestos Management Plan to mitigate potential impacts.
Safe Work Australia, 2020	How to manage and control asbestos in the workplace: Code of Practice.	This document was used to develop the Asbestos Management Plan (**Appendix 17)** to mitigate potential impacts.

Specific additional work required for assessment of the Proposal relating to the environmental factor Air Quality, was provided in the ESD, which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this chapter.

13.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to the Air Quality factor, including details of the surveys and studies undertaken to support the Proposal.

13.3.1 Relevant Studies

A summary of the studies relevant to air quality, undertaken for the Proposal and surrounding area is provided in **Table 13-2**. The assessment of potential impacts on air quality as a result of the Proposal uses information from these reports. The studies completed to inform the Proposal have been conducted in accordance with the relevant policy and guidance.

Table 13-2: Air Quality Studies

Reference	Title	Description	Guidance / Methodology
Ambient Air Quality (Particulates)			
SLR 2021a **Appendix 18**	Phase 2 Mulga East Iron Ore Project Ambient Air Quality Monitoring Program	SLR was engaged to undertake baseline ambient air quality monitoring around the Development Envelope, including continuous monitoring of PM_{10} concentrations at one location using a beta attenuation monitor (BAM) and monthly monitoring of dust deposition rates at three locations using dust deposition gauges.	The ambient monitoring was conducted in general accordance with *AS/NZS 3580.10.1:2016 Methods for sampling and analysis of ambient air: Determination of particulate matter - Deposited matter - Gravimetric method* and *AS/NZS 3580.9.11 Methods for sampling and analysis of ambient air: Determination of suspended particulate matter - PM10 beta attenuation monitors*, as amended by Amdt 1:2009).
Asbestiform Minerals and Asbestos Containing Material			
JBS&G, 2023a	Sampling and Analysis Quality Plan (SAQP)	The SAQP and PESA were designed to assess the potential presence or absence of natural asbestiform minerals resulting from both natural erosion and deposition and imported asbestos from anthropogenic activity within the Development Envelope.	The SAQP and PESA have been prepared in accordance with: • Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia (Department of Health [DoH], 2021); • National Environmental Protection (Assessment of Site Contamination) Measure 1999, as amended 2013; • With respect to WA Department of Water and Environmental Regulation (DWER) Contaminated Sites Guidelines, as amended 2021; and • Relevant Australian Standards (AS4482.1- Guide to the investigation and sampling of sites with potentially contaminated soil (non-volatile and semi-volatile compounds) and AS4482.2 – Guide to the sampling and investigation of potentially contaminated soil (Part 2: volatile substances)).
JBS&G, 2023b **Appendix 13**	Preliminary Environmental Site Assessment (PESA)		
Senversa, 2023 **Appendix 14**	Voluntary Auditors Report (VAR)	The audit was undertaken to independently assess the quality and veracity of the SAQP and PESA.	The VAR has been prepared in accordance with the Contaminated Sites Act, 2003 relevant DWER [formerly Department Environment Regulation (DER)] guidance including The Western Australian Contaminated Sites Auditor Scheme and Requirements for Mandatory Auditors' Reports.

13.3.2 Climate

A detailed description of the climate of the region is provided in **Section 3.4**; however, a summary of key climate information relevant to this factor is provided below.

The mean annual maximum temperature recorded at Karijini North is 34.3˚C and the mean annual minimum temperature is 20.3˚C. The mean maximum daytime temperature is highest in December, at 41.3˚C, and the mean minimum winter temperature is lowest in July at 12.1˚C (BoM 2023b).

Rainfall across the Pilbara region is seasonal and highly variable. It is possible for significant rainfall events to be recorded in one location with minimal rainfall being recorded at the nearest alternative weather station. The region may often experience up to 12 months of dry weather, with hot dry summers and mild winters. Rainfall is typically associated with cyclonic and storm weather systems (van Vreeswyk et al 2004).

Wind roses compiled from data recorded by the Karijini North automatic weather station (AWS) during the baseline air quality monitoring program (2019-2021) (SLR 2021a) are presented in **Figure 3-6**. The highest frequency of winds is from the eastern and south-southwestern quadrants. There is minimal change in the wind distribution between the wet and dry seasons.

Wind speeds during the SLR (2021a) baseline air quality monitoring program were above 5 m/s (the speed above which wind erosion of exposed surfaces generally occurs) for approximately 35% of the time. The corresponding long-term wet and dry season windspeeds indicate a similar distribution.

13.3.3 Ambient Air Quality (Particulates)

A desktop data gap analysis undertaken for the Proposal by SLR (2019) recommended a 12 month ambient air quality monitoring program to address a lack of publicly-available, representative air quality monitoring data in the Pilbara region. In a meeting with HPPL on 2 April 2019, DWER confirmed that a 12 month monitoring program was appropriate to establish a robust baseline for the Proposal and that the methodology proposed by SLR to obtain this data was acceptable. HPPL subsequently engaged SLR to undertake 12 months of continuous monitoring for fine particulates (as particulate matter with an aerodynamic diameter of less than 10 microns [PM_{10}]) at one location and bi-monthly dust deposition at three locations around the Development Envelope (**Appendix 18**).

SLR sited, installed and commissioned the monitoring equipment (with monitoring location shown in **Figure 13-1)** between 7 May 2019 and 9 May 2019 and performed monthly servicing, maintenance and reporting tasks throughout the monitoring period. The monitoring continued until 22 February 2021, beyond the original 12-month duration, due to COVID-19 and wet season conditions restricting site access.

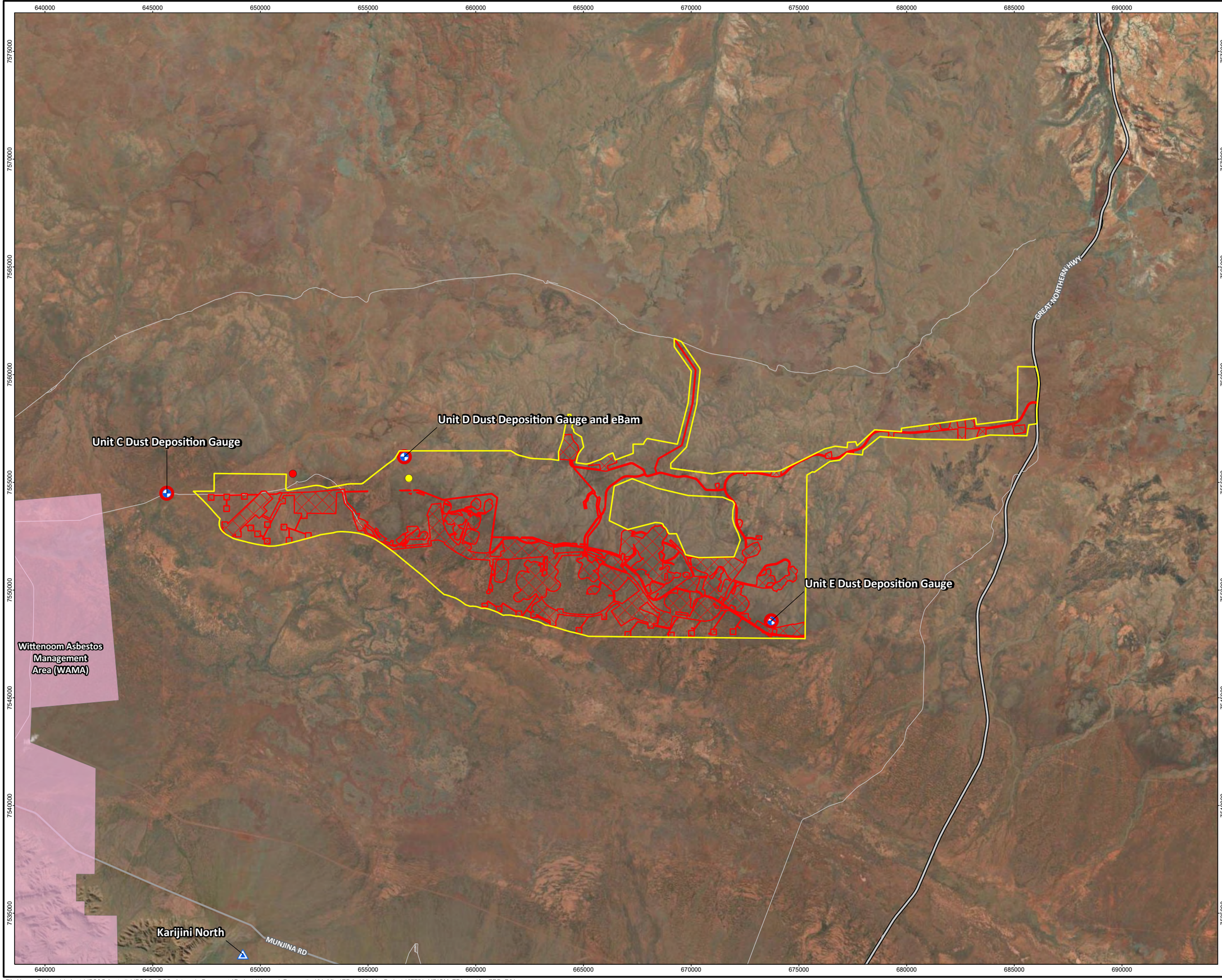
The baseline ambient air quality monitoring program concluded the following (SLR 2021a):

- The maximum measured 24-hour average PM_{10} concentration was 62 µg/m^3 in December 2019, which is below the adopted project criterion of 70 µg/m^3;
- The measured dust deposition rates were highest during the start of the wet season, with an average baseline dust deposition rate recorded over the three monitoring locations of 2.1 g/m^2/month (November 2019 to January 2020);
- High PM_{10} concentrations were identified under all wind directions – i.e., there was no correlation between PM_{10} concentration and windspeed or wind direction;
- Both PM_{10} concentrations and dust deposition rates were higher during the wet seasons than during the dry seasons; and

- No significant change in PM_{10} concentrations or dust deposition rates was evident between monitoring years.

The Pilbara is a naturally dusty environment with wind-blown dust being a significant contributor to the airborne dust levels. In 2000, Sinclair Knight Merz (SKM) was commissioned by the then WA Department of Environmental Protection (DEP) to prepare an Aggregated Emissions Inventory of National Pollutant Inventory (NPI) substances for the Pilbara Airshed for the NPI Database for the 1999 to 2000 financial year (SKM 2003). The study calculated that approximately 170,000 tonnes of dust were emitted because of wind erosion from open bare areas. The open bare areas were associated with eroded land on alluvial plains where over grazing and a run of poor seasons had exposed the soil. Where overgrazing had occurred on soils with little stony mantle for protection from wind erosion, severe erosion had occurred with soil loss due to wind action.

Figure 13-1: Air Quality Monitoring Locations



Legend

- Development Envelope
- Indicative Footprint
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)
- Air Quality Monitoring Sites
- Mulga Downs Exploration Camp (LGATE-013)
- Mulga Downs Homestead (LGATE-013)
- Automatic Weather Station (DPIRD-075)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 22-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:160,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

AIR QUALITY MONITORING LOCATIONS

FIGURE 13.1

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

13.3.4 Soils

As outlined in **Section** 3.10**3.10**, the most extensive soils within the region comprise shallow stony soils on hills and ranges and sand on the sandplains (Landloch 2009, Mine Earth 2021). The dominant soil groups occurring across the Development Envelope (Mine Earth 2021) are:

- Stony soils;
- Red shallow loams;
- Red loamy earths;
- Calcareous shallow loams; and
- Red-brown hardpan shallow loams.

Following heavy rainfall, red brown soils of the Pilbara can develop a hard surface crust, which can reduce the impact of wind erosion; however, disturbance of this crust through ground disturbance combined with low level rainfall can place these areas at risk of wind erosion, resulting in increased levels of airborne dust locally.

13.3.5 Geology

As discussed in **Section 3.93.9**, the bedrock within the Development Envelope comprises rocks of the Hamersley and Fortescue Groups. The Jeerinah Formation (Fortescue Group) and Marra Mamba Iron Formation outcrop in the Chichester Range on the northern side of the Fortescue Valley. The Wittenoom Formation subcrops beneath the valley floor and is overlain by the Brockman Iron Formation, which is a banded iron formation (BIF) within the Hamersley Range to the south. Tertiary deposits that infill the valley, collectively known as 'detrital', comprise alluvium, colluvium (both with varying degrees of iron cementation), pisolite, clay and calcrete. There is also lateritic hard cap development of Tertiary age on basement rocks that may be ferricrete (goethite) and calcrete/silcrete.

Asbestiform minerals are widely distributed in Western Australia, and amphibole and serpentine minerals are significant components of mafic and ultramafic rocks in the State's "greenstone belts". In the Pilbara, amphibole minerals may be encountered in the Brockman Iron Formation of the Hamersley Basin (DMP 2023). More specifically, crocidolite (the source of "blue" asbestos) is typically associated with the Dales Gorge Member of the Brockman Iron Formation (Grubb 1971). A thin (5 mm) band of crocidolite has also previously been identified in the Marra Mamba Iron Formation in the western Fortescue Valley (Barnett & Commander 1986).

Waste rock characterisation for the Proposal concluded that the mineralisation is primarily associated with the Nammuldi Member of the Marra Mamba Formation (that outcrops along the lower flanks of the Chichester Range), although there is also mineralisation in the overlying Tertiary detrital deposits.

As the ore body is located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, intersection of natural asbestiform minerals onsite (i.e., within the Brockman Iron Formation) during mining operation is low.

13.3.6 Hydrology

A comprehensive review of the hydrology of the Development Envelope is provided in **Section 3.113.11**. Surface water forms a potential pathway for asbestiform materials to be dispersed within the Development Envelope and to the wider surrounding area.

13.3.7 Historic Anthropogenic Activities

Asbestos Containing Materials are present in limited site structures within the Development Envelope as discussed in **Section 11.3.5**. Planning for the Proposal identified the potential for natural asbestiform minerals and anthropogenic ACM to be present within the Development Envelope, based on the proximity of the Development Envelope to the Wittenoom Asbestos Management Area (WAMA) (**Figure 13-1**).

Primary sources of ACM are from the known registered contaminated areas outside of the Development Envelope and surrounds. Secondary sources are from anthropogenic activities within the Development Envelope, including use of ACM within anthropogenic built forms (other than those already recorded as registered contaminated sites), and from miscellaneous historical dumping of ACM tailings.

13.3.8 Receptors

Receptors that have the potential to be impacted by reduced air quality (as shown in **Figure 14-2**:) include:

- Youngaleena and Wirrilimarra Aboriginal communities located 15 km south and 7 km southwest of the Development Envelope, respectively;
- Yandeyarra Reserve, located approximately 8 km to the north of the Development Envelope (6 km north of the Northern Access Road at Great Northern Highway);
- Karijini National Park – the northern boundary of the National Park is located approximately 16 km to the south of the Development Envelope;
- The Mungaroona Range Nature Reserve is approximately 13 km to the north of the Development Envelope;The eastern extent of the Development Envelope abuts Great Northern Highway, and the intersection of the Wittenoom-Mujina Road is approximately 20 km south.
- The Fortescue Valley which comprises a network of interconnected ephemeral swamps, claypans and floodplains (Goodiadarrie Swamp);
- The Koodjeepindarranna and Gnalka Gnoona claypans are a major hydrological feature located outside the Development Envelope. They are considered significant habitats for migratory and local birds and invertebrate species during inundation;
- Vegetation, and flora and fauna species within and surrounding the Development Envelope; and
- Heritage sites or potential places of cultural significance, including the lodged site ‘Mungurrdu’ located to the south of the Development Envelope.

13.4 Potential Impacts

An assessment of the potential impacts of the Proposal on air quality values in consideration of the EPA’s objective is provided below. Relevant assessment criteria are also provided.

13.4.1 Direct Impacts

13.4.1.1 Volatile Emissions and Airborne Particulates (Dust)

Construction and operation of the Proposal have the potential to generate volatile emissions (including NO_x and SO_x) through the combustion of diesel for electricity generation, operation of mobile plant and vehicles, and from explosives.

There are a number of activities associated with construction and operation of the Proposal which may give rise to dust emissions, including:

- Clearing of vegetation, removal and stockpiling;
- Wind erosion and dust lift off from stockpiles and unsealed surfaces;
- Heavy plant, haul trucks and light vehicle movements on unsealed surfaces causing disturbance of surface and suspension of fine particles in the air;
- Dust generated by surface disturbance during plant movement, blasting, movement of materials, and tipping of ore from trucks (i.e., fine material from within trucks or fine material disturbed from receiving surface); and
- Particulates emitted to air from the combustion of diesel for electricity generation, operation of mobile plant and vehicles, and from explosives (emissions are predicted to be negligible in the context of the remote location of the Proposal).

Airborne dust (PM_{10}) emissions can impact human health and result in amenity impacts or impacts on ecological or social values through deposition and inhalation pathways.

13.4.1.2 Asbestiform Minerals and Asbestos Containing Material

Asbestiform minerals and ACM may occur within the Development Envelope through the geological and hydrological pathways identified in **Section 33.11** above. These have the potential to be uncovered through activities associated with the Proposal and transported through air, impacting air quality within the Development Envelope and surrounding area. Sources of airborne asbestos with the potential to be carried by the wind to off-site receptors due to Proposal activities include:

- Site exploration and drilling - unintended surfacing of natural asbestiform minerals within the Brockman Iron Formation;
- Demolition and maintenance of existing structures - disturbance of ACM building materials within ancillary structures such as tank stands and bore infrastructure, and in the classified asbestos-contaminated area (registered ID 7303) associated with the former Mulga Downs homestead (JBS&G 2023); and
- Movement of material that was historically illegally dumped - disturbance of ACM historically imported into the Development Envelope, including as a construction base for new infrastructure or as dumped waste.

13.4.2 Indirect Impacts

Changes in air quality due to dust emissions have the potential to indirectly impact flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings.

Deposited dust may indirectly impact the health of vegetation, flora and fauna habitat within the Development Envelope. Detrimental effects on the health of the vegetation may potentially occur in susceptible species because of smothering the physiological processes of the plants. Similarly, deposited dust may impact the amenity of Aboriginal heritage areas.

13.4.3 Cumulative Impacts

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope over the life of mine. The Proposal may result in a minor, temporary increase in localised dust. Given proximity, cumulative dust emissions may arise from the Murray's Hill and Mulga Downs Hub and Rail projects located in the immediate vicinity of the Proposal.

The cumulative impacts associated with air quality during the construction and operation of the Proposal and other projects are discussed in more detail in **Section 17**.

13.5 Mitigation Measures

The hierarchy of impact management has been adopted and implemented for the Proposal by HPPL in relation to this environmental factor as outlined in **Table 13-3**.

Table 13-3: Mitigation Measures

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Direct Impacts			
Air quality impacts may occur due to volatile emission and fugitive dust (PM_{10}) emissions resulting from the following Proposal.	• Complete avoidance of volatile emissions and dust is not possible.	• Standard dust management measures will be utilised to minimise dust emissions, including: o Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; o Vehicle speeds limit on haul roads, work areas and campsites will be imposed and enforced where necessary to minimise dust emissions; o No vegetation clearing and earthworks during wind speed greater than 50 km/hr; and o Clearing activities will be staged to minimise areas of exposed surfaces. • Induction and education of the workforce and contractors with respect to dust minimisation.	• Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities. • Any dust complaints received will be reported to HPPL and entered into the incident management system.
Emissions of asbestos to air due to the presence of potential sources of airborne asbestos fibre.	• Asbestos contaminated areas will be clearly demarcated and access restricted. • Known asbestos contaminated area (abandoned infrastructure area) has been excised from DE, and access to site structure containing ACM will be restricted	• Adherence to the AMP (**Appendix 17**).	• If ACM is found onsite during construction and operation, it will be remediated as per AMP; • Asbestos management will be subject to monitoring through the AMP.

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Indirect Impacts			
Changes in air quality due to dust emissions have the potential to indirectly impact flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings.	• Complete avoidance of dust is not possible.	• Standard dust management measures will be utilised to minimise dust emissions, including: o Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; o Vehicle speeds on haul roads, work and campsites shall be reduced where necessary to minimise dust emissions; o No vegetation clearing and earthworks during winds greater than 50 km/hr; and o Clearing activities will be staged to minimise areas of exposed surfaces. • Induction and education of the workforce and contractors with respect to dust minimisation.	• Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities. • Any dust complaints received will be reported to HPPL and entered into the incident management system.

13.6 Assessment and Significance of Residual Impact

An assessment of the significance of residual impacts to air quality as a result of the Proposal is addressed in this section.

13.6.1 Direct Impacts

13.6.1.1 Volatile Emissions and Airborne Particulates (Dust)

Volatile emissions (including NO_x and SO_x) generated from the Proposal are expected to have negligible impact on air quality.

Assessment Criteria – PM_{10}

The *National Environment Protection Council (NEPC) (Commonwealth) Act 1994* established the NEPC, which determines and evaluates NEPMs for the nation. The *National Environment Protection Council (Western Australia) Act 1996* is a mirror legislation of the commonwealth act and implements the NEPMs in Western Australia.

Air quality criteria are derived from the Air NEPM, which provides air quality standards applicable to urban airsheds, including criteria for particles such as PM_{10}. In Western Australia, the Air NEPM criteria are applied to sensitive receptors, defined as residences, hospitals, schools and other places where people may congregate, including sporting and recreational venues. The remoteness, low population and the high ambient dust levels within the Development Envelope and surrounds mean that these criteria are not directly applicable to the Proposal.

Although DWER does not have generic PM_{10} criteria applicable to remote mining operations, it has previously accepted that the Air NEPM PM_{10} standard cannot be met in the Pilbara region, recognising that its arid climate between June and November and areas of low vegetative cover can lead to periodic dust events caused by wind erosion of exposed surfaces.

The Port Hedland Dust Management Taskforce, established to plan for and coordinate dust management in the town, recommended an air guideline value (AGV) for PM_{10} of 70 µg/m^3 averaged over 24 hours. The AGV was based on the recommendations of a report commissioned by the Department of Health (Lung Institute of Western Australia Inc and Institute of Occupational Medicine 2007). The Western Australian Government has endorsed the AGV for residential areas of Port Hedland, and the value has been used to assess other mining Proposals in the Pilbara region.

Assessment Criteria - Dust Deposition

Without a Western Australian-specific guideline for deposited dust rates, guidelines from other state regulations have been sought. The New South Wales EPA has a dust assessment criteria of 4 g/m^2/month, with a maximum allowable increase of 2 g/m^2/month (NSW EPA 2022). These criteria are based on the outcomes of a study of

community perception of coal dust impacts and are frequently adopted as informal assessment criteria in the absence of other guidance. These criteria have been adopted for this assessment.

13.6.1.2 Expected Impacts

The ambient air quality monitoring program established a baseline for the Proposal. The monitoring determined an average dust deposition rate recorded over the three monitoring locations of 2.1 g/m^2/month. This background level would result in the adopted Proposal criteria of 4 g/m^2/month including background and 2 g/m^2/month excluding background being approximately equivalent. In addition, the ambient air quality monitoring program concluded that measured PM_{10} concentrations were below the adopted assessment criteria of 70 $\mu g/m^3$.

Given the large separation distances to residential receptors (the closest being the Wirrilimarra Community 7 km east of the Development Envelope), there are no sensitive human receptors with the potential to experience health or amenity impacts attributable to fugitive dust emissions carried in the air from the Proposal. In addition, winds are predominantly from the east and south-southwest, and both the Wirrilimarra Community and Youngaleena Community are located south of the Development Envelope; so both communities are located in upwind locations.

Dust may also interfere with the physiological processes of vegetation. However, the semi-arid environment of the Pilbara region is a naturally dusty environment, with wind-blown dust a significant contributor to ambient particulate levels in the region; hence, native vegetation is expected to be reasonably tolerant to dust deposition. Studies undertaken for Rio Tinto (Butler 2009) suggest that the potential for adverse dust deposition impacts on plants is seasonally related. The study failed to identify any significant loss of plant function for exposures of Pilbara species to deposited crustal dust loadings on plant leaves of up to 7,500 g/m^2. Another study by Matsuki et al. (2016) found no evidence of negative impacts on plant health from dust deposition in semi-arid environments.

13.6.1.3 Asbestiform Minerals and Asbestos Containing Material

The PESA concluded that there is a low risk of asbestos from existing structures, ground contamination (in-situ or from erosional deposition) or unexpected finds causing human health impacts at receptors through an inhalation pathway. Following implementation of mitigation measures the residual impact is considered low.

13.6.2 Indirect impacts

The significance of indirect air quality impacts to flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings are discussed in **Sections 8, 10, 11** and **14**, respectively**.**

13.7 Significant Residual Impact

Overall, the assessment of potential air emissions impacts indicates that the EPA's objective for Air Quality can be met and that there will be no significant residual adverse impacts from the Proposal. In addition,

consideration of other statutory decision-making processes (**Section 4.6**) determined that DWER can manage the potential air quality impacts of the Proposal under Part V of the EP Act and the CS Act to ensure that the environmental outcomes in **Section 13.8** are achieved.

Given that no significant residual impacts are predicted for this environmental factor, HPPL considers that the Proposal can be managed to meet the EPA's objective for Air Quality.

13.8 Environmental Outcome

The outcomes of the assessment of potential impacts and proposed mitigation measures to reduce air quality impacts as a result of the Proposal meet the EPA's objective for this environmental factor. The predicted environmental outcomes are outlined in **Table 13-4**.

Table 13-4: Air Emissions Environmental Outcomes

Potential impact	Environmental Outcome
Dust (PM_{10} concentration or dust deposition)	No significant changes to ambient air quality (PM_{10} concentration or dust deposition) at sensitive receptor locations due to the implementation of the Proposal.
Volatile emissions	Negligible.
ACM and asbestiform minerals	Low risk of activities associated with the Proposal causing disturbance to ACM and asbestiform minerals within the Development Envelope and subsequent human health impacts on receptors.

14 Social Surroundings

14.1 EPA Objective

The EPA's objective for the environmental factor Social Surroundings is:

"to protect social surroundings from significant harm" (EPA 2023d).

Social Surroundings is defined in the EP Act as follows:

"In the case of humans, the reference to social surroundings in the definition of environment in subsection (1), is a reference to aesthetic, cultural, economic and other social surroundings to the extent to which they directly affect or are affected by physical or biological surroundings (section 3(2))."

14.2 Policy and Guidance

In addition to the legislation, policy and guidance outlined in **Section 4.1**, specific legislation, policy and guidance relevant to the social surroundings factor that has informed planning for the Proposal is summarised in **Table 14-1**.

HPPL has specifically considered this information for the social surroundings factor as described in **Table 14-1**, which includes:

- Description of the receiving environment and its significance in analyses undertaken to-date and proposed analyses;
- Identification of activities which may lead to impacts on social surroundings; and
- Application of the mitigation hierarchy in elements of Proposal design for potential impacts on social surroundings.

Table 14-1: Social Surroundings Policy and Guidance

References	Title	How Policy/Guidance has been considered
EPA 2023d	Statement of environmental principles, factors, objectives and aims of EIA	Referenced in completion of all aspects of environmental impact assessment.
EPA 2023c	Environmental Factor Guideline: Social Surroundings	Considered in the design (methods and approach) of the social surroundings surveys/ consultation.
EPA 2023e	Technical Guidance: Environmental impact assessment of Social Surroundings – Aboriginal cultural heritage	Considered in the impact assessment for social surroundings.
EPA 2004	Guidance Statement for the Assessment of Aboriginal heritage; No. 41	
DPLH 2023	Aboriginal Heritage Act 1972 Guidelines	
DWER 2021d	Draft Guideline: Assessment of environmental noise emissions	

References	Title	How Policy/Guidance has been considered
DWER 2021e	Draft Guideline: Dust emissions	

Other policy and guidance that are relevant for social surroundings is outlined in **Table 14-2**, including descriptions of how the policy and guidance was considered.

Table 14-2: Other Policy and Guidance

Author	Title	How Policy/Guidance has been considered
EPA 2024a	Instructions: How to prepare and environmental review document	Considered in the development of this ERD.
EPA 2021	Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual	
EPA 2024b	Instructions: How to prepare *Environmental Protection Act 1986* Part IV environmental management plans	Considered in the development of this ERD and for environmental management plans.
DCCEEW 2023	Interim Engaging with First Nations People and Communities on Assessments and Approvals under the Environment Protection and Biodiversity Conservation Act 1999	Considered during engagement with Traditional Owners and the development of this ERD.
DAA & DPC 2013	Aboriginal Heritage Due Diligence Guidelines.	
DMIRS 2023a	Mine Closure Plan Guidance – How to Prepare in Accordance with Part 1 of the *Statutory Guidelines for Mine Closure Plans.*	Considered in the development of this ERD and for the MCP (**Appendix 3**).
DMIRS 2023b	Statutory Guidelines for Mine Closure Plans	
IAP2 Federation. 2015.	Quality Assurance Standard for Community and Stakeholder Engagement	

Specific additional work required for assessment of the Proposal, relating to the environmental factor Social Surroundings, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

14.2.1 Native Title Act 1993

The *Native Title Act 1993* (Cth) recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters, according to their traditional laws and customs.

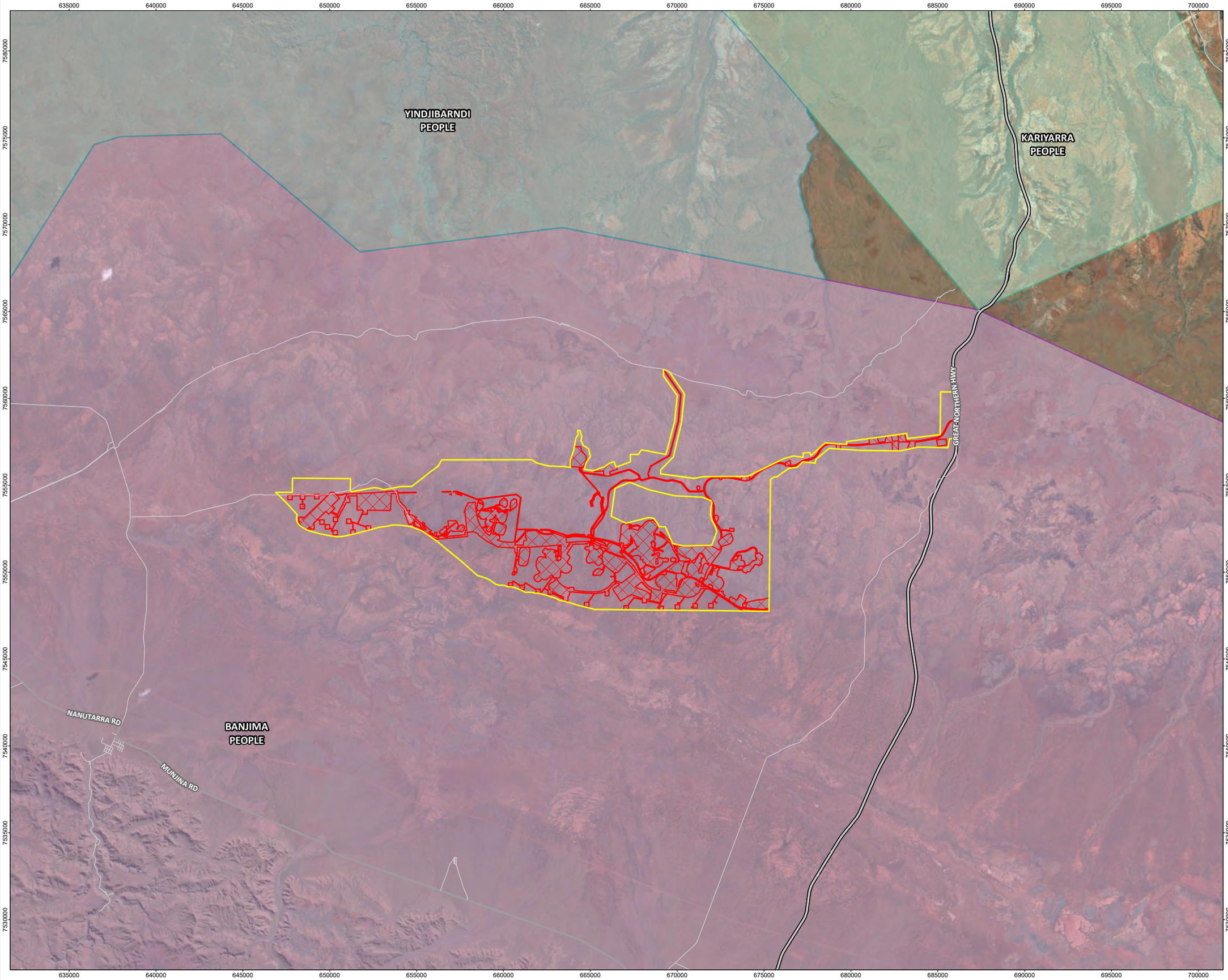
The Proposal is located within the Banjima native title determination area (**Figure 14-1**). The Banjima Traditional Owners hold native title rights and interests over approximately 10,185 km^2 as determined by the Federal Court in WAD6096/1998. The Banjima Traditional Owners are represented by the Banjima Native Title Aboriginal Corporation RNTBC (**BNTAC**).

A heritage agreement is in place between HPPL and the Banjima People. HPPL is in the process of negotiating a native title agreement with BNTAC, which will cover the implementation of the Proposal as it impacts the Banjima native title determination area. The negotiation process has timeframes inbuilt for BNTAC to consult with affected native title holders as required by the *Native Title (Prescribed Body Corporate) Regulations 1999* (Cth). Ongoing consultation will continue throughout the life of the Proposal through the implementation of the proposed Project Agreement (refer to **Section 5.2.2;**).

14.2.2 Aboriginal Heritage Act 1972

The AH Act sets out a framework for the management of Aboriginal heritage in Western Australia. The AH Act protects and manages Aboriginal heritage by requiring approval for activities that may impact or cause harm to an Aboriginal heritage site. HPPL is committed to the protection of Aboriginal cultural heritage and compliance with the AH Act.

Figure 14-1: Traditional Owner Native Title Determination Area



Legend

- Development Envelope
- Indicative Footprint

Native Title Determination (LGATE-066)

- Banjima People
- Kariyarra People
- Yindjibarndi People
- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 08-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:200,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TRADITIONAL OWNER NATIVE TITLE DETERMINATION AREAS

FIGURE 14.1

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

14.3 Receiving Environment

Defining the values of the receiving environment in terms of Social Surroundings necessitates consultation with the Banjima Traditional Owners, who have a long-standing relationship with Banjima Country that is woven into their social and cultural frameworks. Other relevant stakeholders (as listed in Section 14.3.3) have also been consulted. The receiving environment has environmental values that are largely consistent with the environmental values framework used by the EPA to evaluate the impacts and acceptability of Proposals. Social surroundings consultation is used to identify values and uses of the land beyond the generally expected environmental values assessed in other sections of this ERD.

14.3.1 Relevant Studies

A summary of the surveys and studies undertaken for the Proposal to support the understanding Social Surroundings aspects of the receiving environment, potential impacts and management is provided in **Table 14-3**. The assessment of potential impacts to Social Surroundings as a result of the Proposal draws on information from these reports**.**

Table 14-3: Social Surroundings Surveys and Studies

Reference	Report	Description	Guidance / Methodology
Ongoing – Baseline Dust and Noise Sampling at Youngaleena and Wirrilimarra Communities	N/A – Ongoing for 12-month monitoring period	Unattended background noise monitoring is currently being conducted at one location within the Youngaleena Community. which commenced in August 2024 and will continue until August 2025. This noise monitoring is being undertaken to provide an indication of the existing noise environment before any earthworks / construction activities for the Proposal commence. Data collection for baseline dust includes continuous monitoring of PM10 concentrations using a beta attenuation monitor and monthly monitoring of dust deposition rates in terms of grams of dust per month (mg/m^2/month).	Australian Standard 1055. *National Environmental Protection Council Act 1994* (NEPC Act; Cth) National Environment Protection (Ambient Air Quality) Measure (1998, as amended 2021) (National Environmental Protection Council 1994) NEPC Act National Environment Protection (National Pollutant Inventory) Measure (1998, as amended 2008) (National Environmental Protection Council 1994) Air Quality Modelling Guidance Notes (WA Department of Environment 2006) Guideline for managing the impacts of dust and associated contaminants from land development sites remediation and other related activities (WA Department of Environment and Conservation 2011) Environmental Factor Guideline: Air Quality (EPA 2020d) Guideline: Management of diesel emissions in Western Australian mining operations (Department of Mines and Petroleum 2013) Guideline: Management of noise in Western Australian mining operations (Department of Mines and Petroleum 2014)
Aboriginal Cultural Heritage Management (ACHM) 2024 **Appendix 25** **Section 14.3.4.2**	Report of an ethnobotanical survey of Mulga Downs Iron Ore Mine & Hub and Rail Spur	An assessment of flora within the Development Envelope that may be of cultural value to the Banjima People. The assessment included desktop and on-ground survey components.	Not applicable.

Reference	Report	Description	Guidance / Methodology
ACHM 2007- Ongoing **Section 14.3.4**	Archaeological Surveys (64) Ethnographical Surveys (6)	Archaeological surveys (site avoidance and site identification) have been ongoing at Mulga Downs since 2007 to support activities undertaken in this area. Heritage surveys are undertaken collaboratively with respective Traditional Owners. To date, 85% of the Development Envelope has been archaeologically surveyed to site avoidance level and 95% of known ACH within the Indicative Footprint has been surveyed to site identification level. 100% of the Development Envelope has been ethnographically surveyed. The remaining 15% of the Development Envelope will be surveyed for archaeological site avoidance in 2025, and prior to any construction works being undertaken. The results of the surveys undertaken to-date have informed the Proposal design, with amendments being made from the original referral to reduce impacts (**Table 14-7**, **Section 14.5**). The results of future surveys will continue to inform the detailed design of the Proposal, with the focus being to avoid and then minimise impacts to identified sites of heritage significance. These surveys will also inform the required approvals under the AH Act.	Conduct surveys sufficient to determine if an area meets the requirements of a Heritage Site as defined by Section 5 of the AH Act.
LGA 2024 **Appendix 27** **Section 14.6.2.2**	Noise and Vibration Assessment	An assessment of the potential noise and vibration impacts from the Proposal on surrounding noise sensitive receptors including the Youngaleena and Wirrilimarra Communities, heritage sites and bat caves.	Environmental Protection (Noise) Regulations 1997
Ecoscape 2024 **Appendix 21** **Section 14.6.1**	Visual Impact Assessment	Ecoscape undertook a Visual Impact Assessment (VIA) to support assessment of the Proposal based on analysis of seven representative viewpoints and associated photomontages created through 3D modelling. The receptor types were categorised as:	Visual Landscape Planning in Western Australia 2007 Guidance Note for Landscape and Visual Assessment, Australian Institute of Landscape Architects, 2018 provides guidance aimed at landscape architects which sets out minimum requirements and an accepted set of assessment methods;

Reference	Report	Description	Guidance / Methodology
		Culturally significant: including Aboriginal meeting places and culturally significant locations; **Residential:** including communities and camps; **Tourism:** including tourist facilities, attraction, hiking trails and accessible vantage points; and **Transient:** including roads and railways.	Guidelines for Landscape and Visual Impact Assessment (GLVIA), Third Edition (2013) prepared by the Landscape Institute and Institute of Environmental Management and Assessment. These guidelines provides detailed advice on the process of assessing the landscape and visual effects of developments and their significance, as well as cumulative effects
SLR 2021b **Appendix 19** **Section 14.4.3.2**	Ambient Noise Monitoring Program	Unattended background noise monitoring was conducted between May 2019 to February 2021 at two representative locations around the Development Envelope to provide an indication of the existing noise environment before any earthworks / construction activities commenced.	Australian Standard 1055.
SLR 2021 **Appendix 18** **Section 13.3.3**	Ambient Air Quality Monitoring Program	An ambient air quality monitoring program (from May 2019 to February 2021) was undertaken to address the lack of publicly available representative air quality monitoring data relevant to the location. SLR was engaged to undertake ambient air quality monitoring around the Mulga East proposed tenement, including continuous monitoring of PM10 concentrations at one location using a beta attenuation monitor and monthly monitoring of dust deposition rates in terms of grams of dust per month (mg/m2/month). .	*National Environmental Protection Council Act 1994* (NEPC Act; Cth) National Environment Protection (Ambient Air Quality) Measure (1998, as amended 2021) (National Environmental Protection Council 1994) NEPC Act National Environment Protection (National Pollutant Inventory) Measure (1998, as amended 2008) (National Environmental Protection Council 1994) Air Quality Modelling Guidance Notes (WA Department of Environment 2006) Guideline for managing the impacts of dust and associated contaminants from land development sites remediation and other related activities (WA Department of Environment 2011) Environmental Factor Guideline: Air Quality (EPA 2020) Guideline: Management of diesel emissions in Western Australian mining operations (Department of Mines and Petroleum 2013)

Reference	Report	Description	Guidance / Methodology
			Guideline: Management of noise in Western Australian mining operations (Department of Mines and Petroleum 2014)
PSM 2024 **Appendix 28 Section 14.6.2.2**	Geotechnical Assessment of Caves	PSM (2024) was engaged to undertake geotechnical assessments of caves located within the Development Envelope and in close proximity to the northern extent of Fridge Hill pit, to understand potential impacts of the Proposal as a result of blasting and operational vibration	NA
AQ2 2024a **(Appendix 4) Section 7**	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies – Baseline Assessment (171X_492a)	Baseline groundwater, surface water and ecohydrological studies, to support the environmental assessment of the Project. This report details all baseline and conceptualisation work undertaken from 2018 until November 2023	NA
AQ2 2024b (**Appendix 5**) **Section 7**	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies - Impact Assessment (171X_493a)	This assessment provides an environmental impact assessment of the Proposal, identifying key environmental assets and water management strategies.	NA
ACHM 2024b **(Appendix 30) Section 14**	Banjima Social Surroundings Assessment 6-10 May 2024	Report summarises environmental matters raised by Banjima People during a social surrounds consultation for the Mulga Mine Proposal.	NA

14.3.1.1 Ambient Noise

Typical Noise levels of 35 to 40 dB LAeq,15min between 11am to 6pm, then reducing to 23 dB (Minima) and 29 dB (Median) at Night. Key contributors to ambient sound levels are wind behaviour and distant road traffic from Great Northern Highway, and local fauna (insects).

Ambient noise levels broadly increase in warmer months of the year:

- December to March inclusive, LAeq 30-35 dB at night, and 35-40 dB during the day.
- April to November inclusive, LAeq 20 dB at night, and 33-39 during the day.

Under specific weather conditions such as high wind or rain, ambient sounds levels often exceeded night time Assigned Noise Levels.

14.3.1.2 Ambient Dust

The findings of the baseline ambient air quality monitoring program undertaken by SLR (2021a) are discussed in **Section 13.3.3**.

14.3.2 Location and Land Use

The Proposal is located in a remote area of the Pilbara region of WA. The Development Envelope comprises an area of 16,348.53 ha, with an Indicative Footprint of 4,339.16 ha. The nearest town is Tom Price which is located approximately 110 km southwest of the Development Envelope. Port Hedland is located approximately 210 km north, whilst Newman is located approximately 180 km east.

The area within and surrounding the Proposal is dominated by low rocky hills. The location of the Development Envelope avoids topographical features such as large hills or rivers. The visual landscape of the region would generally be described as being natural in appearance with disturbance being limited to pastoral and mining land uses with sparse roads and rail lines. The land uses identified within and adjacent to the Development Envelope are:

- Cultural – the Proposal is situated on the Banjima Native Title determination area;
- Residential - local communities of Youngaleena and Wirrilimarra;
- Tourism – generally passing traffic travelling along the Great Northern Highway;
- Mining - currently no other active mines within 20 km; and
- Transient - roads and railways.

These land uses are discussed below in the context of sensitive receptors.

14.3.2.1 Sensitive Receptors

Two remote Aboriginal Communities are located within the vicinity of the Proposal. The Youngaleena Community is located approximately 15 km south of the Development Envelope, and the Wirrilimarra Community is located approximately 7 km east of the Development Envelope.

Aboriginal heritage values and cultural associations including heritage and ethnographic sites, and are discussed in further detail at 14.3.4.

Wittenoom is located approximately 5 km west of the Development Envelope but no longer has any residents, as the town was degazetted in 2007 and closed in 2013 (DPLH 2021). Wittenoom was originally established as a mining town to support the mining and production of asbestos and was closed due to the health risk. The Wittenoom Asbestos Management Area (WAMA) was established to identify the mine-affected area as a contaminated site and manage impacts from the asbestos contamination.

The Yandeyarra Aboriginal Reserve is located approximately 8 km north of the Development Envelope. The reserve comprises an area of 473,529 ha and is managed by the Mugarinya Community Association Incorporated.

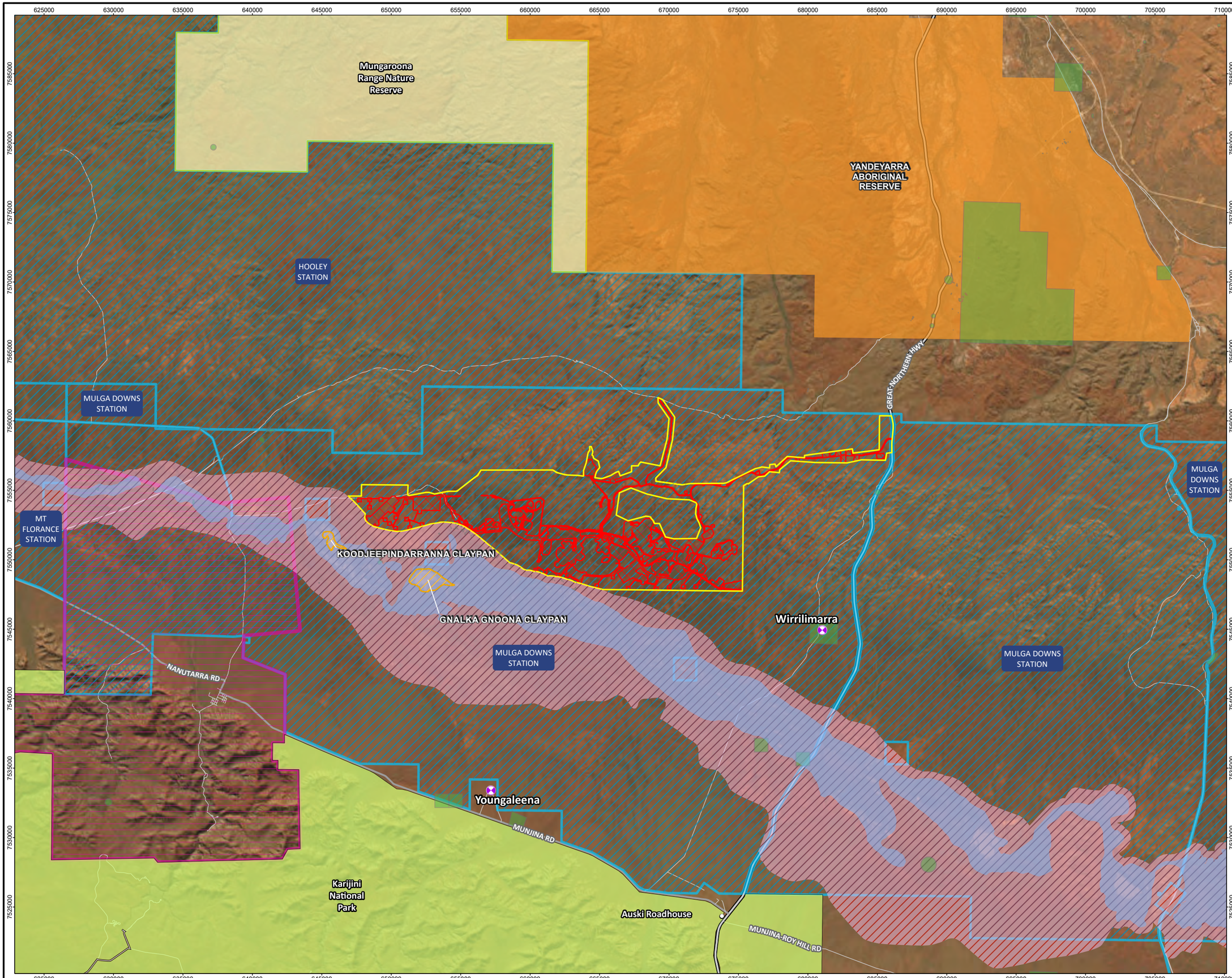
The Development Envelope is located entirely within the boundaries of the Mulga Downs Pastoral station. The land is mainly used for pastoral activities and is also used by Traditional Owners for hunting and other culturally significant purposes. Within the Mulga Downs Pastoral Station is the Mulga Downs Homestead, located directly north of the Development Envelope (**Figure 14-2**:). The Mulga Downs Homestead is uninhabited and has been identified as a contaminated site, which has been fenced off to restrict access.

Tourism in the immediate area surrounding the Development Envelope is very limited. Accommodation is provided (motel and caravan) at the Auski Roadhouse which is located approximately 24 km to the south east of the Development Envelope at the junction of Great Northern Highway and Nanutarra-Munjina Road. Roads through the Development Envelope are associated with access to the Mulga Downs Pastoral facilities and exploration drilling and are not generally used for tourism. The nearest major tourist attraction is the Karijini National Park and the associated gorges within the park. The northern boundary of Karijini National Park is located approximately 7.6 km south of the Development Envelope.

The Mungaroona Range Nature Reserve is approximately 13 km north of the Development Envelope.

The location of the Proposal in relation to sensitive receptors is shown on **Figure 14-2**:

Figure 14-2: Land use and sensitive receptors



Legend

- Development Envelope
- Indicative Footprint
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)
- Lodged Site - Mungurrdu or Mangurrdu (DPLH-100)
- Lodged Site - Other (DPLH-100)
- Yandeyarra Aboriginal Reserve (LGATE-227)
- Pastoral station boundaries (DPIRD-018)
- Claypans (AQ2)

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes [WA066]
- Aboriginal Communities and Town Reserves (DPLH-002)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:250,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LAND USE AND SENSITE RECEPTORS

FIGURE 14-2

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

14.3.3 Social Surroundings Consultation

HPPL has undertaken extensive consultation with a range of different stakeholders (Section 5), with consultation related to Social Surroundings addressed below. Social Surroundings consultation requirements were upgraded by the EPA in 2016 to include recognition of the potentially significant impacts on culture and country for Traditional Owners. This subsequently became a Key Environmental Factor for many environmental impact assessments under Part IV of the EP Act and is now industry-best practice for Traditional Owner consultation, impact identification and impact mitigation. Regarding Wirrilimarra Community, Youngaleena Community and Yandeyarra Community HPPL wishes to understand concerns of the communities relevant to the Proposal; and ensure the Proposal does not unacceptably impact these communities.

14.3.3.1 Methodology

The Banjima Traditional Owners were identified as a stakeholder as well as other communities in proximity of the Proposal. General stakeholder identification processes were used to plan the overall consultation. This identified the nearby communities and infrastructure located in close proximity to the Development Envelope.

14.3.3.2 Banjima consultation

HPPL has undertaken extensive consultation with the Banjima Traditional Owners through BNTAC since 2021, including several agreement negotiation meetings, Hancock Heritage and Environment Reference Committee (HHERC) meetings, on-country consultations, ethnobotanical surveys, heritage surveys and meetings with BNTAC's technical advisors. HPPL is in the process of negotiating a native title agreement with BNTAC, which will cover the implementation of the Proposal as it impacts the Banjima native title determination area. HPPL has been working with BNTAC to understand the potential impacts of the Proposal on Banjima country.

Consultation undertaken to date with Banjima Traditional Owners is detailed within **Section 5.**

HPPL has been consulting with Banjima in regard to:

- understand the social surroundings of the area important to the Banjima people; and
- developing a SCHMP for the Proposal.

Social Surroundings consultation undertaken to date with Banjima native title holders has incorporated:

- Introduction to Social Surroundings and the consultation process;
- Environmental approvals process;
- Introduction to the Proposal, associated infrastructure, mine planning, Indicative Footprints and closure landforms;
- Overview of Environmental and Heritage studies, monitoring and surveys completed;
- Flora and fauna management;
- Technical presentation/discussion: Hydrogeology, groundwater management and downstream risks;
- Water transfer infrastructure;
- Closure planning;

- Waste rock characterisation;
- Technical presentation/discussion: Waste characterisation;
- Surface water and potential impacts on pools/claypans;
- Airport operation and potential associated noise;
- Cumulative impacts to country; and
- Outline of the use of an SCHMP to define ongoing management and consultation of issues of significance to Traditional Owners that require ongoing management and communications throughout implementation of the Proposal.

Through this consultation, the Banjima People have been provided the opportunity to voice any potential concerns they may have and have been able to work with HPPL to identify suitable mitigation and management measures, which are summarised in **Section 14.4.1**.

The on-country consultation sessions were arranged to provide on-ground access with a separate helicopter overview opportunity provided in one of the sessions. Banjima only sessions during the on-country consultation sessions were convened as required. Accommodation was provided at the nearby Auski Roadhouse (Auski).

The itinerary for each day was planned to be flexible to consider and accommodate requests to visit certain places, with consideration for meal and comfort stops.

BNTAC staff and consultants helped to facilitate the discussion sessions and to record the outcomes of the consultation. The consultation records are provided in the ACHM Social Surroundings Assessment 6-10 May 2024 (**Appendix 29**).

HPPL is committed to ongoing consultation and engagement with the Banjima native title holders in relation to the Proposal, including ethnographic and archaeological surveys to identify Aboriginal heritage sites and other places associated with traditional customs linked to the environment. HPPL is committed to ensuring that through all stages of the Proposal (exploration, pre-feasibility studies, design, construction, operation, rehabilitation and closure) important social surroundings factors as defined by the Banjima People are protected and managed appropriately.

Where HPPL identifies any knowledge gaps, targeted engagement with the Banjima People will be sought to further investigate how the Proposal will impact the environment in relation to areas of cultural importance, and to ensure appropriate management of any risks associated with construction and operation.

14.3.3.3 Yindjibarndi consultation

HPPL initiated consultation with the Yindjibarndi People at commencement of the Social Surroundings consultation - on the basis that the MDIOP would need to dispose of excess water via Managed Aquifer Recharge (MAR). Subsequent downsizing of the mining operations and further investigations resulted in the Mulga West Borefield being removed from the Proposal and the Development Envelope in December 2023 (refer to **Section 2.3**). Although the Proposal no longer directly impacts Yindjibarndi Country, HPPL will continue to consult with the Yindjibarndi People regarding any potential indirect impacts of the Proposal on Yindjibarndi Country.

14.3.3.4 Youngaleena Community consultation

HPPL has commenced consultation with the Youngaleena Community, with the first meeting held on 13 May 2024 at Youngaleena. During this meeting an overview of the Proposal was provided along with the proposed timeframes for environmental approvals. In addition, proposed management was discussed including dust, noise, water and visual amenity aspects.

The outcome of the consultation has allowed HPPL to set up and install dust and noise monitors to gather baseline data and enabled the collection of water depth and quality samples from the Community. The VIA has also been updated to include potential impacts to visual amenity at the Community as a result of the Proposal (**Section 14.4.3**).

It is intended that consultation with the Youngaleena Community will be ongoing throughout the Proposal lifecycle. HPPL also intend to monitor at the Community for any potential impacts as a result of dust, noise or altered hydrogeological regimes throughout construction and operation of the Proposal.

14.3.3.5 Wirrilimarra Community consultation

HPPL has commenced engaging with the Wirrilimarra Community, through BNTAC as an intermediary, regarding the Proposal. Feedback has been received in relation to the Proposal's impact on the Wirrilimarra community both formally and informally through BNTAC members. Consultation with Wirrilimarra Community will be ongoing throughout the Proposal lifecycle. HPPL also intend to request permission to monitor at the Community for any potential impacts as a result of indirect impacts such as dust or noise throughout construction and operation of the Proposal.

14.3.3.6 Yandeyarra Aboriginal Reserve consultation

HPPL has ongoing consultation with the residents of the Yandeyarra Reserve, through the Mugarinya Community Association (MCA), and has met regularly with the MCA Board. HPPL continues to consult with MCA in regard to access to the Yandeyarra Reserve, including in relation to any access permits as required.

14.3.3.7 Consultation Outcomes

Key issues and outcomes identified during consultation with the Banjima Traditional Owners are outlined below and are addressed throughout this chapter. Hancock is committed to ongoing consultation with the Banjima People.

Water

Water was identified as a key focal area for Banjima Traditional Owners. Both groundwater and surface water were raised, as well as responsible use of water and concern about the location and extent of MAR required for the Proposal.

Potential indirect impacts to the DPLH lodged Mungurrdu heritage (40484) site through altered hydrological and hydrogeological processes were also raised.

There are two culturally significant pools (claypans) located 3-4 km south of the Development Envelope, Koodjeepindarranna (also referred to as Koodjeepindarrnna) and Gnalka Gnoona (also referred to as Ngarlganoona). These sites have been identified through heritage surveys as significant sites for the Banjima People. The Koodjeepindarrnna and Ngarlganoona claypans are not located within the Development Envelope; however, they may be considered proximal.

The Ngarlganoona Claypan can form into an extensive (> 1,000 ha) waterbody which may persist for extended periods. There are records of these claypans being inundated for several years following continuous favourable climate sequences.

Fortescue Valley

HPPL understands through consultation that the Fortescue Valley, including the surface water and groundwater resources that feed into and support this landscape feature, are culturally significant for the Banjima People.

HPPL has undertaken comprehensive site investigations for groundwater, surface water and ecology to understand baseline conditions, eco-hydrological relationships, and impact pathways associated with the Project (**Section 7**). A key objective in developing water management strategies for the Proposal is minimisation of change to baseline conditions. Surface water and groundwater modelling have been developed to simulate surface water and groundwater management strategies and quantify changes (see **Section 7** and **Section 14.5** for more detail on the management strategies).

Development of a SCHMP

An SCHMP will be developed to address the management of residual impacts on Social Surroundings as they may impact differently over the life of mine, and as is the case with Mine Closure, require ongoing consultation and management. The SCHMP for this Proposal will focus on the social cultural impacts from the Proposal and will be a separate document to the Cultural Heritage Management Plan (CHMP) which is the primary document to support management of Aboriginal Heritage. The CHMP will be prepared to support management and approval under the AH Act.

BNTAC and the Banjima People will have the opportunity to provide input through the development and implementation of the SCHMP. The SCHMP will outline appropriate avoidance and mitigation measures in relation to the placement of Proposal elements, culturally significant flora and fauna and a commitment to ongoing consultation throughout the life of mine.

HPPL is committed to addressing the Social Surroundings factor and ensuring that design, construction and operation of the Proposal considers important factors as defined by the Banjima native title holders, and adopts appropriate protection and management measures. Future consultation will aim to clarify key themes and values that are important to Banjima native title holders.

The outcomes of consultation with the Banjima People and other stakeholders will be formally documented in the SCHMP.

Other Consultation Outcomes

The below list is not exhaustive however other consultation outcomes included the following:

Cultural Awareness Induction Training - Banjima Traditional Owners requested input into the cultural awareness training and induction package for the Proposal.

Location of Proposal elements - Banjima Traditional Owners raised during consultation that the originally proposed airport and camp locations were in the vicinity of key cultural areas located to the west of the Development Envelope.

Amenity - Dust emissions and the impact from dust on Country (amenity) was raised as a concern by Banjima.

Contamination - The Development Envelope for the Proposal (as part of the original Referral) was located in close proximity to the WAMA. It was queried if there was any potential for the DE to be contaminated from activities at Wittenoom.

Environmental Management - Banjima have raised that environmental significance of the area in which the Proposal is situated is of high value and is considered culturally and environmentally important to the Banjima People

Cultural Heritage and Social Surroundings - The Proposal is located within an area that contains significant heritage and cultural associations. The original Proposal also included mining activities and supporting infrastructure within the DPLH lodged Mungurrdu heritage site. The original Proposal Development Envelope and footprint impacted directly on some key features that Banjima had concerns with.

Life of Proposal and Closure Planning - Closure planning and the state of the environment after decommissioning of the Proposal were raised as key aspects for the Banjima People. “What will be left for our People?”

Mine closure and Rehabilitation – Banjima have provided feedback and input into mine closure principles. Banjima People expressed concern about pit lakes left on Banjima Country at the completion of mining and how waste rock dumps will be managed.

Culturally significant flora and fauna - Impacts to culturally significant flora and fauna as a result of the Proposal are of concern to the Banjima People.

Access - Banjima have requested access to certain areas in and around the Development Envelope during Proposal operation for hunting or other activities.

Youngaleena Community - The Community is concerned regarding the potential impacts from dust, noise, water and visual impacts as a result of the Proposal on the Community.

Wirrilimarra Community – HPPL recorded concerns that the previous mine access road (referred to as the ‘Fenceline Road’) and the airstrip location was too close to the Wirrilimarra Community.

14.3.4 Aboriginal Heritage Values and Cultural Associations

The Proposal is located entirely within Banjima Country. HPPL commenced consultation and engagement with the Banjima Traditional Owners in 2007 - initially focused on Aboriginal Heritage surveys to support exploration activities.

14.3.4.1 Heritage Sites

The known archaeological record of the inland Pilbara region within the respective Traditional Owner Countries extend back to over 43,000 years before the present. The Banjima Traditional Owners maintain day-to-day cultural connections with the land within the Development Envelope, by means of the practice of Traditional Law and the exercise of hunting rights (ACHM 2012).

A rich cultural landscape has been identified within and surrounding the Development Envelope.

14.3.4.1.1 Aboriginal Cultural Heritage Inquiry System Search

The Aboriginal Cultural Heritage Inquiry System (ACHIS) maintained by the DPLH was utilised to research and determine which historical heritage survey reports and site files held by the DPLH may be relevant to the Proposal. A search of the ACHIS was undertaken within and surrounding the Development Envelope for identified Registered Sites (ethnographic and archaeological), Other Heritage Places, and the nature and frequency of previous heritage surveys.

Within the Development Envelope, there 6 'registered' sites and 134 'lodged' heritage places (**Figure 14-2**:). Of these, 5 'registered' sites and 33 'lodged' heritage places intersect the Indicative Footprint (**Figure 14-2**:).

14.3.4.1.2 Heritage Surveys

HPPL has surveyed the majority of the Development Envelope and surrounding area for both ethnographic and archaeological heritage sites. These surveys have been undertaken in consultation with Banjima Traditional Owners and confirmed the presence of Aboriginal cultural heritage values within the Development Envelope. **Table 14-4** outlines the survey effort completed to date within the Development Envelope and Indicative Footprint. **Table 14-5** provides a summary of the ethnographic and archaeological heritage surveys undertaken for the Proposal. Survey coverage is presented in **Figure 14-4.**

Table 14-4: Extent of on-ground heritage surveys completed to date for Banjima Traditional Owners

Development Envelop (ha)	Area Surveyed (Development Envelope – ha)		Indicative Footprint (ha)	Area Surveyed (Indicative Footprint – ha)	
	Archaeological Survey	Ethnographic Survey		Archaeological Survey	Ethnographic Survey
16,848.53	14,650	16,848	4,339.16	3,683	4,786

Table 14-5: Summary of Aboriginal heritage surveys undertaken for the Proposal

Survey Type	Years	Method	Total surveys to date
Ethnographic	2012 - 2023	Site Avoidance	6

Survey Type	Years	Method	Total surveys to date
Archaeological	2007 - Ongoing	Site Avoidance/Site identification	64

The entire Development Envelope has been subject to baseline ethnographic surveys. Within the Indicative Footprint, 85% of land has been surveyed for archaeological material - to site avoidance level, the remaining area to be surveyed includes the airstrip and the northern access road. Of the known Aboriginal cultural heritage sites within the Indicative Footprint, 95% have been recorded to site identification level. Further Archaeological site avoidance and site identification surveys are anticipated in 2025.

The heritage surveys undertaken to date have identified 303 sites of heritage value within the Development Envelope, and 41 sites of heritage value within the Indicative Footprint (refer to **Table 14-6** and **Figure 14-5**). HPPL will comply with all obligations as required under the AH Act.

Table 14-6: Sites of heritage value identified to date within the Development Envelope and Indicative Footprint

Heritage Value Type (simplified for clarity)	Development Envelope	Indicative Footprint
Artefact Scatter	235	22
Culturally Modified Tree	37	15
Rockshelter	26	4
Ethnographic	1	-
Historical	1	-
Grinding patch	3	-
Total	**303**	**41**

14.3.4.1.2.1 Koodjeepindarrnna and Ngarlganoona Pools

There are two pools located 3-4 km south of the Development Envelope, Koodjeepindarrnna and Ngarlganoona. These sites have been identified through heritage surveys with for the Banjima People. The Koodjeepindarrnna and Ngarlganoona pools are claypans that do not persistently have an expression of water and instead are seasonal. As discussed in **Section 7.3.4**, baseline studies (AQ2 2024a, b, c) on the hydrology and hydrogeology of these pools concluded that they are supported by direct rainfall and surface water flows and are not groundwater dependent. Based on consultation, their cultural significance is considered high. The Koodjeepindarrnna and Ngarlganoona pools/claypans are also habitats for migratory and local birds and invertebrate species during inundation and have cultural significance to Traditional Owners (ACHM 2024).

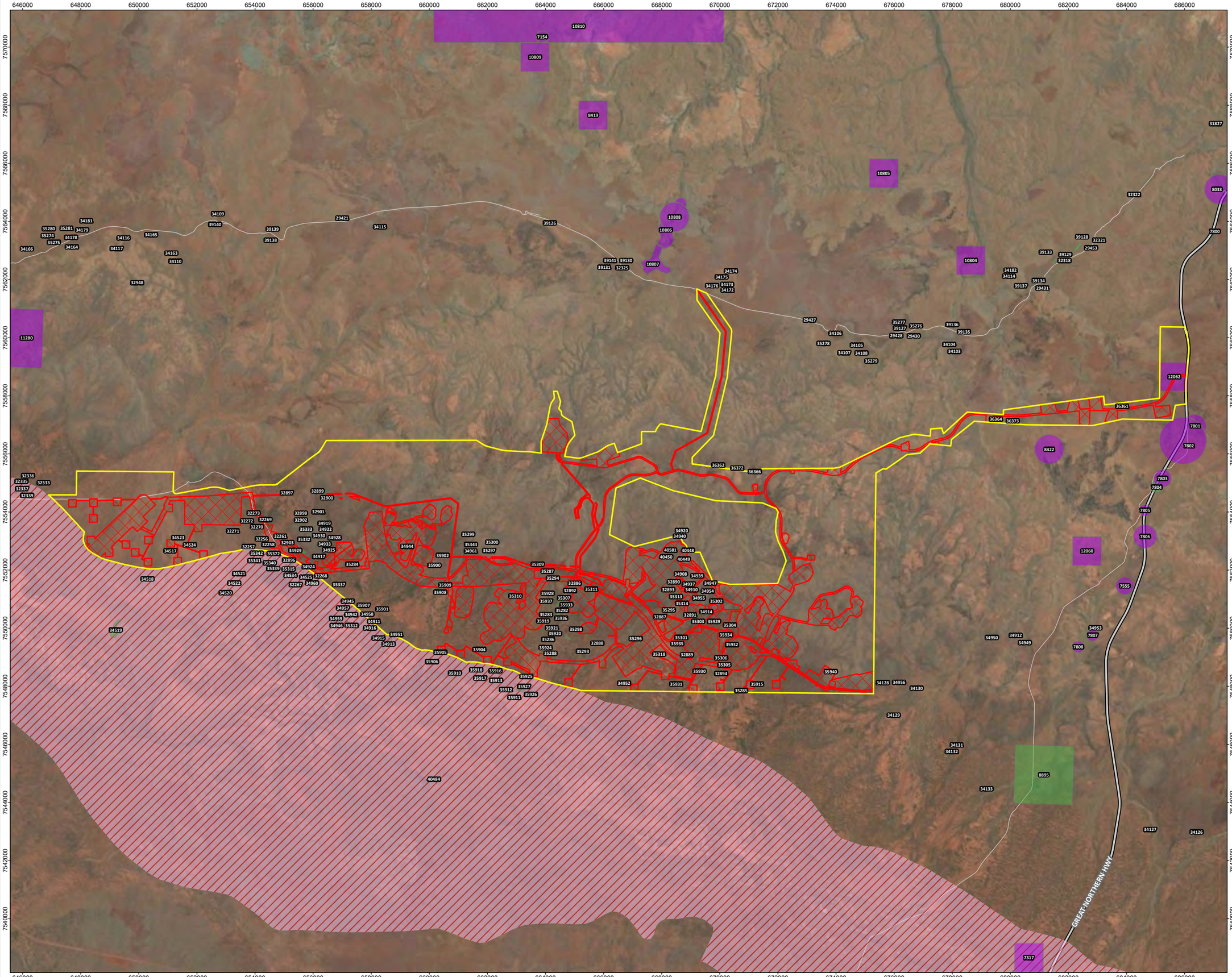
14.3.4.1.2.2Mungurrdu heritage site (40484)

The Mungurrdu heritage site (40484) was lodged with DPLH and covers a significant portion of the Fortescue River Valley. Mungurrdu is located outside but immediately south of the Development Envelope (**Figure 14-2**:). According to the lodgement record, (Place Type) Mungurrdu is import for the following reasons:

- Burial;
- Birthplace;

- Camp;
- Ritual/Ceremonial;
- Creation/Dreaming Narrative;
- Hunting Place;
- Meeting Place;
- Other;
- Plant Resource; and
- Water Source.

Figure 14-3: Heritage Sites (DPLH)



Legend

- Development Envelope
- Indicative Footprint

Aboriginal Heritage Place Status

- Registered Site (DPLH-099)
- Lodged Site - Mungurrdu or Mangurrdu (DPLH-100)
- Lodged Site - Other (DPLH-100)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 11-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

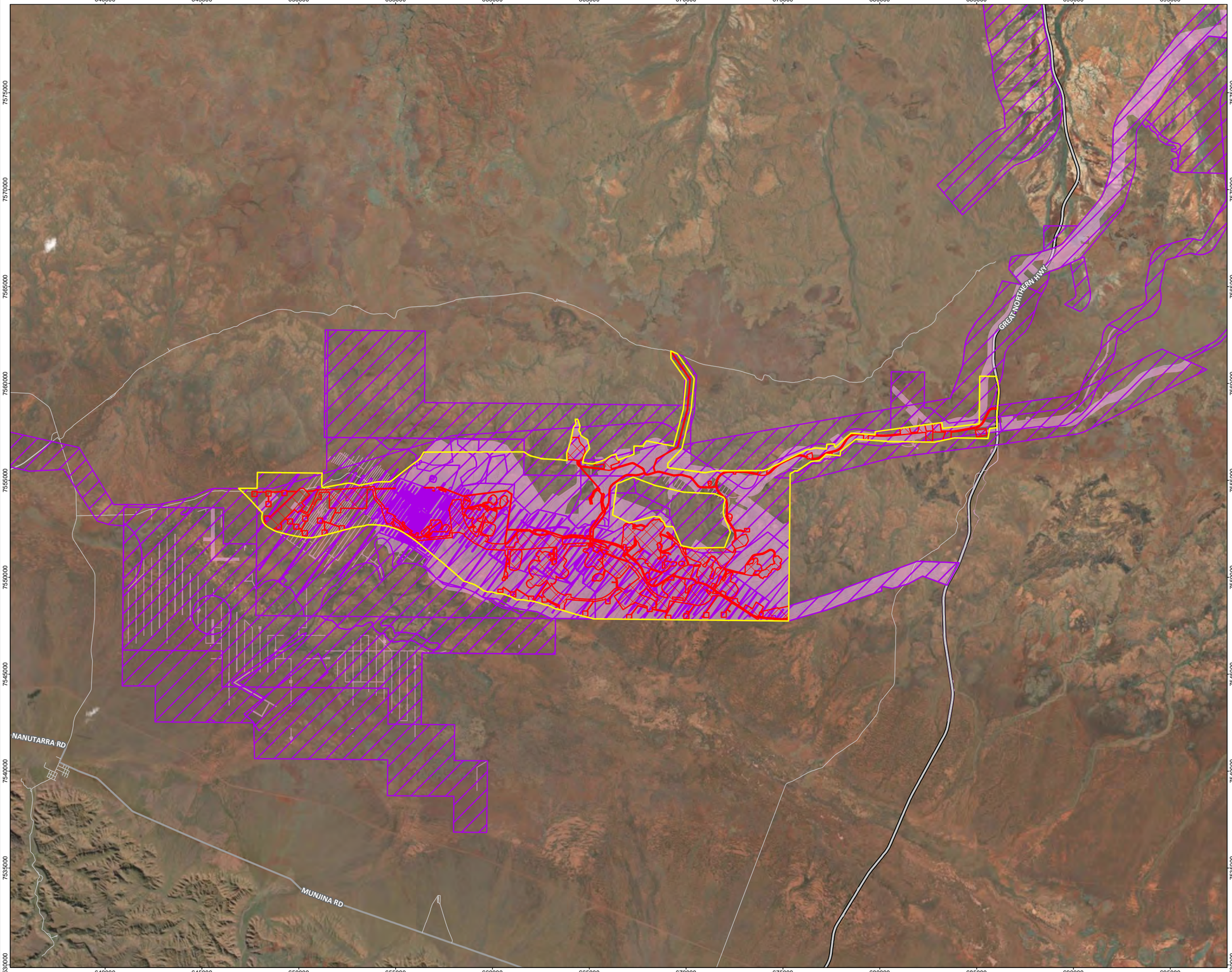
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

HERITAGE SITES (DPLH

FIGURE 14.3

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Image Reference: World Imagery: Earthstar Geographics

Figure 14-4: Heritage Survey and Social Surroundings Coverage



Legend

- Development Envelope
- Indicative Footprint
- Completed Archaeological Survey Completed Ethnographic Survey (HanRoy,2024)
- Completed Ethnographic Survey (HanRoy,2024)
- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 07-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:180,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

Heritage Survey and Social Surroundings Coverage

FIGURE 14.4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 14-5: Heritage Sites Identified During Heritage Surveys

This page has been redacted for confidentiality.

14.3.4.2 Ethnobotanical Survey

An ethnobotanical survey was completed in conjunction with the Banjima Traditional Owners and their heritage services provider, ACHM. The field work component of this survey was undertaken between 30 July 2024 – 1 August 2024. The purpose of the survey was to record the Banjima language names and traditional and cultural uses of the plants that Banjima representatives identified in the landscape. A copy of the survey report can be found in **Appendix 25**.

A total of 20 plants within the Development Envelope were identified from the survey as having traditional and cultural uses to the Banjima People. These are detailed in **Table 14-8** below.

During the survey, the ACHM Anthropologists recorded the following comments and observations from the Banjima People:

Attachment A There are more plants and trees with traditional cultural uses that were not recorded on the present survey and so additional surveys of this type would be useful to continue the plant inventory process.

Attachment B Rehabilitation of the landscapes altered and disturbed by exploration, mining, and associated infrastructure should be an ongoing project during the entire life-of-mine process rather than being something that might be commenced at the end of a mining project.

Attachment C Mining proponents should consider establishment of plant nurseries, employing Traditional Owners, to propagate endemic species that can be used in the land rehabilitation process during the life-of-mine.

Attachment D Bush medicine and bush food plants seem rarer than tree resources (such as “mulga” (Acacia sp.) that are used for their wood. The medicine plants seem to be slow to grow to maturity.

Attachment E The Banjima People representatives stated that they felt it was hard to access the plant resources on their Native Title lands because the mining operations of multiple companies meant that there are many fences, rail lines, gates and other associated restrictions to them accessing their traditional lands.

Attachment F The machinery noise created by exploration and mining operations creates a disturbance that scares animals away from those areas. For example, the author has had several previous conversations with Banjima People on surveys in the Fortescue Marsh area and surrounds where the Banjima People representatives have commented on their being fewer kangaroos and emus in the area – which they attribute to the animals having been scared away by the noise of the mining activities of multiple companies operating in the region. The Banjima People representatives on this ethnobotanical survey stated that they had observed the same thing and that this is a concern because animals are involved in the spreading of plant seeds (via eating the fruits and then defecating the seeds to new locations), but if the animals are scared away from inhabiting a region due to loud noise disturbance there is less natural regeneration of plants in that region.

Attachment G Is it possible that dust from mining operations, that comes down to coat the leaves of trees and shrubs in the surrounding area, is inhibiting plant growth? A Bush Orange (Gudjawari - likely *Capparis umbonata*) was observed by the side of a track to the Mulga Downs exploration camp and was covered in dust and the Banjima representatives had thought it looked somewhat unhealthy.

An overview of where the Survey Team travelled during the three days of the survey and the areas on the ground where ethnobotanical plants were recorded is presented in Figure 14-6. On the first field day of the survey the helicopter was used to fly an inspection flight of both the MDIOM and Hub and Rail Spur Project Areas to give the Banjima People representatives an overview of the scale of the Project area and the opportunity for them to nominate any particular areas they might like to land to look for ethnobotanical plants.

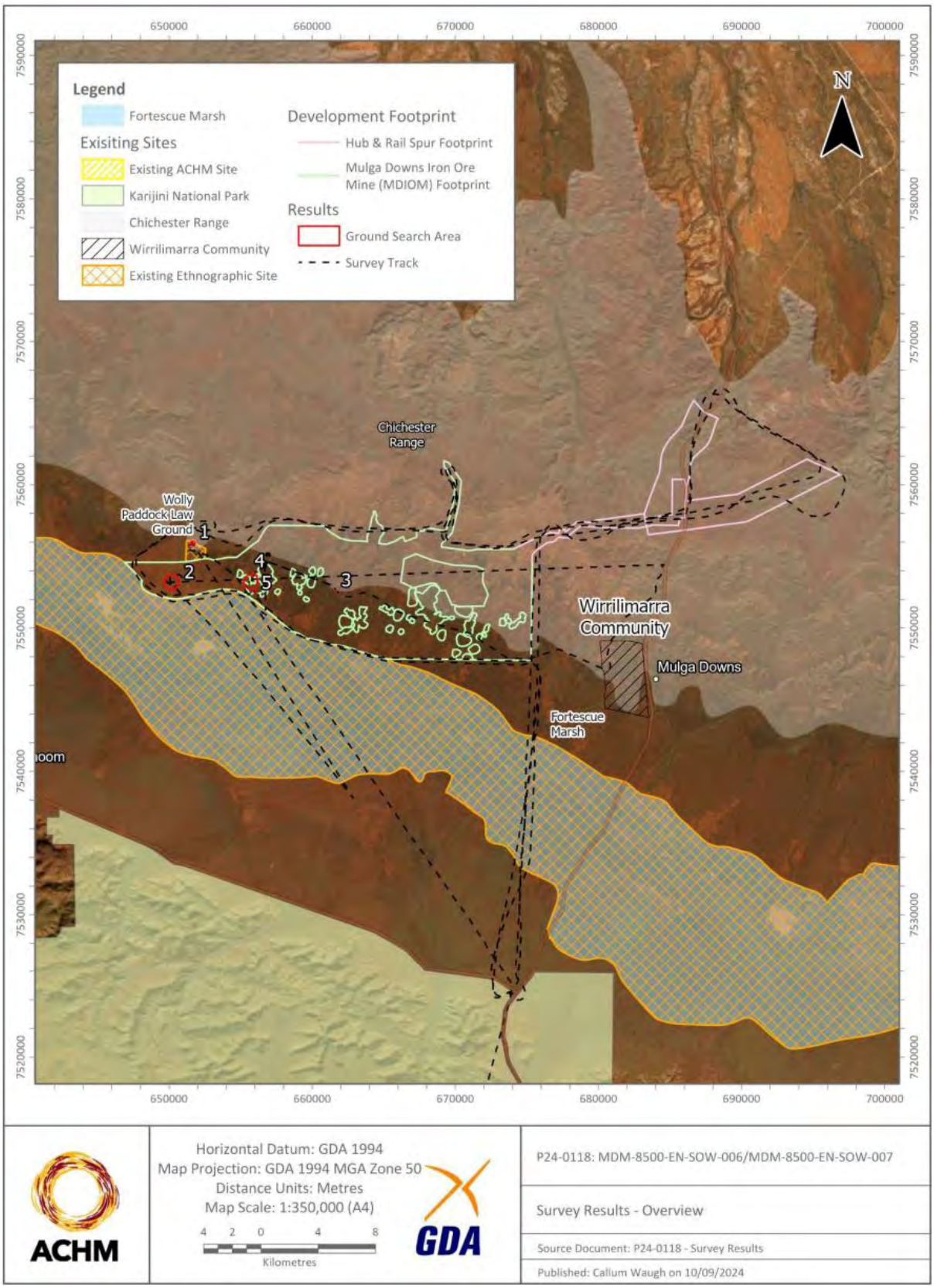


Figure 14-6: Overview of where the ethnobotanical Survey Team travelled (ACHM 2024)

Table 14-7: Culturally significant flora identified within the Development Envelope (ACHM, 2024)

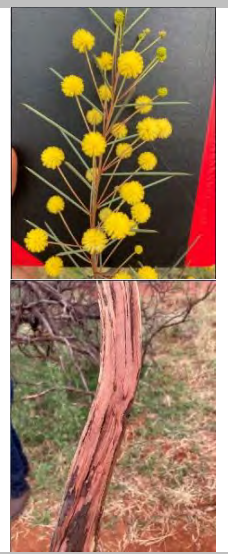
Traditional Name	Scientific Name	Description and traditional uses	Photo
Gawarra	Potentially *Eremophila longifolia*	Tree to approximately 3m high. Leaves deep green with visible venation on top and underside of leaf. Leaves have slight curl to them. Banjima representatives stated that the trees usually occur in small groups of one or two trees together and usually occur far apart from one another and that because of their importance for ritual use, people often remember locations that contain these trees, so they can return to obtain the leaves. ***Uses***: The green leaves of this plant are burnt to create smoke (burrgun) used for cleansing rituals. It was said that one kneels down and puts their head in the smoke. Ritual use examples include: • At ritual ceremonies where boys are initiated to manhood, they will be cleansed with the smoke from these green leaves. • Sisters, mothers and aunties of the initiands will also be cleansed. • The smoke is also used to cleanse the belongings of the recently deceased, which are then redistributed throughout the kinship network of the deceased. • The cleansing effect of the smoke may also be used at a house or place where it is thought that “bad” energy or “bad” spirits may have been encountered. • Smoke from Gawarra can also be used to keep flies and insects away from raw meat while it is being butchered.	 

Traditional Name	Scientific Name	Description and traditional uses	Photo
Windarrmrrha	Potentially *Acacia aneura* (Mulga)	***Uses**:* • Used to make various wooden tools such as punishment spears (*muggurndurr*), men's fighting sticks (*djuna*), and a type of spear called a *bungidee*. • The tree also provides edible fruit that is greyish-green in colour when ripe to eat and found after the tree has flowered. Banjima representatives described the fruit as "crispy or crunchy" and containing "a little bit of juice" and observed that if the fruit doesn't develop properly due to a dry season, the fruit will be small and dry.	
Garrangba	Potentially *Hakea lorea*	Tree or shrub, 1-10 m high, with epicormic buds. Fl. cream-yellow-green-white-orange, Apr to Sep. Red sand, alluvium, clayey soils, sandstone, ironstone, granite, basalt. Plains, ranges, drainage lines, claypans. [A. Spooner, Descriptive Catalogue, 23 June 2003]. The Banjima representatives described that when they observe the flowers of this small tree ripening, they know that it will soon be time for emu chickens to hatch (they are usually growing in their eggs around August and September and the eggs should not be eaten). Emu chicks and adult birds will eat the dried remains of *Hakea lorea* flowers. ***Uses:*** • The flower contains nectar which is sucked from the flowers for sweetness/taste. • The cork-like bark is burnt to produce black coals/charcoal which has several uses including: being rubbed on babies from head to toe to cool them down; and being used in men's ceremonies. • The coal/charcoal can be mixed with animal fat such as emu or kangaroo fat to help the black, cooling barrier adhere to the skin for longer.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
			
Marruwa	Likely *Acacia xiphophylla*	Often gnarled, bushy shrub or tree, 1.5-7 m high. Fl. yellow. Stony clay flats or plains, near rocky creeks. [A. Spooner, Descriptive Catalogue, 18 August 1997]. ***Uses:*** • The wood is used for making boomerangs – the snaking shape of the wood means that many limbs of this tree are already in the correct shape for a boomerang. • The wood is also good firewood that burns for a long time and provides good coals [in which large meat food items can be cooked]. • Sap or "gum" from the tree is also dissolved in the mouth as a food and medicine and is said to be good for treating constipation. The gum is usually available from the tree from August-October but the Banjima informants have observed that if they want to obtain the gum out of season they can cut the bark from the tree with a knife or axe and "come back in a week" to obtain the gum from where they removed the bark. • Dried leaves still on the tree are collected and burnt to ash, which is collected and is called *jurnpa*, and this ash is added to chewing tobacco. • The younger, smaller trees are said to make a good windbreak, as they have a thicker, more dense, canopy that reduces the wind.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Ngurrungnum	Possibly *Acacia victoriae*	Prickly shrub or tree, 2-5(-8) m high. Fl. cream-white/yellow-green, Jun or Aug to Oct. Variety of soils. Often along rivers & stony creek beds, saline flats. [A. Spooner, Descriptive Catalogue, 23 July 1997]. ***Uses*** • Seeds (*dorrndu*) can be eaten straight from tree when green and in pod. The seed pod can also be cooked lightly on coals, or on some burning spinifex. • The sap or "gum" (*gnarlgarla*) is referred to also as "bush lolly" and can be picked straight from the tree and dissolved in the mouth, usually from around September onwards. It is also collected and taken home where it can be soaked in water to soften it before eating. People also "keep it in the freezer for the off season" [when it is not available]. • Bardi grubs are also found underground in and around the roots of this plant. The grubs usually leave an observable hole near the base of the stem and their frass, a type of sawdust-like substance, can be seen outside the entry hole at the base of the stem where the grub has chewed its way in, excreting material as it goes. To find the edible grub, dig the dirt out from around the roots of a tree that shows the signs of the grub. Grubs can be eaten raw after first biting off the head and spitting that out, then eating the rest. The informants stated they preferred to roast the grub on hot coals until it is a "golden colour" and that if you heat the grub too fast, it will burst.	 

Traditional Name	Scientific Name	Description and traditional uses	Photo
Nyirrilyi	Likely *Enchylaena tomentosa* or *Enchylaena tomentosa* var. *tomentosa*	This was a small shrub to approximately 50cm high and other specimens were observed with diameters between 20-100cm. The succulent looking leaves are approximately 5mm long and only 1-2mm wide, are smooth and a sage green colour. The Banjima representatives noticed several of these plants and suggested that Mulga Downs must have the right conditions for them to be plentiful. ***Uses**:* • The plant bears a small red edible fruit. Sometimes the fruits are yellow or white near where you pull the fruit from the plant.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Gurrarda	Likely *Acacia tetragonophylla*	***Uses**:* • The wood is used to make tools such as boomerangs ("if you can find the right tree") and fighting sticks. The wood is prized for the pinkish-red colour it has that imparts a particular look to tools made from it. • The seeds are edible. They can be eaten as is or can be crushed to make a kind of flour/seedcake. • The bark can be used as a leather dye. The bark is added to cold water and the leather soaked in there for several days.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Bugurlda	Possibly *Acacia sclerosperma* subsp. *sclerosperma*	***Uses***: • The seeds are eaten by both people and emus but the seeds of the *Ngurrungnum* (possibly *Acacia victoriae*) are preferred by the Banjima informant.	 
Galarangba	Possibly *Acacia coriacea* subsp. *pendens*	Weeping shrub or tree, (1-)3-6(-8) m high. Fl. yellow/cream, Mar to Aug. Sandy soils. Along rivers & creeks, stable sand dunes. [A. Spooner, Descriptive Catalogue, 17 July 1997]. ***Uses***: • The wood can be used to make tools such as fighting sticks, but is best taken from younger specimens of this tree when the wood quality is deemed similar to Mulga. The older wood is not great for making tools. Wood from this tree is not the first choice of wood for making tools.	

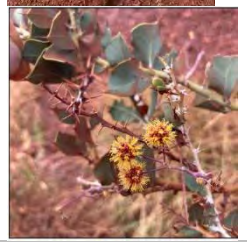
Traditional Name	Scientific Name	Description and traditional uses	Photo
Wirlu	Likely *Eucalyptus victrix*	Spreading tree, 1-12(-22) m high, bark smooth, sometimes with box-type stocking to 1 m. Fl. white-cream, Nov or Jan to Mar. Red loamy or sandy soils, clay loam. Floodplains, flats. [G. Paczkowska, Descriptive Catalogue, 5 December 1995]. The tree usually grows away from main permanent water sources and that where permanent waters are found in gorges of Karijini and elsewhere, there is a different type of "gum tree" (*Eucalyptus* sp.). ***Uses:*** • Tree is used for shade from the sun. • Branches of leaves are used for a surface on the ground on which to place cooked meat • Honey (*jundaru*) can be found in mature hollow branches of this tree, made by native bees.	
Gulya (Murru) and / or Nyirrinyi	Possibly *Ipomoea* sp., OR possibly *Vigna lanceolata* subsp. *lanceolata*	DBCA Florabase description of Ipomoea species, I. muelleri: Prostrate, trailing or climbing perennial, herb, 0.05-0.3(-1) m high, to 2.6 m wide. Fl. pink/red-purple, Mar to Oct or Dec. Sand, clay. Along watercourses. [A. Spooner, Descriptive Catalogue, 8 September 1999]. ***Uses:*** To find the edible tuberous portion underground, people look for "where the ground is cracked" and using a crowbar, or digging stick, can tap the ground and tell by the sound the ground makes whether there is an edible tuber below or not. The tuber is said to be an "orangey, dirty colour". The tuber is cooked by making a fire and then burying the tuber in hot sand already heated by the fire and also (perhaps) with some hot ashes and coals in the immediate vicinity.	No photo available from survey.

Traditional Name	Scientific Name	Description and traditional uses	Photo
Gudjawari	Likely *Capparis umbonata*	"Gujawari/gularndi" in the Banyjima language being the name fora plant with the common name "wild orange or bush orange" and identified as *Capparis mitchelli*. Discussion regarding this plant was interrupted by rain before any ethnographic details were recorded. ***Uses:*** • Edible fruit.	
Djirrbilin	Possibly *Capparis lasiantha*	Spiny, twining shrub or climber, 0.5-4 m high. Fl. white, Jun to Sep. Sandy & clayey soils. [G.Paczkowska, Descriptive Catalogue, 16 April 1996]". In the field this plant was noted as "small shrub 40-50cm tall and in diameter, small thorns at each node". Banjima participants described the fruit on this plant as being approximately 5cm long, with lots of seed inside. The fruit will be yellowish when ripe and the skin of the fruit will start cracking. Aboriginal descriptions in the Taylor and van Leeuwen (2011) document include that "the fruit is yellow when ripe", and "fruit 3-5cm long and 2cm wide. The inside of the fruit is grey in colour", and ". . . the seeds must be removed before eating". ***Uses***: • Edible fruit. The fruit pulp can be squeezed from the fruit and into the mouth but the seed is spat out after sucking the pulp from it. • The leaves are used as medicine. They are boiled in water and the brew is drunk. People also make creams with this plant in current times and mix it with beeswax and oil.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Mirrgun (Mallygun)	Likely *Eucalyptus leucophloia* subsp. *leucophloia*	(Mallee) or tree, 2.5-6 m high, white or white and pink powder bark with black spots. Fl. white-cream, Apr or Aug. Rocky slopes, gullies, plains .[A.Spooner, Descriptive Catalogue, 27 November 2007]. ***Uses***: • The wood is cut from the trunk of the tree to make a carrying bowl (yandi). The yandi is used "to carry heavy food like meat". A yandi can also be used to carry a baby and to cradle the baby off the ground when the group are stationary at camp. • Honey (jundaru) is obtained from hollows in old, mature limbs of the tree. The honey is made by native bees (warnbi – pronounced, roughly, as "worn-bye"). The honey may be carried on a piece of bark cut from the tree.	
Jilarn	Likely *Eremophila cuneifolia*	Spreading, viscid shrub, 0.5-1.8 m high. Fl. blue-purple-pink, Jun to Oct. Red sandy or clayey soils. Stony rises, hillsides & plains, saline plains. [A. Spooner, Descriptive Catalogue, 5 March 1997]. ***Uses***: • Used as a medicine. The leaves are boiled in water and the liquid is drunk. The liquid can be applied to "school sores", cuts, wounds.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Balarra	Unkown	The author made the following observations: dense shrub to approx. 190cm tall, approx 150cm wide. Single specimen with another approx. 10m away and another approx. 8m away. Dry feeling leaf. Banjima commented that the shrub had a white flower that might be 5-6cm wide; however, no flowers were present. They also observed that this plant and surrounding vegetation seemed rather more dry than usual. ***Uses:*** • Has an edible fruit that is eaten by people and emus, usually available end of August/beginning of September. The fruit is round and is a black colour when it is ripe. All the fruit is eaten except the seed. The fruit contains one small seed, according to the Banjima informants.	
Wirralu	Likely *Grevillea striata*	Tree or shrub, 3-12(-15) m high. Fl. white-cream/yellow-green, Jul or Oct to Dec or Jan or Mar. Red sand, loam, clay. Near watercourses, plains. [G.Paczkowska, Descriptive Catalogue, 17 August 1995]. ***Uses:*** • The wood is used to make shields as well as artefacts used in men's ceremonies.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Bunurra	Likely *Corymbia* sp., possibly *C. hamersleyana*	***Uses***: • The sap from the tree is collected and dissolved in hot water and is drunk as a medicine to "cleanse the blood". • Honey is sometimes gathered from old, hollow limbs. • "Bush Coconut" - A round cricket-ball sized gall (galu galu) occurs on these trees and is eaten. It is described as usually being the same colour as the bark on the trunk of the tree and having an "eye" on the underside from which one can dig in one's fingers and pull it apart. The young from whatever insect caused the gall is inside the "coconut" in the form of an edible grub that is "a little bit sweet". The inside of thegall contains firm, fibrous flesh that can be eaten and is said to taste a bit like coconut.	 

Traditional Name	Scientific Name	Description and traditional uses	Photo
Barderri	Likely *Acacia inaequilatera*	***Uses:*** • The bark from this small tree is used in the same way as that of the "Corkwood" known as *Garrangba* (likely *Hakea lorea*) – i.e. the bark is turned to charcoal for rubbing on children's bodies to keep them cool or it may be used in men's ceremonies.	 
Budardu (Burdardu)	*Santalum* sp.	Sandalwood - No photo was taken as this tree was discussed in general conversation, rather than after locating a specimen. ***Uses:*** • Can eat the seed, or heat in fire and rub the seed onto the skin, for its oil, which was said to perhaps partly act as an insect repellent to keep away flies and mosquitoes.	No photo available from survey.

14.3.5 Other Historic Heritage

In WA, the *Heritage Act 2018* (WA) recognises and promotes the importance, understanding and appreciation of WA's cultural heritage. The implementation of the *Heritage Act 2018* provides for the identification and documentation of places of cultural heritage significance and for the conservation, use, development and adaptation of such places. Places of cultural heritage significance are documented within the State Register of Heritage Places, which is organised by the Heritage Council of WA within the 'inHerit' database.

The Mulga Downs shearing shed (place number 01745) was identified in a search of the 'inHerit' database. The shed is not located within the Development Envelope, however, is located in proximity within the boundaries of the Mulga Downs Station and homestead (**Figure 14-2**:).

The Mulga Downs Station and homestead has heritage value for the following groups:

- Banjima Traditional Owners: many of the people who worked and lived on the station were members of the Banjima Traditional Owners. There are known heritage restricted zones for the Banjima across the pastoral station; and
- Hancock Family: the station has been owned by and associated with the Hancock family since 1915. Members of the family are buried in the homestead graveyard.

Places of Commonwealth heritage significance are protected under Part 15 of the EPBC Act and include World Heritage properties, National Heritage places and Commonwealth Heritage places. There are no identified Commonwealth or State listed historic heritage sites within or immediately adjacent to the Development Envelope (Heritage Council, 2020).

14.3.6 Social Surroundings Values

Hancock has undertaken extensive consultation with stakeholders, including the Banjima People, in relation to the Project. Based on the information provided above, the following social surroundings values were determined to require assessment for this factor:

- Disturbance to sites of social, cultural and heritage significance;
- Restricting Access to Country and ability to Care for Country;
- Activities that may impact amenity such as alteration of landscape or installation of infrastructure;
- Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of:
    - Altered hydrological and hydrogeological regimes, including altered water quality;
    - Activities that generate dust, noise and/or vibration; and
- Disturbance to broader cultural associations as a result of environmental changes to Country.

14.4 Potential Impacts

Under the EP Act, social surroundings is considered in EIA where there is a clear direct link between a Proposal impact on the physical or biological surroundings and the subsequent effect on a person's aesthetic, cultural, economic or other social surroundings. This may include impacts to local tourism and land uses, surrounding sensitive receptors such as communities and Aboriginal cultural heritage values through physical ground disturbance, changes to surface water resources, significant dust emissions extending into surrounding areas, ecological impacts to culturally and locally significant flora and fauna (such as flora or fauna used for bush tucker or teaching), or significant visual impacts to landscapes (EPA 2023c).

14.4.1 Proposal Design Considerations

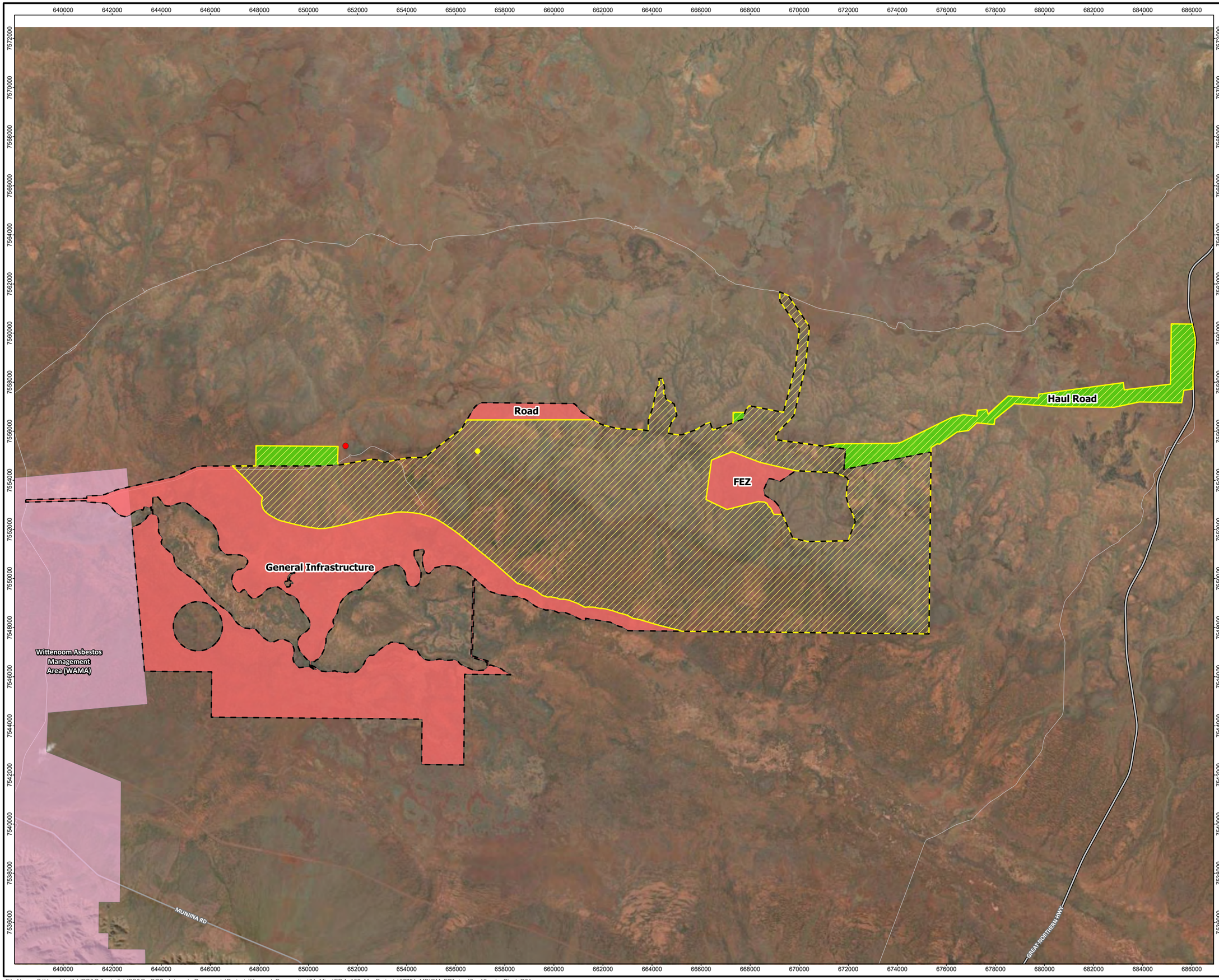
An assessment of the potential direct and indirect impacts of the Proposal to Social Surroundings in consideration of the EPA objectives is provided in the following sections. The assessment is based on the Proposal footprint as modified based on consultation with the Banjima People. A detailed discussion of the changes made to the Proposal during assessment is outlined in **Section 2.3**. A summary of the changes to the Proposal design that have already been implemented and are relevant to consultation with the Banjima People is shown in Table 14-8 below. The table shows avoidance measures included in the Proposal design achieved by excluding areas from the Development Envelope and by altering the mine plan to avoid large dewatering volumes requiring significant aquifer re-injection activities and avoiding the WAMA. The changes in Development Envelope are shown in Table 14-8.

Table 14-8: Summary of consultation outcomes with Banjima Traditional Owners on Proposal design and avoidance and minimisation measures already implemented.

Theme	Issue Raised	Avoidance and Minimisation Measure Implemented
Location of Proposal elements	Banjima Traditional Owners raised during consultation that the originally proposed airport and camp locations were in the vicinity of key cultural areas located to the west of the Development Envelope.	The airport and camp locations have been relocated (to the west and south respectively) to avoid key cultural areas being located further away from the identified cultural areas of significance.
Water	Water was identified as a key focal area for Banjima Traditional Owners. Both groundwater and surface water were raised, as well as responsible use of water and concern about the location and extend of managed aquifer recharge required for the Proposal. Identified potential indirect impacts to the DPLH lodged Mungurrdu heritage (40484) site through altered hydrological and hydrogeological processes was also raised.	Through the s43 application approved on 4 October 2024, HPPL has significantly reduced the amount of dewatering required to construct and operate the Proposal, this in turn has significantly reduced the potential for indirect impacts on Mungurrdu through altered hydrogeology. The Water Management Plan prepared for the Proposal was provided to the Traditional Owners and their advisors for review and input and the feedback provided has been considered in preparing revised versions.
Contamination	The Development Envelope for the Proposal is located in close proximity to Wittenoom Asbestos Management Area. Is there any potential for the DE to be contaminated from activities at Wittenoom?	Through the s43 application approved on 4 October 2024, the Development Envelope for the Proposal no longer intersects the WAMA. There will no longer be ground disturbing works within the WAMA and therefore the potential impacts associated with the redistribution of ACM is reduced.

Theme	Issue Raised	Avoidance and Minimisation Measure Implemented
Cultural Heritage and Social Surroundings	The Proposal is located within an area that contains significant heritage and cultural associations. The original Proposal also included mining activities and supporting infrastructure within the DPLH lodged Mungurrdu heritage site. The original Proposal Development Envelope and footprint impacted directly on some key areas of significance the Banjima.	The Proposal was amended from what was originally referred (20 Mtpa) to the reduced 12 Mtpa mine removes any mining and associated mining infrastructure from within the lodged Mungurrdu heritage site. There is no longer the requirement for any dewatering infrastructure to be constructed and operated within Mungurrdu. Throughout the design process, the Development Envelope and Indicative Footprint has been amended to avoid impacts to key cultural areas.
Wirrilimarra Community	Previous mine access road (referred to as 'Fenceline Road') was too close to the Wirrilimarra Community.	HPPL has now designed the 'northern haul road' to facilitate mine access and haulage of ore. The new route is located approximately 12 km to the north of Wirrilimarrra at its closest point, and the 'Fenceline Road' has been removed from the Development Envelope.

Figure 14-7: Development Envelope Changes



Legend

- Development Envelope (12 Mtpa)
- Development Envelope (20 Mtpa)
- Wittenoom Asbestos Management Area (WAMA)
- Mulga Downs Exploration Camp
- Mulga Downs Homestead
- Highway
- Major road
- Minor road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 29-Aug-2024
Drawn By: dmills	Checked By: LT

Scale 1:140,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

DEVELOPMENT ENVELOPE CHANGES

FIGURE 14.7

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

14.4.2 Direct Impacts

The potential direct impacts of the Proposal to Social Surroundings within or surrounding the Development Envelope, have been identified as follows:

- Disturbance to sites and areas of social, cultural and heritage value;
- Restricting access to country and ability to care for country;
- Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure that impacts ability to enjoy

The Development Envelope excludes the potential for direct impacts to national parks or other recreational or tourism features within the vicinity of the Proposal.

14.4.2.1 Disturbance to Sites and areas of Social, Cultural and Heritage Value

The disturbance of Aboriginal Heritage Sites is regulated under the AH Act.

The Development Envelope includes 303 sites of heritage significance identified during surveys undertaken in consultation with the Banjima Traditional Owners. Sites meeting the criteria for an Aboriginal site under the AH Act are protected by law. Disturbance of some sites will be unavoidable and will be subject to further consultation with the Banjima Traditional Owners and approvals under the AH Act.

Within the current Indicative Footprint, there are 41 sites of heritage significance, representing approximately 14% of the sites identified (**Table 14-6**) .

The direct disturbance of Heritage Sites is acknowledged to have impacts on Social Surroundings as it results in the removal of artefacts and disturbance of sites that have been inhabited and used by previous generations of Banjima People. The changes in Country (caused by clearing, mine pits, waste rock dumps, storage of materials and infrastructure) around any Heritage Sites that remains accessible during mining will change the experience and amenity of visiting a Site.

14.4.2.2 Restricting Access to Country and ability to Care for Country

Implementation of the Proposal includes ground disturbance and placement of infrastructure, which has the potential to alter or restrict access for the Banjima People to Country, including sites of cultural or heritage significance. This has the potential to impact the locations available for traditional social activities and practices, including connection to and the ability to teach and care for country, gather bushtucker, camp, fish and hunt.

Access restrictions will impact the ability of Banjima Traditional Owners to visit particular locations on their native title determination area within the footprint area and may impact on access through the Development Envelope. Access restrictions will be based on ensuring peoples safety, given that mining activities present hazards within certain areas of the mine. The key access restrictions will be around the mine pits, internal roads, haul roads, and key mine infrastructure such as the processing facility and any other areas where access must be restricted for safety reasons. The access restrictions are necessary during active mining for safety reasons.

Access restrictions will apply to those areas for all or part of the mine life whilst construction, mining and rehabilitation works are being undertaken. Access can be resumed as mining activities cease and areas are rehabilitated to be safe. Access to pits shall be restricted via abandonment bunds for safety reasons. Pits are being backfilled to above the groundwater level. When factoring material settlement and depth to groundwater, some pits may be backfilled to surface, while some pits may be mounded above pre-existing ground level. A conservative approach would be to assume access restrictions to all mine pits. The indicative pit layout is illustrated in **Figure 2-3**. Fences, gates and other physical barriers will be used to prevent access to restricted areas, which will be identified and confirmed through consultation. Signs and other written communication methods will be utilised to identify when and where access will be restricted.

14.4.2.3 Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure

The construction and operation of the Proposal will directly alter the visual amenity of the local landscape within the footprint as a result of mining activities, including changes to landforms such as:

- Excavation of mine pits with associated abandonment bunds for closure;
- Construction of waste rock landforms; and
- Supporting infrastructure such as roads, bores, pipes, laydown areas, airport, accommodation village and wastewater treatment plant.

Mining activities and the resulting alteration of visual amenity may alter the experience of Banjima Traditional Owners when on Country within the Development Envelope.

The VIA undertaken by Ecoscape (2024) to support assessment of the Proposal recognised locations with cultural significance (such as Aboriginal meeting places and heritage restricted zones) as relevant receptors for the purpose of the VIA. The VIA is provided as **Appendix 21**.

The highest degree of impact from the Proposal will occur within the operational phase and specifically towards the end of mine life where above ground mound elements are established. Assessment of the operational phase represents the worst case impact and is inherently conservative, whereas in reality, all Proposal elements are not likely to all be visually significant at the same time. It is anticipated that construction and maintenance activities will be significantly less than the modelled operational impacts.

Other than Mulga Homestead, which was also assessed as 'Moderate', the other viewpoints (including Karijini National Park, Youngaleena and Wirrilimara) were assessed to experience a generally Low level of visual impact, mainly the result of large distance between the viewpoint and Proposal infrastructure.

HPPL was not granted access to the Wirrilimara Aboriginal community for the VIA. However, 3D modelling was created to assess the site, and the results showed a low level of impact from Proposal elements.

14.4.3 Indirect Impacts

Potential indirect impacts arising from the current Indicative Footprint or activities within the Proposal may cause indirect impacts to Social Surroundings, including heritage sites, social, cultural and environmental values within and/or surrounding the Development Envelope. The potential indirect impacts have been identified as follows:

- Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including changes to groundwater depth, water, surface water flows and altered surface and groundwater quality;
- Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and/or vibration; and
- Disturbance to broader cultural associations as a result of environmental changes to country.

14.4.3.1 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality

Mining activities that contribute to altered hydrological and hydrogeological regimes (including altered water quality), from dewatering, MAR and changes to surface water flow may indirectly impact sites of cultural significance by altering the surface water and groundwater regimes that characterise these sites.

The key potential impacts of the Proposal to hydrological regimes are:

- Groundwater drawdown from orebody dewatering;
- Groundwater mounding from MAR to dispose of excess water with a predicted groundwater uplift to within 2.5 m below ground, causing vegetation health impacts and increased salt accumulation; and
- Altered surface water flows and catchment modifications which may impact including creek lines, floodplains and the Fortescue Valley environmental and cultural assets resulting in a modification of inflows and potential changes to the persistence of water.

These impacts are discussed further in **Section 7**.

Sites that may be indirectly impacted within the vicinity of the Development Envelope include the Mungurrdu lodged DPLH site (40484 - located immediately south; **Figure 14-2**:) and the Koodjeepindarrnna and Ngarlganoona pools (located 3 km and 4 km south, respectively; **Figure 3-11**).

14.4.3.2 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and/or vibration

Dust, noise and vibration emissions will be produced from construction and operation of the Proposal through mining activities including (but not limited to) blasting, vegetation clearing, and rehabilitation. These emissions may indirectly affect the amenity of sites of cultural significance through dust deposition, impacts to the structural integrity of heritage sites and overall disruption of Traditional Owners customary practises.

Dust emissions have the potential to indirectly impact flora that is used for cultural and traditional purposes (**Section 13**). Noise can disturb and displace fauna species used in hunting, requiring Traditional Owners to travel

further when hunting. Heritage sites within the Development Envelope may be impacted and negotiation with the Traditional Owners who are the custodians of these areas is in process. While many sites are not likely to be inhabited or visited for long periods by people, some may be sensitive to vibration levels caused by mining activity.

These emissions may also indirectly impact surroundings sensitive receptors including the Youngaleena and Wirrilimarra Communities (located 15 km south and 7 km east, respectively), and conservation reserves such as Karijini National Park (located 7.6 km south).

Noise and Vibration Assessments

LGA (2024) was engaged to undertake an assessment of the potential noise and vibration impacts from the Proposal on surrounding noise sensitive receptors, including:

- Wirrilimarra and Youngaleena Communities;
- Heritage sites;
- Auski Roadhouse;
- Munjina East Gorge;
- Karijini Eco Retreat; and
- Mulga Downs Homestead (North).

Four scenarios were modelled as part of the assessment. These scenarios were considered to be 'worst-case' to ensure a conservative approach to modelling:

1. Scenario 1A: East-Central Areas with Conveyors;
2. Scenario 1B: East-West Areas with Conveyors;
3. Scenario 2A: East-Central Areas with Road Trains; and
4. Scenario 2B: East-West Areas with Road Trains.

The noise assessment also modelled noise levels at bat cave receptor locations. Potential impacts to terrestrial fauna from noise and vibration are discussed in **Section 10**.

PSM (2024) was engaged to undertake geotechnical assessments of caves located within the Development Envelope and in close proximity to the northern extent of Fridge Hill pit, to understand potential impacts of the Proposal as a result of blasting and operational vibration. A copy of the geotechnical assessment, including the locations of caves surveyed is provided as **Appendix 28**.

The findings of LGA (2024) and PSM (2024) are discussed in the following sections.

Noise Limits

The Regulations adopt three noise metrics to quantify the noise limits:

- LAmax signifies a noise level which is not to be exceeded at any time;

- LA1 signifies a noise level which is not to be exceeded for more than 1% of the time; and
- LA10 signifies a noise level which is not to be exceeded for more than 10% of the time.

A summary of the applicable noise limits is provided below in **Table 14-9**. The criteria limit utilised for the assessment of noise levels was "Noise sensitive premises: any other area than highly sensitive area".

Table 14-9: Assigned Noise Limits Summary (LGA, 2024)

Part of premises receiving noise	Time of day	Assigned limit dB(A)		
		LA10	LA1	LAmax
Noise sensitive premises: highly sensitive area	07:00 to 19:00 hours Monday to Saturday	45 dB(A) + Influencing Factor	55 dB(A) + Influencing Factor	65 dB(A) + Influencing Factor
	09:00 to 19:00 hours Sundays and public holidays	40 dB(A) + Influencing Factor	50 dB(A) + Influencing Factor	65 dB(A) + Influencing Factor
	19:00 to 22:00 hours all days	40 dB(A) + Influencing Factor	50 dB(A) + Influencing Factor	55 dB(A) + Influencing Factor
	22:00 hours on any day to 07:00 hours Monday to Saturday and 09:00 hours Sunday and public holidays	35 dB(A) + Influencing Factor	45 dB(A) + Influencing Factor	55 dB(A) + Influencing Factor
Noise sensitive premises: any other area than highly sensitive area	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Commercial premises	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Industrial and utility premises	All hours	65 dB(A)	80 dB(A)	90 dB(A)

Noise Levels

The maximum noise levels for the four scenarios modelled at each of the sensitive receptors considered in the assessment are outlined in **Table 14-10**.

Operational mining noise from the Proposal received at the nearest sensitive receptors, is predicted to comply with the criterion provided in the Environmental Protection (Noise) Regulations 1997 at all times and in worst case scenarios. The sensitive receptors considered in accordance with the Regulations were Communities, accommodation villages and tourism sites.

The criteria at one heritage receiver location was not achieved (MIB-MD13-042). The closest Heritage site (MIB-MD13-042) is 40 metres from the pit edge and therefore receives the highest noise level when mining activities occur nearby. All other heritage site received locations were found to be compliant with the adopted criteria (LGA 2024). For safety reasons it is expected that Traditional Owners access will be restricted in proximity (approximately 1 km) to work areas.

Table 14-10: All Scenario's Assessment, L10 dB(A) (LGA, 2024)

Receiver					
	Approximate Nearest Distance to Site	Predicted	Adjusted	Criteria Level	Assessment
Bat Sites	60-150 metres	38-68	68	70	Complies
Homesteads	33 km	-	-	35	Complies
Auski Village	23 km	-	-	35	Complies
Karajini Eco Retreat	37 km	-	-	35	Complies
Munjina East Gorge	36 km	-	-	35	Complies
Communities	8.5 km	18	23	35	Complies
Heritage Sites	40 metres	67	67	60	+ 7

Notes:

- *Adjusted by + 5 dB for tonality when assessing to human receptors.

- Cells denoted with a "-" result are greater than 20km away and not predicted by the computer model.

Noise level predicted from the airport for the nearest sensitive sites are summarised in **Table 14-11**. The assessment predicted compliance at all receptor locations for aircraft arrivals and departures (LGA 2024).

Table 14-11: Aircraft Noise Assessment, dB LAmax (LGA, 2024)

Receiver	Nearest distance to runaway (km)	Departures, dB LAmax	Arrivals, dB LAmax	Assessment Criteria dB LAmax	Assessment
Bat Sites	18 km	<12	<10	70	Complies
Homesteads	33 km	-	-	80	Complies
Auski Village	38 km	-	-	80	Complies
Karajini Eco Retreat	33 km	-	-	80	Complies
Communities	21 km	<10	<5	80	Complies
Heritage Sites	5 km	30	25	80	Complies

*** Predictive noise modelling does not calculate to locations farther than 20km from a given noise source so those locations are shown as "-" results.**

Airblast and Vibration

Airblast noise and vibration levels have been predicted to the nearest caves receiver locations and heritage receiver locations. The Wirrilimarra Community is 8.5km from the nearest pit and has also been considered. Impacts from blast noise and vibration to homesteads, accommodation villages, tourism sites (including Karijini Eco Retreat) and communities in the vicinity of the Proposal are demonstrated to be compliant with relevant criteria noting the distances to these receptors exceeds 8.5 km (LGA 2024).

Guidance on airblast noise and vibration levels to address the nearest heritage sites were assessed however, there are no applicable criteria. Blasting strategies will be developed based on the outcomes of the airblast noise

and vibration model in conjunction with the geotechnical surveys and monitoring to minimise impacts on sensitive heritage sites.

Ground vibration levels at the closest heritage sites, within 100 m are most critical. Cave integrity assessments have been undertaken for selected heritage caves.

Caves

PSM (2024) undertook geotechnical assessments of caves located within the Development Envelope and in close proximity to the northern extent of Fridge Hill pit, to understanding potential impacts due to Proposal blasting and operational vibration. This included an assessment of structural integrity and therefore safe vibration limits. To assist in assessing appropriate blasting limits for the caves, each site was assigned a qualitative susceptibility rating based on key geotechnical features observed in the cave and/or escarpment around the cave entrance, including:

- Identified specific potential rockfall hazard sources;
- Open/dilated defects;
- Structural controls on cave formation or stability (e.g. major joints, bedding);
- Interpreted potential for significant roof collapse events, including observations of:
    - Wide spans;
    - Flat roof profiles;
    - Persistent sub-horizontal bedding partings; and
    - Highly jointed and dilated rock mass.

Based on the assessment undertaken across 19 caves, four were considered low risk, 11 were considered medium risk and four were considered high risk.

14.4.3.3 Disturbance to broader cultural associations as a result of environmental changes to country

It is understood that each Traditional Owner group holds different values, practices and Lore associated with their ancestry and Country. As knowledge holders and the Traditional custodians of the land, Traditional Owners protect Country in accordance with Traditional lore.

The Traditional Owners hold an extensive body of biocultural knowledge on fauna and flora and pass this knowledge to the younger generations. Within the Development Envelope, 20 plant species have been identified as having cultural or traditional uses to Banjima People (**Appendix 25**). The Koodjeepindarrnna and Ngarlganoona pools/claypans are also habitats for migratory and local birds and invertebrate species during inundation and have cultural significance to Traditional Owners (ACHM 2024). The Mungurrdu site was identified during heritage surveys, which encapsulates the upper Fortescue River. The Fortescue Valley is part of a songline which extends the length of the Fortescue River to where it goes below ground at Millstream (Goode 2009). Traditional songs are shared during Lore time.

Changes to environmental values or the Fortescue River have the potential to disrupt this lineage and impact traditions. The potential environmental impacts to the claypans of the Fortescue River (including the Koodjeepindarrnna and Ngarlganoona pools and the Mungurrdu site) due to changes in hydrological regimes are discussed in more detail in **Section 7**.

Artificial light pollution can have impacts on the Banjima people, who are connected to their land and cultural practices in the Pilbara region of Western Australia.

Disruption of Traditional Practices: The Traditional Owners rely on the night sky for navigation, storytelling, and cultural ceremonies. Light pollution can obscure the visibility of stars and celestial bodies, disrupting these traditional practices.

Loss of Cultural Knowledge: Many Indigenous knowledge systems are tied to the night sky. Light pollution can hinder the transmission of this knowledge to younger generations, leading to a potential loss of cultural heritage

Surrounding sensitive receptors, including the Youngaleena and Wirrilimarra Communities and users of the Mulga Downs Pastoral Station or Karijini National Park may also have an altered experience in the area as a result of mining activities.

14.4.4 Cumulative Impacts

Banjima Traditional Owners raised concerns of cumulative impacts to country during consultation for this Proposal, as noted in **Section 14.3.2.1**. Traditional Owners hold a deep spiritual connection to the environment, as it encompasses Caring for Country, which according to traditional lore, is their responsibility to maintain.

The EPA raised the issue of cumulative environmental impacts of developments and projects within the Pilbara region (EPA 2014). The issues raised by the EPA include legacy mine pit lakes, water management, introduced species and native vegetation clearing. The Proposal and other projects in the Pilbara will have a cumulative impact on social surroundings values in the region. Nearby projects include (but are not limited to):

- HPPL- Mulga Downs Hub and Rail Spur – within the eastern boundary of the Development Envelope;
- HPPL - Murray's Hill Mine – within the Development Envelope;
- Fortescue Metals Group Limited (FMG) - Solomon Project Lower Fortescue Borefield Development (20 km west of the Development Envelope) and Solomon Rail (directly north of the Development Envelope); and
- Rio Tinto Iron Ore (RTIO) – Koodaideri (Gudai-Darri) Project and heavy haulage rail line - ~20 km south of the Development Envelope.

Cumulative Impacts are addressed in detail in **Section 17**.

14.5 Mitigation

The hierarchy of impact management (Avoid, Minimise, Rehabilitate/Monitoring) has been adopted and implemented for the Proposal by HPPL, in relation to the Social Surroundings environmental factor.

In response to the potential direct and indirect impacts identified in **Section 14.4** and the issues raised during consultation with Banjima Traditional Owners (**Section 14.3.3**), HPPL have proposed the mitigation measures in **Table 14-12**.

Table 14-12: Summary of consultation outcomes with Banjima Traditional Owners and proposed mitigation

Theme	Issue Raised	Proposed Mitigation
Cultural Awareness Induction Training	Banjima Traditional Owners requested input into the cultural awareness training and induction package.	Banjima will be provided opportunity to review and input into the cultural awareness induction and training.
Water	Water was identified as a key focal area for Banjima Traditional Owners. Both groundwater and surface water were raised, as well as responsible use of water and concern about the location and extend of managed aquifer recharge required for the Proposal. Identified potential indirect impacts to the DPLH lodged Mungurrdu heritage (40484) site through altered hydrological and hydrogeological processes was also raised.	Surface water management measures will be implemented for the Proposal, and design of the Proposal will consider mitigation of altered surface water flows to reduce indirect impacts on Mungurrdu through altered hydrology. The surface water management concept is to reinstate surface water flows downstream of Proposal infrastructure. The Water Management Plan prepared for the Proposal was provided to the Traditional Owners and their advisors for review and input and the feedback provided has been considered in preparing revised versions.
Amenity	Dust emissions and the impact from dust on Country (amenity) was raised as a concern by Banjima.	HPPL is committed to sealing the mine access road (northern haul road) to minimise dust emissions. In addition, dust management measures will be utilised by HPPL including water carts, road maintenance and other emerging technologies. HPPL will investigate the use of alternate dust suppression methods.
Environmental Management	Banjima have raised that environmental significance of the area in which the Proposal is situated is of high value and is considered culturally and environmentally important to the Banjima People	HPPL has committed to working with the Banjima Traditional Owners to ensure appropriate environmental management is incorporated throughout construction and operation of the Proposal. All management plans developed for the Proposal have been provided to the Traditional Owners and their advisors for review and input.
Cultural Heritage and Social Surroundings	The Proposal is located within an area that contains significant heritage and cultural associations. The original Proposal also included mining activities and supporting infrastructure within the DPLH lodged Mungurrdu heritage site. The original Proposal Development Envelope and footprint impacted directly on some key features that Banjima had concerns with.	HPPL is aware and will comply will all commitments as required under the AH Act and HPPL will continue to work with Banjima to develop a CHMP where required by Law. Indirect impacts to heritage such as through erosion and sedimentation, dust or altered hydrological regimes will be managed through the relevant management plans developed for the Proposal, of which Banjima and their Technical Advisors have been provided opportunity to review.
Life of Proposal and Closure Planning	Closure planning and the state of the environment after decommissioning of the Proposal were raised as key aspects for the Banjima People. “What will be left for our People?”	The Proposal will be implemented in accordance with the MCP prepared to support the Mining Proposal under the Mining Act. HPPL are committed to working with the Banjima Traditional Owners to develop this MCP, which will include commitments regarding closure objectives and measures, and the management of residual risk.

Theme	Issue Raised	Proposed Mitigation
Rehabilitation	Through consultation, the Banjima People identified that there are to be no pit lakes left on Banjima Country at the completion of mining.	HPPL have committed to ensuring all pits will be backfilled to ensure backfill is above the water table after settlement. This will avoid the creation of pit lakes at closure. HPPL is committed to caring for country and returning disturbed land to a state which ties into the surrounding landscape where possible. During the preparation and implementation of HPPL's Mine Closure Plan, HPPL will commit to ongoing engagement and involvement with the Banjima People in regard to rehabilitation and mine closure. HPPL will engage with the Banjima People on land rehabilitation matters including: • safe access to country; • final rehabilitated landform design; • social surroundings aspects; • designs that integrate into the surrounding landform; • that the land is left safe to humans and animals; • that the land is revegetated with native vegetation species consistent with surrounding land including species of bush tucker and bush medicine where possible. HPPL will provide Banjima the opportunity to review and comment on rehabilitation aspects as documented in the Mine Closure Plan including the final seed list used for rehabilitation. Training and work opportunities will be offered to the Banjima People for delivering this service.
Culturally significant flora and fauna	Impacts to culturally significant flora and fauna as a result of the Proposal are of concern to the Banjima People.	HPPL are committed to undertaking ethnobotanical surveys with Banjima. The results of these surveys and subsequent management measures will be included in the SCHMP.
Access	Banjima have requested access to certain areas in and around the Development Envelope during Proposal operation for hunting or other activities.	Access to certain areas within the Development Envelope will form part of the negotiation agreement between HPPL and Banjima.
Youngaleena Community	The Community is concerned regarding the potential impacts from dust, noise, water and visual impacts as a result of the Proposal on the Community.	HPPL is currently undertaking baseline data (dust and noise) monitoring at the Community, to further understand any potential impacts resulting from the Proposal. HPPL will monitor for dust, noise and water levels and quality at the Community during construction and operations.

The Proposal will be undertaken in accordance with a SCHMP which will be prepared in consultation with the Banjima People to outline any residual avoidance and management strategies to be implemented by the Proposal to manage potential impacts to Social Surroundings. The SCHMP will include the mitigation measures

already discussed with Banjima as outlined in **Table 14-12**.. The SCHMP will be treated as confidential to the Banjima Traditional Owner group.

A Heritage Agreement is in place between the company and the Banjima native title holders which sets out an agreed process by which heritage surveys are undertaken. Impacts to heritage sites (as identified through heritage surveys and in consultation with Banjima – **Section 14.3.4.1**) will be managed through the development of a CHMP. The CHMP will be developed and implemented in accordance with the AH Act, which will outline mitigation and management measures to be implemented by the Proposal for heritage sites. HPPL are aware and will comply with all obligations as required by legislation under the AH Act. Where possible, every effort will be made to avoid or reduce impacts to Aboriginal cultural heritage through the planning, design and construction phases.

Table 14-13 details the mitigation measures (avoidance, minimise and rehabilitate/monitoring) relevant for potential direct and indirect impacts to Social Surroundings from the Proposal. These measures have considered issues raised during consultation with Banjima Traditional Owners, and are in addition to the mitigation measures previously proposed as outcomes of previous consultation (**Table 14-12**). They are also in addition to mitigation measures that will be implemented for the Proposal generally, which address potential impacts associated with the other key environmental factors.

Table 14-13: Mitigation Measures for Social Surroundings

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Direct Impacts			
Disturbance to sites of social, cultural and heritage value	• Indicative Footprint amended to avoid key heritage sites with ongoing refinement of the Mine Plan to maximise site avoidance. • Development Envelope excludes the lodged Mungurrdu site. • Heritage sites will be demarcated and identified as no-go areas for site personnel prior to ground disturbing works. • Aboriginal cultural heritage, or suspected Aboriginal cultural heritage, must not be removed from any heritage place under any circumstance, unless authorised under the AH Act.	• Personnel must not enter an Aboriginal Cultural Heritage site or a Heritage Restriction Zone (HRZ) without prior consent. • Ongoing engagement with Traditional Owners to understand key impacts and avoid where possible. • Appropriate education of the workforce will occur through the implementation of a Cultural Awareness Training program. • Adherence to internal GDP procedures. • Maintenance of Traditional Owner access to culturally significant places where safe and practical. • Implement a CHMP. • Implement HPPL's Heritage Management Framework; a suite of management procedures.	• Impacts to specific sites of cultural and heritage significance, if unavoidable, will be discussed with Traditional Owners and Approvals sought under the AH Act. • Salvage of heritage material will be undertaken, where appropriate, in consultation with Traditional Owners, prior to direct impact. • Repatriation and restitution of salvaged Heritage material will be undertaken in consultation with Traditional Owners. • Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes in consultation with Traditional Owners and the objectives of the MCP, as required under the Mining Act. • Monitor sites of cultural and heritage significance and report new or unauthorised disturbances to culturally sensitive sites.
Restricting access to Country and ability to care for Country	• Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi Country.	• Ongoing consultation with Traditional Owners during the Proposal.	• Rehabilitation and closure undertaken to meet land use outcomes negotiated with Traditional Owner groups and MCP.

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
	• Indicative Footprint amended to avoid key heritage sites with ongoing refinement of the Mine Plan to maximise site avoidance and avoid access restrictions. • Development Envelope excludes the lodged Mungurrdu site.	• Maintenance of access to culturally significant places where safe and practical. • Implement a SCHMP. • Facilitate Banjima Traditional Owner involvement in monitoring activities where possible.	• Post-closure access to sites of cultural significance will be maintained. • Post-closure access restrictions will be limited only to areas immediately adjacent to remaining open pits (due to safety reasons).
Activities that may impact amenity such as alteration of landscape or installation of infrastructure	Impacts cannot be avoided and therefore minimisation and rehabilitation are the key mitigation measures.	• Minimise clearing areas as far as practicable. • Ongoing consultation with Traditional Owners during the Proposal. • Waste dumps will be designed to blend in with the surrounding landscape. • Implement a SCHMP. • Noise, dust and vibration mitigation measures to be implemented.	• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners and the objectives of the MCP, as required under the Mining Act. • Monitoring for dust, noise and visual impacts will be ongoing.
Indirect Impacts			
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including	Avoidance measures are not applicable, the focus will be on minimisation measures to reduce the likelihood of impacts.	• Implement the CHMP. • Implement water management measures, including implementation of the Water Management Plan. • Engagement with Traditional Owners to identify sites of cultural significance and avoid impacts to these sites where possible. • Minimise, as far as practicable, interactions with significant water features and impacts to surface water flow, including	• Monitoring surface water quality in accordance with a Water Management Plan. • WRDs at closure will be rehabilitated to ensure they are stable, non-poluting and revegetated. • Closure landforms are designed to minimise long-term impacts to

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
altered water quality		changes to the hydrological regimes of culturally significant water sources. • Minimise clearing and access restrictions within areas used for cultural purposes or areas that have cultural significance (e.g. at watercourse crossings). • Ensure sediment controls are in place during construction at waterway crossings. • Implement a SCHMP that is co-developed with the Banjima Traditional Owner group. • Implement waste rock management plan.	hydrological regimes associated with sites of cultural significance. • Groundwater recovery will be investigated and incorporated into the final MCP, to be submitted to support the Mining Proposal.
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and vibration	• Avoidance buffers of 25m (individual sites may have additional buffers applied in consultation with Banjima traditional owners) will be established around retained heritage sites within the Development Envelope, in consultation with Traditional Owners. These avoidance buffers will be demarcated and managed in accordance with appropriate site procedures. This will be monitored via the Ground Disturbance Permit process. • HPPL will consult with the Banjima Traditional Owners regarding asbestos management. The Proposal is located outside of the WAMA. HPPL is not proposing to undertake any mining in	• The Proponent will implement standard dust management measures to minimise potential airborne dust emissions and associated impacts to amenity. This includes (but is not limited to) use of dust suppression on access roads and open areas, water sprays for ore processing, transport and stockpiles, limiting the number and height of stockpiles, controlling/reducing trip distance and ensuring vehicles are confined to designated routes with speed limits strictly enforced. • Implement a CHMP. • Operating noise, vibration and potential mitigation measures (e.g. sound absorption devices) must be considered when selecting equipment. • Equipment must be fitted with appropriate noise reduction devices (where necessary) to comply with Proposal HSE and regulatory requirements.	• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners and the objectives of the MCP, as required under the Mining Act. • Monitor sites of cultural and heritage significance and the avoidance buffer zones. Report new or unauthorised disturbances to culturally sensitive sites and avoidance buffers.

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
	proximity to Wittenoom and has no intention to reopen Wittenoom.	• Blasting activities must be undertaken in accordance with Mines Safety Inspection Regulations 1995 and Noise Regulations. • Regularly inspect, maintain and replace mobile equipment so that noise levels are minimised during the equipment life. • Implement HPPL's Drill and Blast near ACH Procedure.	
Disturbance to broader cultural associations as a result of environmental changes to Country	• Direct impacts to claypans (including Koodjeepindarrnna and Ngarlganoona pools) and Fortescue valley are avoided through Proposal design. • Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi country.	• Implement a SCHMP. • Engagement with Traditional Owners to identify and avoid potential impacts where possible.	• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners, includingincorporation of bushtucker/ medicine species, and habitat for traditional hunting species and the objectives of the MCP, as required under the Mining Act. • Seed collection prior to/during construction and operations for use in rehabilitation with involvement of Traditional Owners. •

14.6 Assessment and Significance of Residual Impact

An assessment of the significance of residual impacts of the Proposal on Social Surroundings is presented in the following sections.

14.6.1 Direct Impacts

14.6.1.1 Disturbance to sites and areas of Social, Cultural and Heritage value

The Development Envelope for the Proposal contains 303 sites that have been identified as having cultural and heritage value to the Banjima Traditional Owners. Within the Indicative Footprint there are 41 sites of value (refer to **Figure 14-4**). Direct impacts to Aboriginal heritage sites resulting from the Proposal will be managed under the provisions of the AH Act and through the development and implementation of a CHMP where required under the Act.

The Development Envelope has been amended since the Proposal's initial referral to the EPA to exclude key sites of significance to the Banjima Traditional Owners. These include:

- Koodjeepindarrnna and Ngarlganoona pools; and
- Mungurrdu lodged DPLH heritage site.

The Indicative Footprint design has also been amended to further reduce impacts to sites with culture and heritage value to the Banjima Traditional Owners. It is expected that at least 85% of the sites within the Development Envelope will be avoided.

The avoidance, minimisation and rehabilitation measures outlined within **Section 14.5** have been developed to ensure that this direct impact is mitigated. HPPL will continue to engage with Banjima on the development of a CHMP in relation to the sites that will be impacted by the Proposal to inform the development and implementation of the proposed and additional mitigation and management measures, and will comply with legislative requirements under the AH Act. Given the above assessment, it is expected that there will be no significant residual impacts related to the disturbance to sites of Cultural and Heritage value.

14.6.1.2 Restricting Access to Country and Ability to Care for Country

During construction and operation of the Proposal, access to sites of cultural significance within the Development Envelope may be restricted due to safety reasons. Access to heritage sites by the Banjima Traditional Owners is currently being assessed during the negotiations undertaken for the Proposal.

The Mungurrdu DPLH lodged heritage site and the Koodjeepindarrnna and Ngarlganoona pools are located outside of the Development Envelope and therefore access to these areas will not be directly restricted.

HPPL commits to ongoing engagement with Banjima native title holders in relation to ongoing access into, or across, the Development Envelope, noting that heritage sites (including Mungurrdu) in close proximity to active mining areas may become inaccessible for periods of time for safety reasons. Access will be renewed following completion of works in the area and when it is considered safe.

HPPL intends to provide ongoing access during construction and operations through:

- Development of an access protocol through the negotiation of the project agreement;
- Involvement in flora, fauna and water monitoring;
- Involvement in heritage monitoring; and
- Potential creation of additional access tracks to specific Aboriginal cultural heritage of significance, if required.

HPPL will aim to provide ongoing access post-closure to sites and places of cultural significance. HPPL will also restrict workforce and contractors' access to Aboriginal cultural heritage within the Development Envelope except for the purposes of monitoring.

The above proposed management and mitigation commitments in relation to ongoing consultation, workforce and contractors' access to areas of cultural concern and the provision of ongoing access to the Development Envelope, are expected to be sufficient to minimise restrictions to country. After consideration of the above assessment and through the implementation of the mitigation measures outlined in **Section 14.5**, it is expected that there will be no significant residual impact related to restricting access to Country and the ability to care for Country.

14.6.1.3 Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure

The Proposal involves the development of a mine and associated mining infrastructure in a previously undisturbed area, contributing to potential direct impacts to amenity due to the alteration of the landscape. Proposal components that are potentially significant to visual amenity are the pits, WRDs, stockpiles, borrow pits and supporting infrastructure such as accommodation and workshops.

While visual impacts are expected at culturally significant sites during the construction and operations phase, mitigation measures outlined within **Section 14.5** will minimise impacts post-closure, including rehabilitation of disturbance, focussing on minimisation and rehabilitation/monitoring. Ongoing consultation will occur with the Traditional Owners on visual impacts from the proposed infrastructure and final landscape at closure. Through implementing these mitigation measures and ongoing consultation, no significant residual impacts are expected for this potential direct impact.

14.6.2 Indirect Impacts

14.6.2.1 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality

14.6.2.1.1 Altered hydrological and hydrogeological regimes

The key potential impacts of the Proposal to hydrological regimes are:

- Groundwater drawdown from orebody dewatering.
- Groundwater mounding from MAR to dispose of excess water with a predicted groundwater uplift to within 2.5 m below ground, causing vegetation health impacts and increased salt accumulation.

- Altered surface water flows and catchment modifications which may impact including creek lines, floodplains and the Fortescue Valley environmental and cultural assets resulting in a modification of inflows and potential changes to the persistence of water.

The conceptual ecohydrological model provides a basis for evaluating groundwater drawdown that could affect the Fortescue Valley vegetation and claypans. There is no observed or conceptualised groundwater contribution to any surface water features within the Development Envelope. Therefore, changes to groundwater levels are not anticipated to affect surface water features of cultural significance.

Further, no GDE's were identified in the Mulga East or Malay Well tenements and a reduction in groundwater levels is not predicted to impact the terrestrial environment. However, the predicted groundwater uplift to within 2.5 m could potentially interface with vegetation root systems and therefore the health and condition of native vegetation. This is discussed further in **Section 7**.

Mitigation and management of impacts as a result of alterations to groundwater levels and surface water flows are discussed in **Section 7** and include implementation of a WMP, pit optimisation and mine planning to reduce dewatering and MAR if required. The Proposal includes several operational MAR areas, to allow agile water management, where increases in MAR in some areas can happen if reductions in MAR in other areas are required. Additional mitigation measures for Social Surroundings values related to water are discussed in Section 14.5, including mine planning to manage surface water flows to Mungurrdu and the provision of the WMP to Banjima Traditional Owners and BNTAC for review and feedback.

The residual risks of reduced surface water flows to the environment (Fortescue Valley and associated features, including the Koodjeepindarrnna and Ngarlganoona pools) on the downstream side of the Proposal, are generally considered to be low. The Koodjeepindarrnna and Ngarlganoona pools are outside of the Development Envelope and located within catchments to the west and east of the mine disturbance areas which do not experience significant changes.

Impacts to surface water flows will be managed through the design and implementation of the surface water management measures (via the WMP) which will minimise the potential impact of altered surface water flows resulting from the Proposal on sites of Aboriginal significance to an acceptable level. HPPL will ensure compliance with Bed and Banks Permits, as required under the RiWI Act. In addition, HPPL will manage any sites of Aboriginal heritage significance in consultation with the Banjima Traditional Owners.

Ongoing monitoring for development of the Baseline Water Quality data set to monitor the potential impact of the Proposal on the downstream environment will be undertaken.

Based on the above assessment, it is considered that alterations to surface water flow and groundwater levels can be managed to ensure that there is no significant residual impact to heritage sites or areas of cultural significance.

14.6.2.1.2 Water quality

During construction and operation, the Proposal has the potential to contaminate surface water due to storage and handling of hazardous materials, hydrocarbons, and waste. Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur.

Modification of the physical water quality (i.e. suspended sediments) may occur in the downstream environment, which may be due to erosion of disturbed areas or diversion of surface water flows resulting in increased sediment loads to the Fortescue Valley and associated features, including the Koodjeepindarrnna and Ngarlganoona pools.

Potential impacts to surface water quality will be managed by appropriate storage and management of hydrocarbons and chemicals, diversion of stormwater around operating areas and diversion structures are design to capture and minimise sediment runoff to undisturbed areas and drainage lines. A Water Management Plan (**Appendix 6**) has been prepared which provides additional information on the surface water management measures proposed.

Groundwater contamination may occur from sources such as the WRD landforms or spills. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low.

Given the absence of observed or conceptualised groundwater contribution to any surface water features within the Development Envelope, changes in groundwater quality are not anticipated to affect surface water features of cultural significance. However, MAR may give rise to salt accumulation in the upper soil profile, resulting from the combined effects of increased evaporative concentration and/or reduced salt leaching into the deeper profile. If sustained over long periods, this could have adverse impacts on vegetation health by reducing soil water extractability. Water quality at claypans (including Koodjeepindarrnna and Ngarlganoona pools) could also be affected by salt loads in the upper profile. As discussed in Section 7.7.1 of the Inland Water Section, predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM.

With the recession of water table associated with decreased MAR, surviving tree root systems (i.e. above zone of prolonged saturation) would be expected to gradually recolonise the desaturated zone down to root impeding layers and salt flushing processes would be reinstated. A program of ongoing monitoring of groundwater levels and vegetation condition will be undertaken. Further, given no GDE's are present, any impacts to groundwater quality will not significantly impact the terrestrial environment.

Groundwater management and monitoring is outlined in the WMP (**Appendix 6**). Ongoing monitoring for development of the Baseline Water Quality data set to monitor the potential impact of the Proposal on the downstream environment will be undertaken.

Based on the above assessment, it is considered that water quality can be managed to ensure that there are no significant residual impacts to Aboriginal cultural heritage.

14.6.2.2 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust and noise and vibration

14.6.2.2.1 Dust

Dust could affect the amenity of the Development Envelope and surrounding area; however, the Proposal is remote from communities and other sensitive receptors and, as such, impacts to residences from dust are

expected to be limited. The amenity of places of cultural significance, heritage sites and the land in general may be affected by dust, but it is anticipated that dust impacts will be confined to the Development Envelope.

HPPL commits to implementing standard dust management measures to minimise airborne dust emissions and deposition outside of active mining areas. These measures are expected to minimise potential visible dust impacts within the Development Envelope.

The SCHMP will be updated as additional on-country consultation provides information in relation to the identification and management of impacts, including those related to dust emissions at culturally significant sites.

Dust may also interfere with physiological processes of vegetation (refer to **Section 8**), including bush tucker. However, the semi-arid environment of the Pilbara region is a naturally dusty environment with wind-blown dust a significant contributor to ambient dust levels in the region, hence, native vegetation is expected to be reasonably tolerant to dust deposition. Studies undertaken for Rio Tinto (Butler, 2009) suggest that the potential for adverse dust deposition impacts on plants is seasonally related. The study failed to identify any significant loss of plant function for exposures of Pilbara species to deposited crustal dust loadings on plant leaves of up to a high level of 7,500 g/m². Another study by Matsuki (2016) also found no evidence of negative impacts on plant health from dust deposition in semi-arid environments. This is considered likely to include any plants used for bush tucker, medicine or other cultural purposes. The Proposal has been designed to limit the potential for dust emissions.

HPPL will implement a number of dust management measures during construction and operation of the Proposal (**Section 14.5**); including, but not limited to:

- Use of dust suppression to manage dust generation from access roads and open areas;
- Use of water sprays to manage dust generation from ore processing, transport and stockpiles;
- Limit the number and height of stockpiles;
- Trip distances controlled and reduced where possible; and
- Vehicles confined to designated routes with speed limits strictly enforced.

Based on the above assessment, residual impacts to sites of cultural significance and surrounding sensitive receptors are not considered to be significant, due to the implementation of mitigation measures outlined in **Section 14.5**.

14.6.2.2.2 Noise and Vibration

The noise and vibration assessment conducted by LGA (2024) found that the criteria at one heritage receiver location was not achieved (MIB-MD13-042). The closest Heritage site (MIB-MD13-042) is 40 metres from the pit edge and therefore receives the highest noise level where mining teams work nearby. All other heritage site locations were found to be compliant with the adopted criteria (LGA 2024). For safety reasons it is expected that access to Traditional Owner, will be restricted in proximity (approximately 1 km) to work areas.

Guidance on airblast noise and vibration levels to address the nearest heritage sites were assessed, however, there are no applicable criteria. Blasting strategies will be developed based on the outcomes of the airblast noise

and vibration in conjunction with the geotechnical surveys and monitoring to minimise impacts on sensitive heritage sites.

Based on the PSM (2024) assessment undertaken across 19 caves, four were considered low risk, 11 were considered medium risk and four were considered high risk. To reduce the likelihood of significant damage above the natural background level of degradation, the recommended PPV limits were as follows:

- 75 mm/s for low to medium susceptibility caves; and
- 25 mm/s for high susceptibility caves (PSM, 2024).

The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes minimising disturbance to caves.

14.6.2.3 Disturbance to broader cultural associations as a result of environmental changes to country

HPPL recognises that important cultural values are held by Traditional Owners in relation to areas and landforms such as country, the night sky, waterways, waterholes and rock shelters. These areas are often associated with stories and songs which Traditional Owners hold sacred and pass on through generations.

Native fauna also has cultural value for hunting and other purposes. Fauna are expected to avoid and/or move away from the noise and activity of construction areas. With large areas of connected habitat surrounding the Development Envelope, this may result in a localised decrease in fauna abundance and diversity. Any impacts are expected to remain localised to the Development Envelope. Extensive areas of habitat will remain in the Development Envelope and surrounding areas which will continue to support culturally significant flora and native fauna.

In consideration of the above and by implementing the mitigation measures outlined in Section 14.5, including ongoing consultation with Traditional Owners, there is likely to be no significant residual impact to broader cultural associations as a result of environmental changes to country.

14.7 Significant Residual Impact

Overall, with the implementation of mitigation actions as formalised and detailed within management plans such as the SCHMP, impacts to Social Surroundings are considered manageable and that the EPA's objectives for this factor can be met. This will be managed via ongoing consultation with Banjima Traditional Owners and other stakeholders identified above.

14.8 Environmental Outcome

HPPL will implement the Proposal to ensure no significant, irreversible damage occurs to social surroundings values. In addition, HPPL are committed to minimise indirect impacts to the health of nearby communities or damage to Traditional Owner's spiritual connection to the environment. HPPL will implement the Proposal in alignment with an agreed policy and process for survey engagement, management, reporting, record keeping and the development of management plans.

An SCHMP will be co-developed and finalised with appropriate mitigation measures identified during consultation with Banjima Traditional Owners . Noting ongoing consultation is being undertaken, HPPL have identified in **Table 14-14** initial environmental outcomes for the Proposal for the Social Surroundings factor.

Table 14-14: Environmental Outcomes

Potential impact	Environmental Outcome
Direct impacts	
Disturbance to sites and areas of Social, Cultural and Heritage Values	The entire Development Envelope will be surveyed for heritage significance, impacts to sites will be managed via the AH Act. No disturbance to Aboriginal cultural heritage sites as identified in consultation with the Banjima Traditional Owners, unless consent is granted to disturb that site under the AH Act.
Restricting access to Country and Ability to Care for Country	Subject to reasonable health and safety requirements, no interruption of ongoing access to land utilised by the Banjima people.
Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure	The level of visual impact to be generally 'Low' with one area of 'Moderate' impact experienced at the Mulga Downs homestead, noting that this area has been identified as a contaminated site, is uninhabited and fenced off (VP04)
Indirect impacts	
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality	Groundwater drawdown and catchment area modifications will not materially impact on the key ecohydrological receptors. Potential impacts on claypans (including Koodjeepindarrnna and Ngarlganoona pools)can be managed to ensure they are not significant. Water quality and hydrological/hydrogeological regimes will be maintained and monitored through implementation of the Water Management Plan. Water quality and hydrological/hydrogeological regimes can be managed to ensure no significant impact to heritage sites or areas of cultural significance
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust and noise and vibration	No dust plumes originating from the Proposal received at sensitive receptors outside of the Development Envelope. Noise and vibration will be managed in accordance with relevant regulations (Table 14-1).
Disturbance to broader cultural associations as a result of environmental changes to country	No impacts to cultural associations outside the Development Envelope.

Based on the above, the Proposal is considered to be able to meet the EPA's objective for this factor. The mitigation measures adopted in the Proposal design phase together with the implementation of the proposed mitigation measures is expected to ensure that there are no significant residual impacts to Social Surroundings.

15 Other Factors

The ESD notes the following 'Other' factors which may be relevant to the Proposal. The potential impacts of the Proposal on these factors are addressed in **Table 15-1**:

- Landforms; and
- Human Health.

Table 15-1: Assessment of Other Environmental Factors

Factor	EPA Objective and Guidance	Receiving Environment	Assessment of Proposal Impact	Proposed Mitigation
Landforms	EPA Objective: "To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected." (EPA 2021a). EPA Guidance: Environmental Factor Guideline: Landforms (EPA 2018b).	The Pilbara landscape is one that has evolved over millions of years through several orogenic events, repeated and ongoing erosion and material deposition. The landscape is variable and closely related to the underlying geology, the structural geological features and weathering over time (van Vreeswyk et al. 2004; Pepper et al. 2013). The most noticeable (or dominant) features of the landscape that have evolved over time in the Pilbara region are the plateaus of the iron rich Hamersley and basaltic Chichester Ranges that traverse the craton from east to west over a distance of approximately 350km and reach elevations of up to 900mAHD and 600mAHD respectively (Pepper et al. 2013). The geomorphology within the Development Envelope and surrounding areas is closely related to the underlying geology. To the north it is dominated by the low, topographically subdued hills of the Chichester Ranges whilst to the south the landscape is dominated by the Fortescue River valley.	Baseline environmental surveys for the area of the Proposal and surrounds relevant to the 'Landforms' factor have been completed as outlined within Landloch (2009) and Mine Earth (2020). Mining activity will result in a direct residual direct effect (loss) on a portion of the Chichester Range landform through the excavation of mine pits and construction of waste landforms, over a linear distance of approximately 40 km. In consideration of the broader local extent of such landforms (noting Chichester Ranges extend ~350 km) and the extent of similar landforms across the wider Pilbara region, the effect of the Proposal to the Chichester Ranges landform is not considered to be environmentally significant. The Fortescue Valley is split by the Goodiadarrie Hills into the Fortescue Marsh to the east, and the Goodiadarrie Swamp to the west. The Proposal is fully contained within the Goodiadarrie Swamp catchment. The Goodiadarrie Swamp comprises a series of variably interconnected ephemeral swamps, claypans, and floodplains that form a wetland mosaic over a distance of 70 km. Collectively, the Goodiadarrie Swamp has an area of approximately 4,140 km^2. The Goodiadarrie Swamp catchment is bounded by the Chichester Range to the north and the Hamersley Range to the south (AQ2 2024a). Discharge of surface water into the Fortescue Valley is from the northern Chichester Ranges and the southern Hamersley Ranges. The Proposal will be developed to ensure the flow of surface water from the northern Chichester Range to the Lower Fortescue River valley is maintained and	HPPL propose to manage the potential effect of the Proposal to 'Landforms' through key management measures including: • Avoidance of Claypan habitat features within the Fortescue River Valley landform; • Surface water management structures designed to maintain natural patterns of surface water flow; and • Progressive and post-mining rehabilitation of landforms to restore flora and vegetation values and fauna habitat values. Based on the predicted impacts of the Proposal to the recorded landform values, subject to the implementation of the identified management measures (above), it is considered EPA objective for the environmental factor of 'Landforms' can be met.

Factor	EPA Objective and Guidance	Receiving Environment	Assessment of Proposal Impact	Proposed Mitigation
			sustained. Accordingly, the impact of the Proposal to the Fortescue River Valley landform is not anticipated to be significant.	
Human Health	EPA Objective: "To protect human health from significant harm." (EPA 2021a). EPA Guidance: Environmental Factor Guideline: Human Health (EPA 2016i).	The Proposal is located in a remote area of the Pilbara region in Western Australia. The nearest town is Tom Price which is located approximately 110 km to the southwest of the Development Envelope. Port Hedland is located approximately 210 km to the north, whilst Newman is located approximately 180 km to the east. The Youngaleena community is located approximately 12 km to the south of the Development Envelope. The Wirrilimarra community is located approximately 8.5 km to the east of the Development Envelope. There is no community at Wittenoom, as the town was degazetted in 2007 and closed in 2013 (DPLH 2021). Tourism in the immediate area surrounding the Development Envelope is very limited. Accommodation is provided (motel and caravan) at the Auski Roadhouse which is located approximately 24 km to the south east of the Development Envelope at the junction of Great Northern Hwy and Nanutarra-Munjina Rd. The nearest major tourist attraction is the Karijini National Park and the associated gorges within the park. The northern boundary of the National Park is located approximately 7.6 km to the south of the Development Envelope.	For the purposes of EIA, consideration of possible impacts to human health is largely confined to EIA of harmful emissions to air and harmful discharges to soil, inland waters and marine waters, that is through impacts to the physical environment. Because the consideration of the above health hazards are explicitly informed through other EPA guidelines, the assessment of impacts to human health provides the specific framework for considering the possible impacts to human health arising from the emission of radiation. The Proposal has no potential to cause or emit radiation that could impact on human health.	Not applicable. However, radioactive materials, if required, can be managed by under DEMIRS and DG Act.

16 Offsets

This section summarises the predicted significant residual environmental impacts associated with the Proposal and the offsets proposed.

The process of identifying significant residual impacts and determining appropriate offsets follows the framework provided by the WA Environmental Offsets Policy (GoWA 2011) and the WA Environmental Offsets Guidelines (GoWA 2014). While the Proposal is not undergoing an accredited assessment with the Commonwealth, the offsets proposed are appropriate and consistent with the EPBC Act Environmental Offsets Policy and have been developed to satisfy the offset requirements for both assessments.

16.1 Objective

Environmental offsets are actions that provide environmental benefits which counterbalance the significant residual environmental impacts or risks of a Proposal. Environmental offsets need only be applied where the residual impacts of a Proposal are determined to be significant, after avoidance, minimisation and rehabilitation have been pursued. Unlike mitigation actions, which occur on-site as part of the Proposal and reduce the direct impact of that Proposal, offsets are generally undertaken outside of the Development Envelope and counterbalance significant residual impacts.

To ensure consistency and transparency on whether offsets should be applied to a Proposal, the significance of residual impacts has been determined through the application of the residual impact significance model (RISM) provided in the Environmental Offsets guidelines. This model outlines how significance is determined and when an offset is likely to be required, or may be required, in relation to relevant EPA environmental factors and the relevant clearing principles in Schedule 5 of the EP Act (GoWA 2014). The mitigation hierarchy of 'avoid, minimise, rehabilitate and offset' has been considered in the assessment of this Proposal consistent with both State and Federal guidance and policy.

16.2 State Policy and Guidance

The rate, scale and nature of current and future development, combined with the impacts of other land uses and threatening processes, have raised the WA EPA's concerns about cumulative environmental impacts in the Pilbara region. In relation to the potential for significant residual impacts, the EPA (2014) identified concern regarding the regulation and management of cumulative impacts on native vegetation due to impacts from clearing, pastoralism, feral animals, weeds and climate change in the Pilbara, and the lack of reliable information on the extent and condition of native vegetation at a regional scale. The EPA has therefore determined that a proactive approach is required to compensate the clearing of native vegetation in the Pilbara and has established a strategic regional conservation initiative to consolidate and manage offset funds for the Pilbara, known as the Pilbara Environmental Offsets Fund (PEOF) (DWER 2021f).

The PEOF pools financial contributions for environmental offsets for Pilbara resource and infrastructure projects approved under the EP Act, which are conditioned in accordance with the WA Environmental Offsets Policy (GoWA 2011) and associated *WA Environmental Offsets Guidelines* (GoWA 2014). Financial contributions to the

PEOF will be used to implement conservation projects that counterbalance any significant residual impacts of those developments at a landscape level in the Pilbara.

Contributions to the PEOF to offset the significant residual impact from the clearing of native vegetation considered in 'Good to Excellent' condition has been used as the standard offset approach by the EPA and proponents in the Pilbara since 2012.

A draft Impact Reconciliation Procedure (IRP) (**Appendix 23**) has been prepared to support the assessment of the Proposal under both the EP Act and the EPBC Act. The purpose of the IRP is to outline the methodology that will be used to calculate the area of vegetation cleared. The IRP has been developed as per the *Instructions on how to prepare Environmental Protection Act 1986 Part IV Impact Reconciliation Procedures and Impact Reconciliation Reports*.

16.2.1 Consistency with State Offset Principles

The EPA notes that in establishing and implementing the PEOF, the WA Government has committed to ensuring that the offsets implemented via the PEOF are underpinned by the principles set out in the WA Environmental Offsets Policy (GoWA 2011). An assessment of the proposed offsets against these principles is provided in **Table 16-1**.

Table 16-1: Consideration of State Offset Principles

Principle	Consideration
Environmental offsets will only be considered after avoidance and mitigation options have been pursued.	• The Proposal design adopts the hierarchy of risk management to avoid, reduce, and mitigate environmental impacts. Designating a Indicative Footprint provides flexibility in considering alternative designs and locations of supporting infrastructure within the Development Envelope to minimise impacts on the environment. The location of non-fixed assets will be optimised within the Development Envelope through applying the risk management hierarchy; including: • Locating non-process infrastructure in areas where no or a low-density of conservation significant species of flora and fauna have been recorded; and • Considering alternative options for locating the airport or using existing facilities at other sites to reduce the total Indicative Footprint. • The following additional mitigation measures have been adopted through ongoing mine design and planning: • Avoid direct impacts to areas of high-value habitat through establishment of the FHEZ and the FHEZ Corridor. • Reduction in the amount of native vegetation clearing. This is further discussed in **Section 2.3.3**. • Surplus water will no longer be discharged to the environment. All surplus water not required for the operation of the mine will now be managed through MAR. • Opportunities to backfill the pit voids to above surrounding groundwater level, will be pursued • HPPL now intend to utilise a solar farm as a supplementary renewable energy power source. • Waste rock will initially be used to construct infrastructure (e.g. access roads and ramps, RoM and stockpile bases, drainage structures and safety bunds) with the

Principle	Consideration
	remainder stored in above ground WRDs or used to backfill pits. Based on amendment to the original referred Proposal, the approximate volume of waste rock to be mined over the LoM has reduced from 1,755.5 Mt to approximately160 Mt. • The application of the mitigation hierarchy for the Proposal has ensured that all practical avoidance and minimisation measures have been considered and pursued where appropriate. Offsets have only been considered for those significant impacts that are not able to be avoided or minimised
Environmental offsets are not appropriate for all projects	The identified significant residual impacts are considered appropriate to be offset as they are not considered to be either minor (too minor to require an offset) or likely to be considered environmentally unacceptable regardless of offsets.
Environmental offsets will be cost effective, as well as relevant and proportionate to the significance of the environmental value being impacted.	HPPL commits to providing financial offsets that are cost effective, relevant and proportionate to counterbalance the significant residual impacts to the identified environmental values. The offset rates are expected to be appropriate to the Fortescue Valley and Chichester sub-regions of the Pilbara. They include a base rate which applies to vegetation clearing generally and a higher rate that accounts for specialised environmental values.
Environmental offsets will be based on sound environmental information and knowledge.	The Pilbara is predominantly Crown land so traditional land acquisition offsets are not possible and on-ground conservation actions are difficult for a single proponent to implement due to tenure constraints including pastoral leases and mineral tenements. Contribution to the PEOF is not a traditional offset where, for example a single conservation project would need to consider sound environmental information and knowledge about a particular species or community. However, the conservation and research projects to be implemented at a broad-scale through the PEOF are intended to address the cumulative impacts of mining in the Pilbara as identified by the EPA and provide a more detailed understanding of conservation values in the Pilbara region to improve decision making regarding conservation and management.
Environmental offsets will be applied within a framework of adaptive management.	HPPL understands an adaptive management framework should be applied in relation to environmental offsets to take account of the potential risks. One of the key risks associated with the PEOF as an environmental offset being applied for the majority of projects in the Pilbara is managing the time lag between establishing offsets and generating the anticipated benefits. This challenge and the adaptive management framework around conservation outcomes are being addressed in the development of the PEOF mechanisms including partnerships, scheduling, procurement, funding arrangements, performance measures and reporting requirements in consultation with stakeholders.
Environmental offsets will be focussed on longer term strategic outcomes.	The EPA recognises that the establishment of the PEOF is consistent with this principle in that strategic approaches, such as the use of the PEOF, will provide a mechanism to coordinate implementation of offsets across a range of land tenures (GoWA 2014). The PEOF provides a strategic, coordinated approach to the application of environmental offsets to achieve broad-scale biodiversity conservation outcomes for the Pilbara region. HPPL recognises the commitment of the EPA to this strategic approach and is contributing via being a participant in the working group for establishment of the PEOF.

16.3 Assessment of Significant Residual Impact

Environmental offsets will only be applied where the residual impacts of the Proposal are determined to be significant after avoidance, minimisation and rehabilitation have been pursued (GoWA 2014). These measures have been detailed in the relevant impact assessments for each environmental factor (**Sections 7** to **14** of this ERD). **Section 16** outlines the significant residual impacts of the Proposal**.** In general, significant residual impacts include those that affect flora and fauna of conservation significance (such as declared rare flora and threatened

species that are protected by statute), areas within the formal conservation reserve system, important environmental systems, species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions. Significant residual impacts to environmental values recognised under WA legislation and policy and were determined in accordance with the RISM provided in the WA Environmental Offsets Guidelines (GoWA 2014).

Table 16-2: Residual Impact Significance Model (RISM)

Part IV Environmental Factors	Flora and Vegetation			Terrestrial Fauna		Subterranean Fauna	
	Rare Flora	Threatened Ecological Communities	Remnant Vegetation	Wetlands and Waterways	Conservation Areas	High Biological Diversity	Habitat For Fauna
Residual impact that is environmentally unacceptable and cannot be offset	None identified.	None identified.	None identified.	None identified.	None identified.	None identified	None identified.
Significant residual impacts that will require an offset – All significant residual impacts to species and ecosystems are protected by statute or where the cumulative impact is already at critical level	None identified.	None identified.	Clearing of up to 4,339.16 ha of native vegetation of which 4,296.93 ha is in 'Good' to' Excellent' condition and includes a PEC, riparian and sheetflow dependent vegetation. The Proposal is located within the Fortescue Valley and Chichester IBRA subregions. Contribution to the PEOF will be made at a dollar rate per ha of vegetation in Good to Excellent condition that is cleared.	Clearing of up to 4.31 ha of riparian vegetation.	None identified.	None identified	Based on the Indicative Footprint, the Proposal will involve the clearing of approximately 1,406.03 ha of 'high value' habitat for listed fauna species.
Significant residual impacts that may require an offset – Any significant residual impact to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed	None identified.	None identified.	None identified	None identified	None identified.	None identified	None identified

Residual impacts that are not significant	No Threatened flora species will be impacted. Direct impacts to three Priority flora species: *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638); *Triodia veniciae*; and *Dolichocarpa sp. Hamersley Station* (A.A. Mitchell PRP 1479) (Priority 3).	No TECs are present in the Development Envelope.	The Proposal will not impact any vegetation types that are highly cleared. All vegetation types occur extensively outside of the Development Envelope. Unmanaged, there is a potential for 335 ha of native vegetation to be indirectly impacted through changes to surface water flows. These areas will be monitored with contingency actions implemented as required to ensure these impacts do not occure.	The Development Envelope is within the Chichester Range, on the northern flanks of the Fortescue Valley. The Fortescue Valley comprises a network of interconnected ephemeral swamps, claypans and floodplains (Goodiadarrie Swamp), and is an ESA. The ESA is located outside the Development Envelope. The residual impacts of the Proposal to Inland Waters are not considered significant. HPPL considers the Proposal can be managed to meet the EPA's objective to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	There are no formal conservation areas within the Development Envelope. Nearby conservation reserves (including Karijini National Park) will not be impacted by the Proposal.	The Pilbara region has very high biodiversity value, possessing high species richness and many endemic flora and fauna species. The Proposal is within the Fortescue and Chichester bioregions, which are not nationally or internationally recognised biodiversity hotspots.	Impacts to the remaining fauna habitat types are not considered significant. The lithological units which represent likely stygofauna and troglofauna habitats, and which have shown to have ahigh diversity and abundance, are extensive and continuous over a wide area within and surrounding the Development Envelope.

Table 16-3: Environmental Offsets Table

Existing Environment	Mitigation			Significant Residual Impact
	Avoid and Minimise	**Rehabilitation**	**Rehabilitation Success**	
Flora and Vegetation				
The Proposal will result in the following impacts to flora and vegetation values: Clearing of up to 4,339.16 ha of native vegetation of which 4,296.93 ha is in Good to Excellent condition. 2,973.51 ha of sheetflow vegetation will be directly impacted. Loss of up to 70.31 ha of Four Plant Assemblages of the Wona Land System Priority 1 PEC. Loss of up to 4.31 ha of riparian vegetation, No Threatened flora species will be impacted by the Proposal. Individuals of three Priority flora species will be impacted.	Minimise clearing as far as practicable. Where possible Proposal elements have been located to avoid impacts on environmental factors. Avoid unnecessary clearing and ground disturbance: Utilise areas of existing disturbance before clearing of new ground where possible. Where possible Proposal elements have been located to minimise impacts on environmental factors. Clearing has been minimised within restricted vegetation communities where possible. Clearing has been minimised within locally significant vegetation communities where possible. HPPL will ensure clearing only occurs in approved ground disturbance. No more than 30% of individuals of the three Priority flora species: *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638); *Triodia veniciae*; and *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) will be impacted. Phase the works to enable progressive clearing and where possible progressive rehabilitation. Manage construction and operational works through an EMS. Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management.	Site specific, progressive rehabilitation as per Preliminary Mine Closure Plan (**Appendix 3**). Rehabilitation of land as soon as possible after completion of activities. HPPL will ensure stockpiled topsoil is signposted to prevent accidental use or degradation of soil resources. Topsoil will be progressively re-spread over temporary construction areas or utilised for future rehabilitation.	**Can the environmental values be rehabilitated? Evidence? Operator experience in undertaking rehabilitation?** All rehabilitation is undertaken in accordance with HPPL's Rehabilitation Procedures. HPPL is experienced in mine site rehabilitation as demonstrated at its existing Pilbara operations. **What is the type of vegetation being rehabilitated?** Rehabilitation will enable the pre-mining vegetation types to re-establish in cleared areas. **Time scale** Progressive rehabilitation will continue to be undertaken throughout the life of the Proposal where practicable, however the majority of the rehabilitation will be undertaken at closure.	**Extent** Clearing up to 4,339.16 ha of native vegetation. Quality Up to 4,296.93 ha of native vegetation in Good to Excellent condition. **Land tenure** Not applicable. **Time scale** Temporary clearing areas will be progressively rehabilitated.
Terrestrial Fauna				
The Proposal will result in the following impacts to terrestrial fauna: Clearing of up to 4,339.16 ha of fauna habitat within two Pilbara IBRA bio-subregions. Loss of high value fauna habitat.	Where possible Proposal elements have been located to avoid impacts on environmental factors. Avoid unnecessary clearing and ground disturbance: Utilise areas of existing disturbance before clearing of new ground where possible. HPPL has redesigned the Development Envelope to avoid 1,320.82 ha habitat (the FHEZ) which is considered as priority for the Pilbara Olive Python, Northern Quoll, Pilbara Leaf-nosed and Ghost Bat. The habitat includes Drainage Lines / Floodplain habitat which allows for dispersal of ground dwelling species. An additional FHEZ Corridor has also been proposed with contains an additional 991.45 ha habitat. Minimal ancillary related activities with be permitted within the FHEZ Corridor. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal.	Site specific, progressive rehabilitation as per Preliminary Mine Closure Plan (**Appendix 3**). Rehabilitation of land as soon as possible after completion of activities. HPPL will ensure stockpiled topsoil is signposted to prevent accidental use or degradation of soil resources. Topsoil will be progressively re-spread over temporary construction areas or utilised for future rehabilitation. Rehabilitation is expected to return disturbed areas to a stable and vegetated state, providing some habitat value for fauna over time.	**Can the environmental values be rehabilitated? Evidence? Operator experience in undertaking rehabilitation?** All rehabilitation is undertaken in accordance with HPPL's Rehabilitation Procedures. HPPL is experienced in mine site rehabilitation as demonstrated at its existing Pilbara operations. **What is the type of vegetation being rehabilitated?** Rehabilitation will enable the pre-mining vegetation types to re-establish in cleared areas. **Time scale** Progressive rehabilitation will continue to be undertaken throughout the life of the Proposal where practicable, however the majority of the rehabilitation will be undertaken at closure.	**Extent** Clearing of up to 4,339.16 ha of fauna habitat, including approximately 1,462.51 ha of high value fauna habitat, based on the Indicative Footprint. **Quality** Fauna habitat of high value to fauna species. Land tenure Not applicable. **Time scale** Temporary clearing areas will be progressively rehabilitated.

Existing Environment	Mitigation			Significant Residual Impact
	Avoid and Minimise	**Rehabilitation**	**Rehabilitation Success**	
	Creek line crossings will be designed to maintain flow, appropriately engineering culverts or bridges will be installed to allow access of fauna. HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with a GDP) Clearing will be managed as outlined in the CSFMP and as per the EMS. Directional lighting onto active construction areas to minimise the potential for light overspill in accordance with EMS; and Ensure staff and contractors are provided with appropriate training in regard to protection of significant fauna and associated habitats.			

16.4 Proposed Offsets

To offset clearing of vegetation, HPPL proposes offsets in the form of financial contributions to the PEOF, as outlined in **Table 16-4** which can be used to fund programs that will mitigate impacts to:

- Native vegetation in 'Good to Excellent' condition within the Fortescue and Chichester IBRA subregions which contains;
    - High value fauna habitat (Rocky Hills, Stony Spinifex Plains and Hillslopes, Drainage Lines / Floodplains and Gibber Cracking Clay);
    - PEC (Four Plant Assemblages of the Wona Land System Priority 1 PEC);
    - Other important vegetation (potential sheetflow); and
    - Riparian vegetation.

HPPL will continue to liaise with DWER in relation to identifying programs which could be supported by the offset funding for this Proposal. HPPL supports the use of the PEOF to fund the management of the environment by the Banjima People, either through a Banjima led program or a co-management approach between the Banjima People and HPPL.

The PEOF has set a per hectare rate for four IBRA subregions in the Pilbara bioregion. The PEOF rates are based on the following considerations:

- The level of biodiversity protection in the region, and
- Cumulative impacts to environmental values, including high quality vegetation and the conservation of significant-species habitat.

Generally, the rates are divided into either a base rate or a higher rate. The rates are applied as follows:

- Base rate – impacts to native vegetation in good to excellent condition, which may include impacts to fauna habitat; and
- Higher rate – types of specialised environmental values, including but not limited to impacts on:
    - Riparian vegetation;
    - Threatened or Priority ecological communities;
    - Important vegetation types; and
    - Specialised fauna habitat.

Areas requiring offsets outlined below are conservative estimates based upon the most current mine planning information at the time of preparing this ERD. The actual quantum of impact and offsets required will be determined through an Impact Reconciliation Procedure (IRP; **Appendix 23**). The proposed offset rates and the estimated areas are provided in **Table 16-4**.

Table 16-4: PEOF Offset Values

Environmental Values	IBRA subregion	Offset Rate ($/ha)	Residual Impact Area (Ha)
Base rate			
Native vegetation in good to excellent condition	Fortescue	$1,972	0.00
Native vegetation in good to excellent condition	Chichester	$932	0.38
Higher rate			
Native vegetation in good to excellent condition, including:	Fortescue	$3,944	4,053.80
Riparian vegetation			4.31
Other important vegetation (sheet flow)			2,957.17
High Value fauna habitat			1,266.33
Native vegetation in good to excellent condition, including:	Chichester	$1,864	243.12
Four Plant Assemblages of the Wona Land System PEC (P1)			70.31
Other important vegetation (sheet flow)			16.34
High value fauna habitat			196.18

16.5 Impact Reconciliation

A draft IRP, that is consistent with the EPA's Instruction for preparing IRPs, has been prepared by HPPL and is provided in **Appendix 23**. The draft IRP has been prepared to support the assessment of the Proposal under both the EP Act and the EPBC Act.

Clearing required for the Proposal will be offset at the rates for the Chichester and Fortescue Plains sub-regions based on 2023/24 financial year rates and subject to annual indexation based on CPI (DWER 2021f).

HanRoy's Ground Disturbance Permit Procedure will apply to all ground disturbance undertaken for the Proposal. This ensures all clearing complies with relevant approval boundaries, limits and conditions. Following ground disturbing activities, HPPL will utilise on-site visual inspection and aerial imagery in combination with baseline mapping shapefiles and GIS technology to determine the extent of native vegetation and terrestrial fauna habitat cleared at the end of each financial year within the reporting period.

HPPL will prepare Impact Reconciliation Reports (IRRs) to document the actual clearing undertaken. The IRR(s) will be provided to DCCEEW and DWER to enable the contributions payable to be confirmed.

17 Cumulative Impact Assessment

In determining the significance of an impact, it is important to also consider the impacts at the regional scale. The cumulative impact assessment process considers both direct and indirect impacts that may combine over time and/or space, for example the potential for multiple mining projects to affect environmental values within a region. In isolation, a project may not be considered to have a significant impact, however, when considered along with other projects, activities and threats in the region, the cumulative impacts may be significant (EPA, 2014).

In consideration of the cumulative impacts of multiple projects in the Pilbara, the EPA prepared strategic advice under s16I of the EP Act, *Cumulative environmental impacts of development in the Pilbara region* (EPA, 2014). In this report, the EPA acknowledged that the Pilbara region is a national biodiversity hotspot. It is characterised as an area of very high biodiversity, with high species richness and many endemic flora and fauna species. The WA EPA also recognised that the Pilbara is an important area for the mining industry. The region is likely to remain the principal area for iron ore mining for the next 50 years, given the size of the iron ore reserves (DWER 2019, JBS&G 2022).

The EPA also recognised that the scale and nature of the clearing within the Pilbara has additional consequences. These include loss and fragmentation of fauna habitat, interruption of and changes in overland surface water flows, and reduced vegetation condition and fauna population resilience through mechanisms such as changes in fire regimes and increased feral pests and weeds (DPaW 2017b, JBS&G 2022).

The Development Envelope is situated in the upper section of the Fortescue River Valley and is located between the Chichester and Hamersley Ranges. The Fortescue Marsh is located approximately 60 km upstream of the Proposal. Therefore, as part of the assessment, the EPA Report 1484 (advice under s. 16(e)) – *Environmental and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area* (EPA 2013), will also be considered. As outlined in the approved ESD for the Proposal, the CIA will consider the environmental effects of surrounding projects and activities within 100 km of the Proposal, with a total area of 3,141,588.47ha.

There is the potential for cumulative impacts on the environmental values for the following factors:

- Inland Waters;
- Flora and Vegetation;
- Terrestrial Fauna;
- Subterranean Fauna;
- Greenhouse Gas emissions;
- Terrestrial Environmental Quality;
- Air Quality; and
- Social Surroundings.

The following section presents the findings of the Cumulative Impact Assessment for the Proposal in context with the environmental effects of past and existing projects in the area, including reasonably foreseeable

projects which have not yet commenced. Projects considered in the cumulative impact assessment are presented in **Table 17-1** and shown in **Figure 17-1**.

The following assumptions apply to the cumulative impact assessment:

- The cumulative impact assessment has been undertaken using publicly available spatial data.
- Existing and proposed disturbances not associated with EP Act approvals could not be considered in a consistent and robust manner as no spatial data is publicly available. Cumulative impact calculations therefore do not take into consideration areas outside of those assessed under the EP Act;
- Given disturbance approved under the EP Act is within a Development Envelope or Purpose Permit boundary, cumulative impacts resulting from third-Party operations used in this assessment are conservative as the actual extent of clearing within those boundaries is likely to be significantly less.
- The Local Assessment Area for the purpose of the assessment is 100 km with a total area of 3,141,588.47ha, as required by the ESD, from the centroid of the Development Envelope. This assessment boundary has been applied to all relevant environmental factors, with the exception of Social Surrounds. The Regional Assessment Area is the Pilbara Bioregion with an area of 17,831,891.67ha. Refer to **Table 17-1** and **Figure 17-1.**
- The cumulative assessment for Social Surrounds has been undertaken within the Banjima Native Title Determination Area (refer to **Figure 17-10**).

Table 17-1: Projects within the Local Assessment Boundary

Existing Approved Proposal	Description
Roy Hill Infrastructure Mulga Downs Hub and Rail Spur (under assessment)	The Mulga Downs Hub and Rail Spur is located approximately 210 km south of Port Hedland and 180 km northwest of Newman in the Pilbara region of Western Australia. The Mulga Downs Hub and Rail Spur is for the development of a hub and rail spur to connect into the existing Roy Hill Railway for the transport of iron ore to Port Hedland. The Mulga Downs Hub and Rail Spur includes, and is not limited to, truck unloading and train loading facilities, product rehandling facilities, stockyards, a laboratory, a rail loop and rail service tracks, lateral access roads, rail associated infrastructure including a rail spur line, passing loops, sidings fibre optic cable, telecommunications towers, access tracks, borrow pits and laydown areas. Additionally, the Mulga Downs Hub and Rail Spur will contain bulk fuel storage and fuelling facility, energy supply infrastructure, ancillary buildings, wastewater treatment plant, accommodation village and an airstrip. Included are access roads for haul, construction, and light vehicles. Construction and operations water supply/bores and water storage will also be required. The Mulga Downs Hub and Rail Spur is located within a Development Envelope no greater than 17,714.01 ha and will require clearing of no more than 2,304.74 ha of native vegetation.
Mount Bruce Mining Pty Limited, Koodaideri Iron Ore Mine and Infrastructure Project (MS 0999)	An open cut iron ore mine and associated infrastructure for the extraction, processing and transport of iron ore. The Koodaideri Iron Ore Mine and Infrastructure Project is located approximately 110 km west-north-west of Newman in the Pilbara region of Western Australia and Includes a 167 km railway connecting the main network operated by Rio Tinto's Iron Ore business.
RHI Rail Mainline (MS 847)	RHIO operates a single heavy haulage rail line facility to Port Hedland. Referral documentation is no longer publicly available. The EPA report does not contain sufficient information to consider this project in the Cumulative Impact Assessment.
FMG Cloudbreak Iron Ore Mine and Life of Mine Expansion (MS 0899)	The Cloudbreak mine comprises an open pit mining operation, borefield, reinjection borefield and associated project infrastructure. It is located approximately 90 km to the east of the Proposal. Cloudbreak shares heavy haulage rail line facilities with Christmas Creek. The Proposal crosses the Cloudbreak/Christmas Creek rail line towards the northern boundary of the Development Envelope.

Existing Approved Proposal	Description
FMG Eliwana Railway Project (MS 1108)	The Eliwana 120 km heavy haulage rail line traverses the Chichester Ranges, Yule River catchment and Fortescue River Valley. The rail line may impact flora/vegetation and terrestrial fauna values of these areas and surface water flows to the north into the Yule River Valley.
FMG Solomon Iron Ore Project – Sustaining Production (MS 1062)	An iron ore mining and export operation based on iron ore resources located on the central Hamersley Ranges, approximately 60 km north of Tom Price, Western Australia. The FMG Solomon Mine involves the establishment and operation of the two mining areas (and associated infrastructure) and the construction and operation of a railway connecting the mining areas to Fortescue's existing Port Hedland to Cloudbreak rail line.
FMG Eliwana Mine (MS 1109)	The Lower Fortescue Borefield Development is located immediately to the south-west of E 47/1315 and the proposed groundwater supply borefield. Drawdown impacts related to the abstraction of groundwater may overlap those anticipated from the proposed E 47/1315 borefield.
BHP Pilbara Strategic Proposal	Strategic Proposal for future iron ore mining and associated activities and operations. New Operations include Caramulla, Coondiner, Gurinbiddy, Jinidi, Marillana, Mindy, Ministers North, Mudlark Munjina/Upper Marillana, Ophthalmia/Prairie Down, Rocklea, Roy Hill, Tandanya. Future expansions to new operations to these and existing mining operations at Jimblebar, Mining Area C, Newman and Yandi
HPPL Murray's Hill project	Refer to Section 2.2.5.1.
Brockman Mining Limited, Marillana Iron Ore Project (MS 855)	The Marillana iron ore project is a 700-750 Million tonne (Mt) iron ore mine, processing facility and associated infrastructure in the Pilbara Region of Western Australia. The project area is located approximately 100km north west of Newman in the Fortescue Valley, approximately 15 km south of the Fortescue Marsh. Note: The PER is not available on the EPA website. Therefore only information from the EPA Assessment Report (1376) is available.
FMG Pilbara Transmission Project (not assessed)	Pilbara Energy Company Pty Ltd (PEC), a wholly owned subsidiary of Fortescue Metals Group Limited (Fortescue), is proposing to develop the Pilbara Transmission Project (the Project), a high voltage transmission network in the Pilbara region of Western Australia. The Project comprises: • 220 kV overhead powerline infrastructure • terminal, substation and gantry infrastructure. The Project follows existing Fortescue rail corridors from Port Hedland to the Cloudbreak and Solomon mine sites and is approximately 375 km in length with pylons located approximately 300 m apart and at changes of direction/vertices.
Pilbara Energy Generation Project	Within cleared area of the Solomon Iron Ore Mine. Not considered further in this assessment.
Hamersley Iron Marandoo Iron Ore Project (MS 1020)	The Marandoo Mine Phase 1 is located in the central Pilbara region of Western Australia, approximately 37 km east of Tom Price and 77 km north-east of Paraburdoo. The mining component of the Project is confined to the existing Marandoo mine lease which was excised from Karijini National Park in 1991.

The total extent of disturbance within the Local Assessment Area for projects considered in the assessment and the additional disturbance proposed as a result of the Proposal is provided in **Table 17-2**. Approved projects represent 41.10% of the Local Assessment Area and the Proposal contributes an additional 0.14%.

Table 17-2: Cumulative Impacts within the Local Assessment Area

Description	Extent	
	Ha	% of Local Assessment Area
Extent of Local Assessment Area*	3,141,588.47	100
Extent of disturbance for approved projects	1,291,169.66	41.10
The Proposal (Proposed disturbance)	4,339.16	0.14

*Included the proposal development envelope

Figure 17-1: Projects in the Local and Regional Assessment Areas

Legend

Legend
- Development Envelope
- 100km buffer
- EPA Referred Significant Proposals (DWER-120)
- Clearing Instruments Proposals (Areas Applied to Clear) (DWER-075)
- Pilbara IBRA region (DCCEEW)

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Client: Hancock Prospecting Pty Ltd

Version: A | Date: 30-Mar-2025

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0 20 40
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PROJECTS IN THE LOCAL AND REGIONAL ASSESSMENT AREAS

FIGURE 17.1

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Image Reference: World Imagery: Earthstar Geographics

17.1 Inland Waters

The Proposal and other projects in the region may have a cumulative impact on inland waters at a regional scale through:

- Changes in surface hydrological regimes;
- Changes in groundwater levels through abstraction and/or reinjection.

17.1.1 Surface Water

As discussed in Section 6 the Development Envelope is located within the Chichester Ranges, on the northern flanks of the Lower Fortescue Valley which drains into Goodiadarrie Swamp which is fed by multiple surface water catchments (**Figure 7-1**). The Development Envelope intersects 16 delineated water catchment areas. East of the Development Envelope, the Goodiadarrie Hills form the western boundary of the Upper Fortescue River Catchment, disconnecting the Fortescue Valley in the vicinity of the Proposal from the Fortescue Marsh to the east (AQ2 2024b).

The Fortescue Valley (shown as the ESA) (**Figure 7-29**) and identified as DIWA066 is bound by the Chichester Range to the north and the Hamersley Range to the south. It comprises an extensive network of interconnected ephemeral claypans and broad floodplains which extend further to the west toward Mt Florance Station. Major surface water features, such as the Koodjeepindarranna and Gnalka Gnoona Claypans have developed at the interface of the alluvial fan margins and extensive shallow calcrete associated with the valley floor paleodrainage (AQ2, 2024a). Catchment inflows occur from the north and south, with the Development Envelope intersecting the northern flow path of the catchments of both wetlands (AQ2 2024).

The claypans are subject to frequent inundation associated with surface runoff from alluvial fans to the north and south of the Fortescue Valley following moderate to large rainfall events. Impacts from construction activities, clearing of native vegetation, and landforms and drainage channels on the alluvial fans may be subject to erosion and may lead to deposition of sediments within the claypans if not managed.

Cumulative impacts to the Fortescue Valley and the associated claypans are not considered significant from the Murray's Hill Project and diversion of surface water drainage has been assessed as part of the MDIOM Proposal's groundwater and surface water impact assessment in AQ2 (2024b). The mine development areas will cause a reduction in surface water flows to the environment on the downstream side of the Project, particularly around the Fridge Hill mining area, due to a reduction in contributing catchment areas. To reduce the impact of the mine development on the hydrological regime of the downstream and upstream environments, surface water diversions are proposed to divert water around mine development areas and reduce the likelihood of ponding.

The residual risks of the Project to the hydrological environment have been assessed taking into account the proposed mitigation measures and the results of the flood modelling and claypan water balance modelling. As discussed in Section 7, the residual risks were generally considered to be low.

A Water Management Plan (HanRoy 2024) has been prepared and provides additional information on the surface water management measures proposed.

The proposed surface water management measures (including culverts/bridge, stream training, grading of ground along the alignments to the culverts and erosion protection measures) of the Mulga Downs Hub and Rail project will minimise disruption to the surface water regime and reduce the potential effect of the rail alignments on environmental receptors such as the Fortescue Valley. Cumulative impacts are therefore considered to not be significant (Calibre 2022).

17.1.2 Groundwater

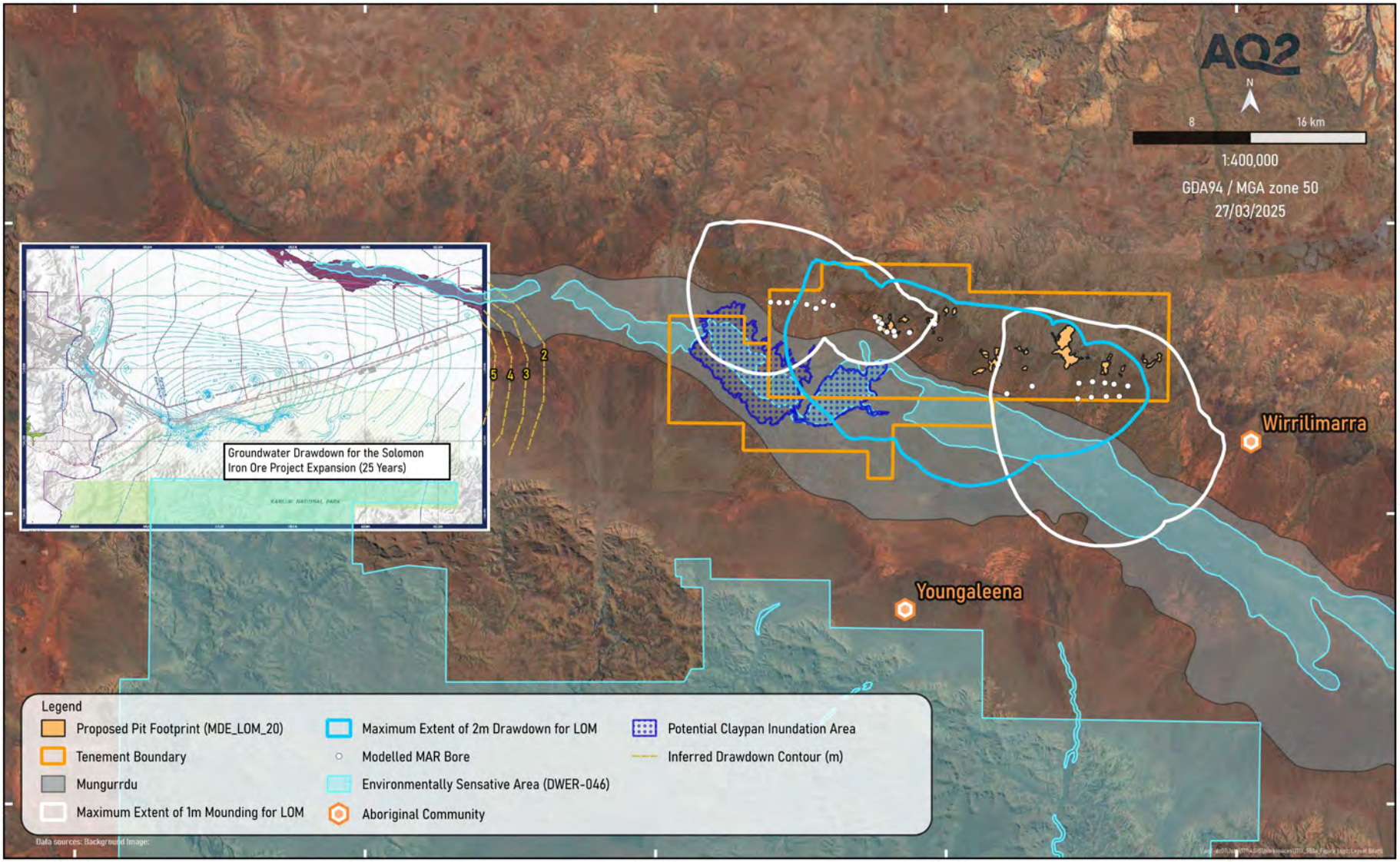
Other than Murray's Hill and Mulga Downs Hub and Rail Spur, the groundwater drawdown extent and surface water discharge extents from the Proposal do not overlap with impacts from other projects. Based on the available data for the proposed Solomon Iron Ore Expansion Project (Fortescue 2015), the predicted maximum extent of the 2m drawdown contour for the Proposal is ~16.5 km from the inferred 2m drawdown contours for the Solomon Iron Ore Expansion Project **(Figure 17-2)**.

Mining related to the Murray's Hill Proposal will not be below the groundwater table therefore eliminating the need for groundwater abstraction for dewatering. The average water demand for the Murray's Hill Proposal during both construction (6 months) and operation (5 years) is 3 ML/d (1.1 GL/yr), with the operation of the Murray's Hill Proposal anticipated to overlap with the commencement of the MDIOM Proposal. The water supply will be sourced from groundwater, within the mining / MAR areas for the MDIOM Proposal. Earlier groundwater abstraction in these areas will provide advanced dewatering and / or increased MAR capacity. As such, and as the water demands for the Murray's Hill Proposal are relatively small compared to the predicted dewatering for the mine (ie up to 11.4 GL/yr), the early groundwater abstraction for supply purposes are not anticipated to have a significant effect on the modelled drawdown / drawup with respect to impact assessment.

As the Mulga Downs Hub and Rail Spur will only commence once the MDIOM Proposal is in operation, the short-term water demands for the southern extent of the Hub and Spur intend to be sourced from the dewatering discharge at the mine. As such there will be no additional drawdown impacts from the Hub and Rail Spur in to the Fortescue Valley.

Groundwater abstraction at nearby communities and for pastoral activities are also considered minor in comparison to the potential impacts associated with the Proposal.

Figure 17-2: Maximum drawdown modelled (source AQ2)


600000E
620000E
640000E
660000E
680000E
7560000N
7540000N
7520000N
AQ2
N
8
16 km
1:400,000
GDA94 / MGA zone 50
27/03/2025
Groundwater Drawdown for the Solomon Iron Ore Project Expansion (25 Years)
5
4
3
2
Wirrilimarra
Youngaleena
Legend
Proposed Pit Footprint (MDE_LOM_20)
Tenement Boundary
Mungurrdu
Maximum Extent of 1m Mounding for LOM
Maximum Extent of 2m Drawdown for LOM
Modelled MAR Bore
Environmentally Sensative Area (DWER-046)
Aboriginal Community
Potential Claypan Inundation Area
Inferred Drawdown Contour (m)
Data sources: Background Image:

17.2 Vegetation and Flora

17.2.1 Land Systems

There are 48 land systems in the Local Assessment Area, of which 10 are inside the Development Envelope (Figure 17-3 and Figure 17-4). Potential cumulative impacts to these land systems are assessed in Table 17-3 for the Local and Regional Assessment Areas. One of these land systems, the Jamindie Land System, was identified as under 'Moderate threat in the EPA's report on the *cumulative environmental impacts of development in the Pilbara region* (EPA, 2014). The other nine land systems were not identified as being under threat.

Impacts to the Jamindie land System from approved projects in the Local and Regional Assessment Areas are 0.06% and 0.02% respectively, of which the Proposal contributes 3.40% and 1.31%.

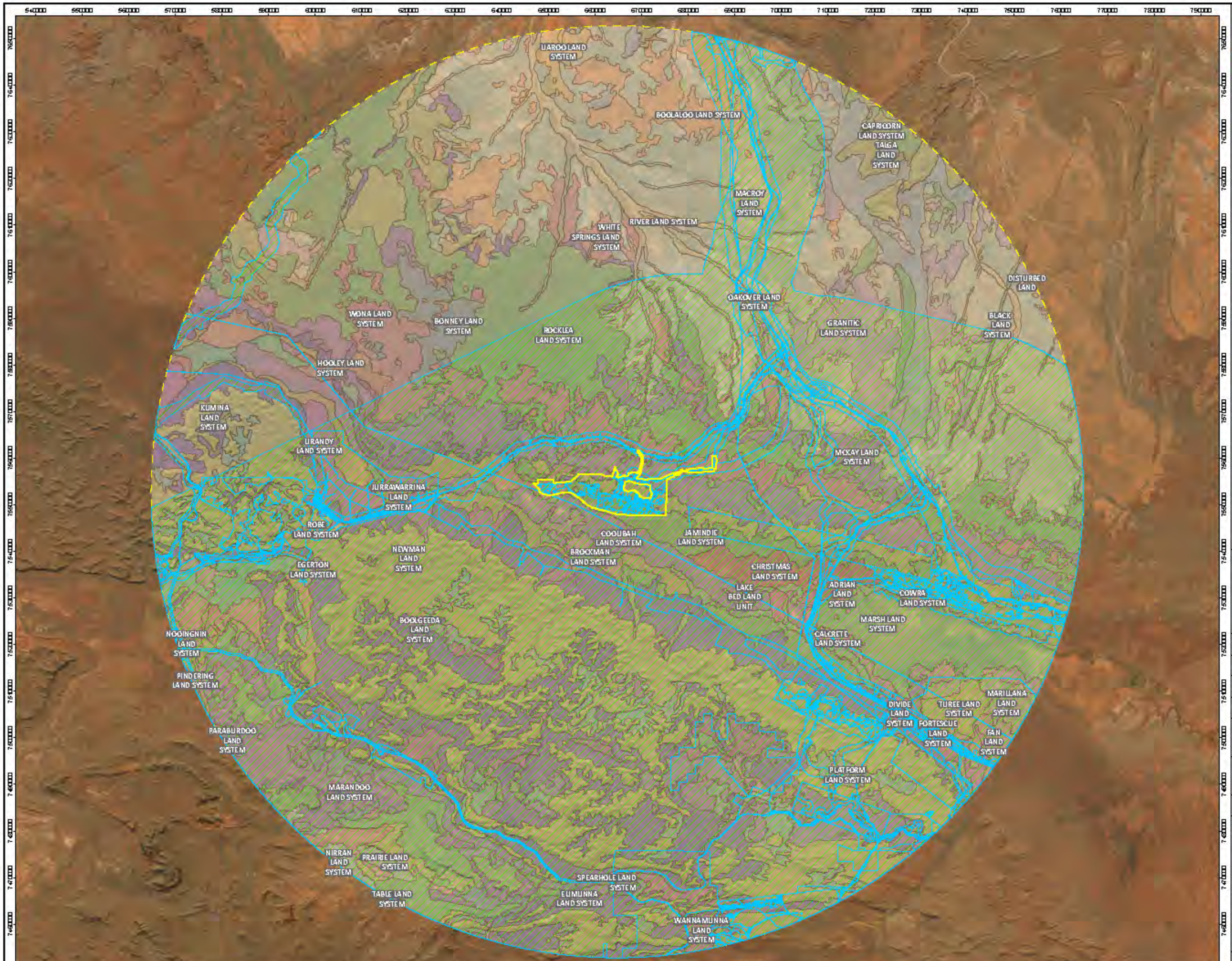
Based on the assessment, the Proposal does not significantly contribute to cumulative impacts to land systems within the Regional or Local Assessment Areas.

Table 17-3: Cumulative Impacts to Land Systems

Land System	Approved Impact Area (ha)	The Proposal Area of Impact (ha)	Local Impact			Regional Impact	
			Local Assessment Area Total (Ha)	Proposal Contribution (%)	Total Local Cumulative Impact (%)	Extent Regional Assessment Area (ha)	Proposal Contribution (%)
Bonney System	97.47	4.99	4762.31	0.10	2.15	74,940.55	0.01
Boolgeeda System	18,640.12	238.79	332,110.72	0.07	5.68	961,637.09	0.02
Brockman System	5872.12	16.11	11,845.19	0.14	49.71	74,108.02	0.02
Hooley System	705.61	488.56	7,116.41	6.87	16.78	59,081.14	0.83
Jamindie System	42.06	2,515.15	74,079.51	3.40	3.45	192,227.17	1.31
Jurrawarrina System	1,147.05	0	22,693.38	0.00	5.05	66,474.69	0.00
McKay System	6,731.17	87.67	177,414.74	0.05	3.84	426,144.89	0.02
Newman System	24,647.66	834.30	442,187.47	0.19	5.76	1,993,744.45	0.04

Land System	Approved Impact Area (ha)	The Proposal Area of Impact (ha)	Local Impact			Regional Impact	
			Local Assessment Area Total (Ha)	Proposal Contribution (%)	Total Local Cumulative Impact (%)	Extent Regional Assessment Area (ha)	Proposal Contribution (%)
Rocklea	1,659.80	66.02	99,993.46	0.07	1.73	2,881,635.56	0.00
Wona System	239.08	87.56	25,301.73	0.35	1.29	194,821.41	0.04

Figure 17-3: Cumulative Impact Assessment – Land Systems



Legend
- Development Envelope
- 100km buffer
- EPA Referred Significant Proposals (DWER- 120)
- Clearing Instruments Proposals (Areas Applied to Clear) (DWER-DFS)

Soil Landscape Mapping - Rangelands (DPIRD-053)
- Adrian Land System
- Black Land System
- Bonney Land System
- Bodaloo Land System
- Bodgeeda Land System
- Brockman Land System
- Calcrete Land System
- Capricorn Land System
- Christmas Land System
- Coolibah Land System
- Cowra Land System
- Disturbed land
- Divide Land System
- Egerton Land System
- Ellmunna Land System
- Fan Land System
- Fortescue Land System
- Granitic Land System
- Hooley Land System
- Jamindie Land System
- Jurrawarrina Land System
- Kumina Land System
- Lake bed land unit
- Macroy Land System
- Marandoo Land System
- Marillana Land System
- Marsh Land System
- Mckay Land System
- Newman Land System
- Nimin Land System
- Noogingnin Land System
- Oakover Land System
- Paraburdoo Land System
- Pindering Land System
- Platform Land System
- Prairie Land System
- River Land System
- Robe Land System
- Rocklea Land System
- Spearhole Land System
- Table Land System
- Taiga Land System
- Turee Land System
- Uaroo Land System
- Urandy Land System
- Wannamunna Land System
- White Springs Land System
- Wona Land System

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Scale 1:740,000 at A3

0 10 20
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

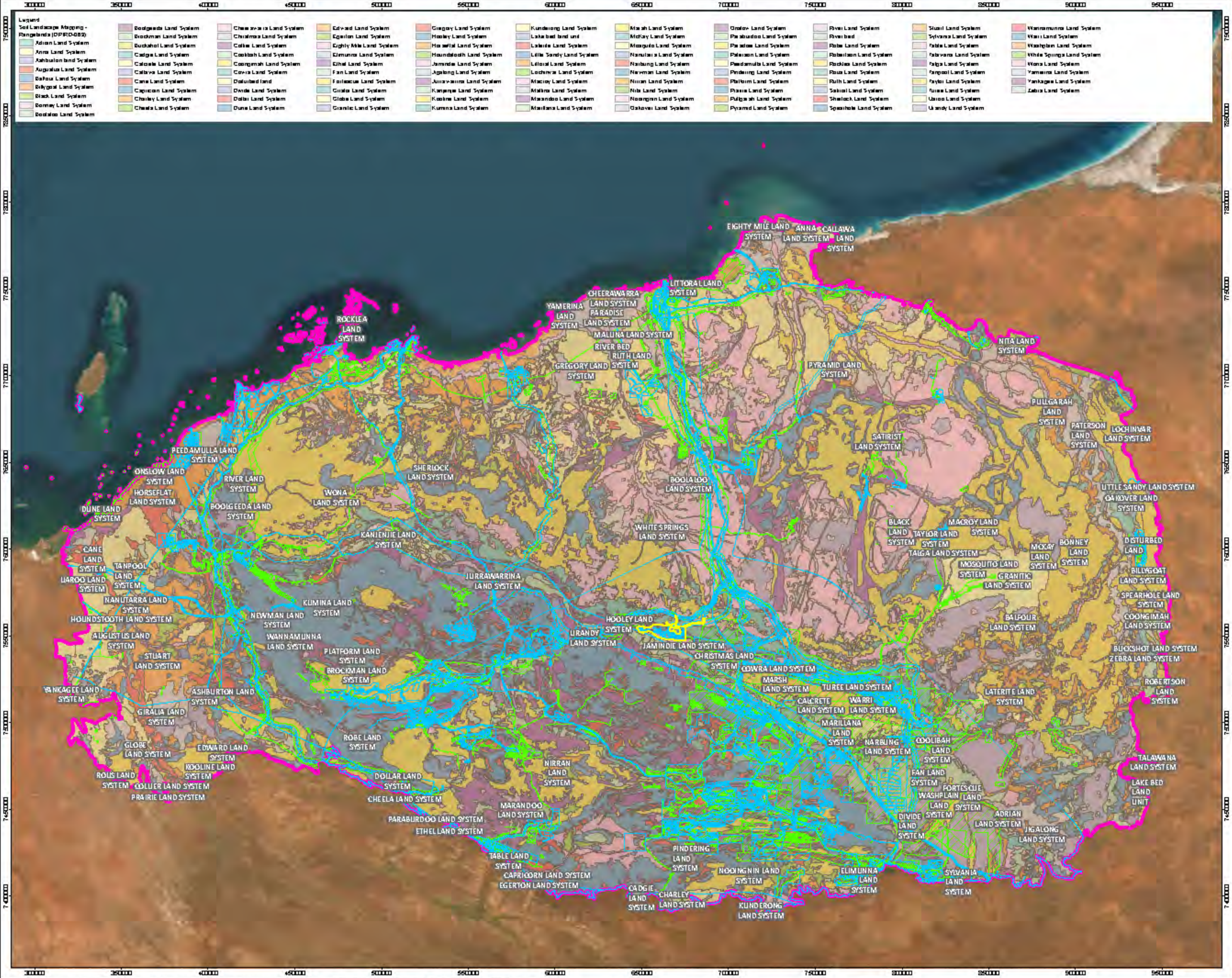
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACT ASSESSMENT - LAND SYSTEMS

FIGURE 17.3

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Image Reference: World Imagery: Earthstar Geographics

Figure 17-4: Cumulative Impact Assessment – Pilbara IBRA Land Systems



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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACT ASSESSMENT – PILBARA IBRA LAND SYSTEMS

FIGURE 17.4

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Image Reference: World Imagery: Earthstar Geographics

17.2.2 Broad-scale mapping

Clearing for the Proposal will result in the loss of native vegetation from the Development Envelope. Detailed vegetation mapping has been completed for the Development Envelope; however, it is not available for the broader Pilbara region. Therefore, the assessment of potential cumulative impacts to vegetation require broader mapping available across the region. Broad-scale vegetation mapping has been used to assess the cumulative loss of vegetation and flora from existing and reasonably foreseeable future projects in the region.

There are 31 pre-European vegetation associations in the Local Assessment Area, four of which are inside the Development Envelope (**Figure 17-5** and **Figure 17-6**). Cumulative disturbance to these vegetation associations is assessed in **Table 17-4**.

The Proposal will result in the clearing of up to 4,339.16 ha of native vegetation in addition to the potential clearing of approximately 76,900.09 ha within the Local Assessment Area. The current extent of vegetation within the Pilbara region is 17,731,765 ha (GoWA 2019). Based on the predicted impacts, clearing for the Proposal will contribute a further 1.17% to vegetation clearing within the bioregion (Regional Assessment Area). The Proposal contributes 2.42% to the total clearing extent within the Local Assessment Area.

A total of 164.63 ha within the Development Envelope has been recorded as cleared/completely degraded as a result of previous activities including drill lines, access tracks, fence lines and existing infrastructure of which 42.23 ha occurs within the Indicative Footprint. There is a total of 122.40 ha of cleared/completely degraded areas within the Development Envelope which occurs outside of the Proposal Indicative Footprint resulting from previous exploration and pastoral activities. The majority of these existing disturbed areas are narrow and linear.

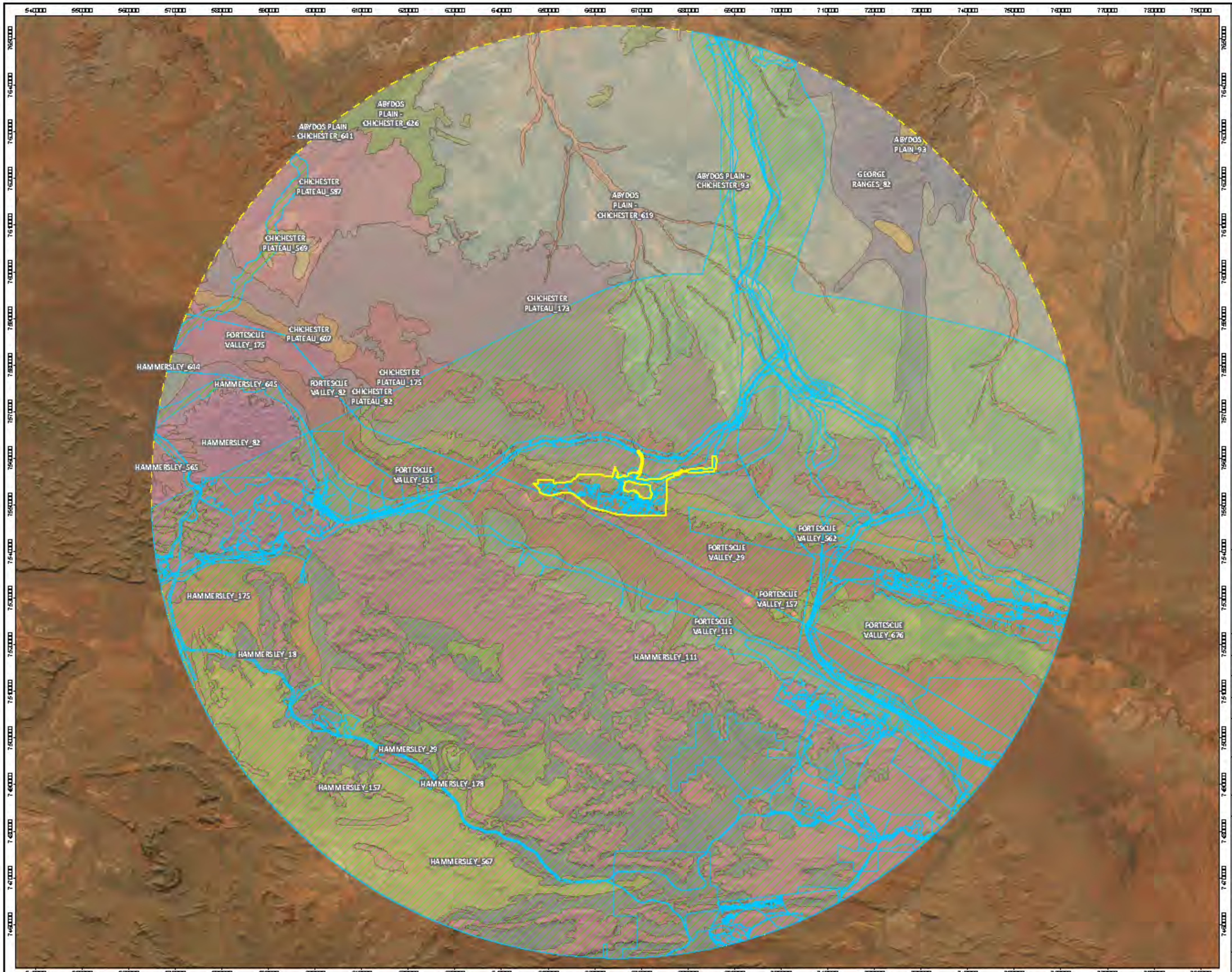
Based on the assessment, the Proposal does not significantly contribute to cumulative impacts to pre-European vegetation within the Regional or Local Assessment Areas.

Table 17-4: Cumulative Impacts Pre-European Vegetation

Vegetation Association	Approved Impact Area (ha)	The Proposal Area of Impact (ha)	Local Impact			Regional Impact	
			Total Area Mapped in Local Assessment Area (Ha)	Proposal Impact Contribution (%)	Total Cumulative Impact (%)	Area of Impact within Regional Assessment Area (ha)	Proposal Contribution (%)
29: Sparse Low Mulga Woodland, discontinuous in scattered groups.	13,844.78	3,195.44	297,806.08	1.07	5.72	1,109,382.90	0.29
173: Hummock grasslands, shrub steppe; Kanji over Soft Spinifex & Limestone Spinifex on basalt.	24788.69	183.15	395,210.04	0.05	6.32	1,753,520.20	0.01
175: Grassland short bunch-grass savanna.	37,884.62	57.77	107,244.38	0.05	35.38	389,121.33	0.01

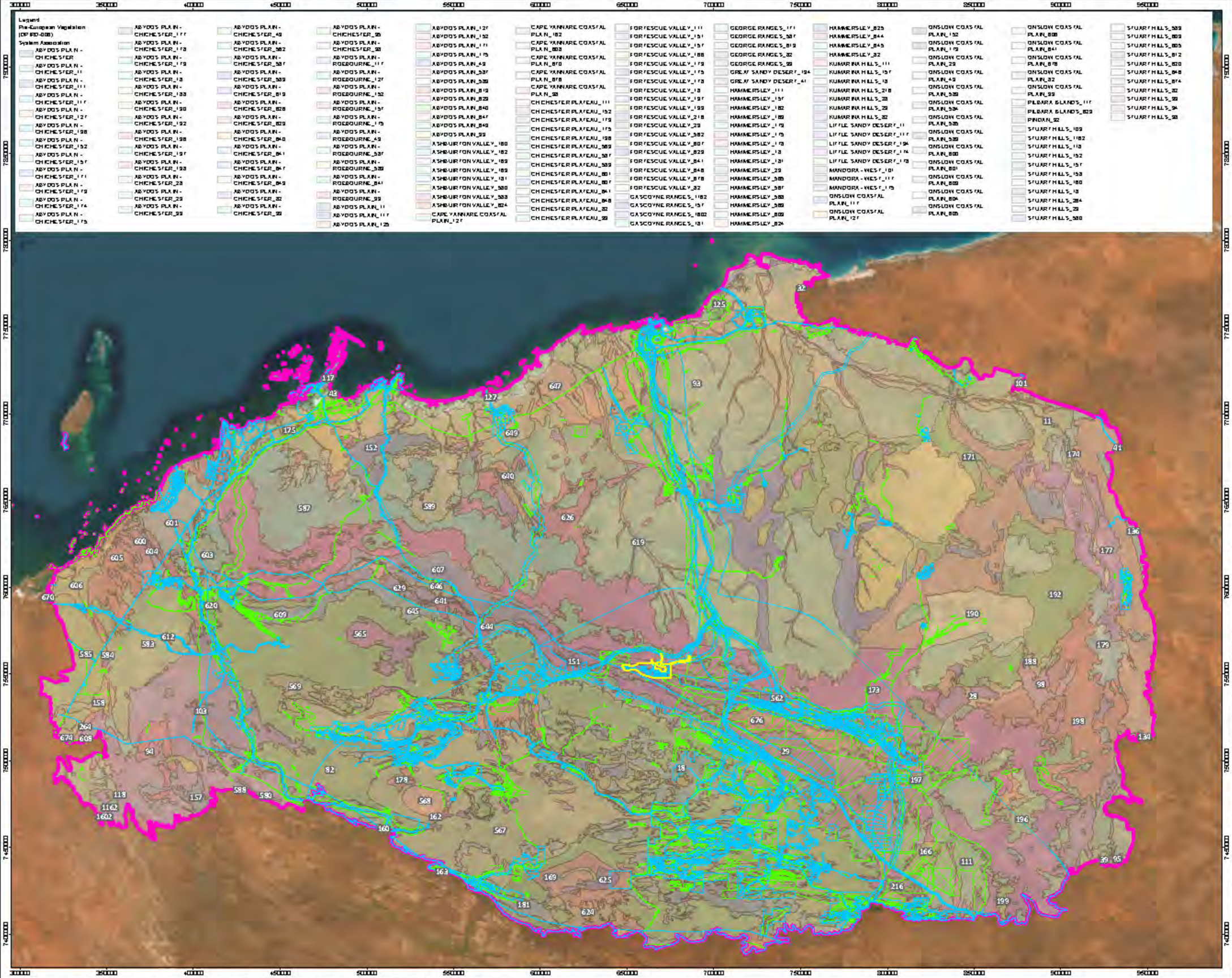
562: Mosaic of low Mulga woodland in valleys, and open low Snappy gum tree steppe and Hummock grasslands of Limestone Spinifex.	382.00	902.80	72,669.71	1.24	1.77	103,662.41	0.87

Figure 17-5: Cumulative Impact Assessment – Pre-European Vegetation



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Image Reference: World Imagery: Earthstar Geographics

Figure 17-6: Cumulative Impact Assessment – IBRA Pre-European Vegetation



Legend

- Development Envelope
- Pilbara IBRA region (DCCEEW)
- EPA Referred Significant Proposals (DWER-120)
- Clearing Instruments Proposals (Areas Applied to Clear) (DWER-075)

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Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACT ASSESSMENT – PILBARA IBRA PRE-EUROPEAN VEGETATION

FIGURE 17.6

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Image Reference: World Imagery: Esri Master Geographics

17.2.3 Local Vegetation Types

Both the Mulga Downs Hub and Rail Spur Project and the Murray's Hill Project are located in the immediate area of the Proposal. Cumulative impacts to vegetation types has therefore been undertaken at a local scale in consideration of these projects (**Figure 17-7).**

Cumulatively, the three projects will not result in a loss greater that 15.86% of any vegetation type, with the majority of vegetation types being impacted by less than 8.51%. The maximum loss resulting from the Proposal is 14.79% (15.86% cumulatively) (AWL (1)); with losses to all other vegetation types associated with the Proposal being less than 7.05%.

More than 84% of the mapped extent of each vegetation type impacted will remain and therefore all vegetation types will continue to be represented in the local area. Based on the assessment, impacts to local vegetation types from these projects are unlikely to be significant, noting that these vegetation types are expected to extend beyond the areas surveyed.

Table 17-5: Cumulative Impacts - Local Vegetation Types

Vegetation Type	Mapped Extent In the Local Survey Area (ha)*	Proposal Loss (ha)	Mulga Downs Hub and Rail Loss (ha)**	Murray's Hill loss (ha)	Total extent impacted (Ha)	% Impact of Proposal	Total Cumulative % Impact
AaAxSL	3,628.68	68.53	25.01	0.00	93.54	1.89	2.58
AdEvWL	12,051.30	4.31	0.00	0.24	4.55	0.04	0.04
ASL (1)	1,854.75	64.95	0.00	42.32	107.27	3.50	5.78
ASL (2)	4,283.22	253.47	20.74	13.65	287.86	5.92	6.72
AWL (1)	14,111.52	2087.41	0.00	150.42	2237.83	14.79	15.86
AWL (2)	7,240.06	35.98	0.00	4.87	40.85	0.50	0.56
AWL (3)	4,066.26	8.83	0.00	0.00	8.83	0.22	0.22
AxAsSL	9,779.71	454.33	0.00	0.00	454.33	4.65	4.65
MSW	2,433.38	12.96	54.41	0.00	67.37	0.53	2.77
MTG (1)	576.38	40.61	0.00	0.00	40.61	7.05	7.05
MTGW	3,162.29	69.98	139.85	0.00	209.83	2.21	6.64
THG (1)	21,015.77	939.23	53.60	18.71	1,011.54	4.47	4.81
THG (2)	5,732.79	184.90	0.00	122.26	307.16	3.23	5.36
THGB	4,697.16	71.13	328.62	0.00	399.75	1.51	8.51
TvHG	122.15	0.31	4.50	0.00	4.81	0.25	3.94

*Note: area calculations are based on multiple surveys with some overlap and as a result some figures may be an overestimate.

**Maximum extent of either alignment option and excluding the area of overlap (hub) with the Proposal. Implementation of the Proposal will occur prior to the Hub and Rail Spur Proposal.

Figure 17-7: Cumulative impacts - Local Vegetation Types

610000 620000 630000 640000 650000 660000 670000 680000 690000 700000 710000

7570000 7560000 7550000 7540000 7530000

NANUTARRA RD

MUNJINA RD

MUNJINA-ROY HILL RD

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint

Vegetation type

- ASL (1)
- ASL (2)
- AWL (1)
- AWL (2)
- AWL (3)
- AaAxSL
- AdEuWL
- AxAsSL
- AxS
- BpoFL
- ErEbTG
- EuWL
- MSL (1)
- MSL (2)
- MSW
- MTG
- MTG (1)
- MTG (2)
- MTG (3)
- MTGW
- Mosaic of AdEuWL /*
- THG (1)
- THG (2)
- THGB
- THGG
- TbHG
- TuHG
- TwHG
- Restricted (Heritage)
- Cleared/Disturbed area

Roads (GATE-195)

- Highway
- Major road

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Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 04-Nov-2024
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Scale 1:310,000 at A3

0 2 4 Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACTS ON LOCAL VEGETATION TYPES FOR THE PROPOSAL

FIGURE 17.7

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com/© - Imagery Date: 28 May 2022.

17.2.4 Flora

Three 'Priority' flora species are present within the Indicative Footprint and will be impacted by the Proposal:

- *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) (Priority 1);
- *Triodia veniciae* (Priority 1); and
- *Dolichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3)

The cumulative impact of the Proposal and nearby projects on these species is outlined in **Table 17-6.**

All 3 species above will be impacted by the Proposal common to the other projects considered in the cumulative assessment. D*olichocarpa sp*. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) and T*riodia veniciae* (Priority 1) species were recorded within the Mulga Downs Hub and Rail Spur project directly adjacent to the Proposal. *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) (Priority 1) was recorded within the Murray's Hill proposal. The predicted cumulative impact on Priority flora species is therefore not considered to be significant and is unlikely to alter the conservation status of the species.

Table 17-6 Cumulative Impacts to Conservation Significant Flora

Taxa		Existing and Proposed Projects within Region (Development Envelope or Local Extent if known)												Cumulative Impact				Additional Records	
	Total Records (# of individuals) across projects considered in Cumulative Assessment	Proposal – Survey Area* Development Envelope** (Indicative Footprint)	Mulga Downs Hub and Rail Development Envelope** (Indicative Footprint)	Koodaideri Iron Ore Mine and Infrastructure (MS 999)	Cloudbreak Iron Ore Mine LoM (MS899)	FMG Eliwana Railway Project (MS 1108)	FMG Solomon Mine (MS1062)	FMG Eliwana - Mine (MS 1109)	HPPL Murray's Hill (not assessed)	Marillana Iron Ore Project (MS 855)	Yandicoogina Iron Ore Project (MS 1038)	FMG Pilbara Transmission Project (not assessed)	Marandoo (MS 1020)	Cumulative Impact (individuals)	Cumulative % of the Proposal	Cumulative % impact of total records	Proposal contribution to % cumulative loss	WA Herbarium Records	Atlas of Living Australia Occurrence Records
Hibiscus sp. Mulga Downs (S. Hitchcock SH 638) (P1)	4,226	4,226* 1,427** (622)	1** (0)	-	-	-	-	-	31	-	-	-	-	653	14.72	15.45	95.25	4	0
Triodia veniciae (P1)	3,994	3,994* 1,278** (574)	2764** (842)	-	-	-	-	-	0	-	-	-	-	1,416	14.37	35.45	40.53	26	22
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)	180,223	180,220* 29** (2)	180,183** (118,330)	-	-	3	-	-	0	-	-	-	-	118,335	<0.001	65.67	<0.001	38	0

NA – Not publicly available to determine whether impacts occurred, or taxa not listed as impacted.
Survey Area* includes the areas surveyed for both the Proposal and the Mulga Downs Hub and Rail.

17.2.5 Surface Water Dependent Communities

The Proposal contains 9.22% of the mapped extent of potential sheet flow dependent vegetation across the projects considered in the cumulative assessment and will result in a loss of 14.05% of the known extent (**Table 17-7**). About 80% of the mapped extent of these communities will remain following clearing required for all projects considered in the cumulative impact assessment. It is noted that this assessment is based only on the known mapped extent as data is not available across the whole region. It is also noted that the total survey extent mapped in relation to the Proposal both inside and outside the Development Envelope is 44,964.21 ha (and including Murray's Hill and Mulga Downs Hub and Rail spur). Therefore, the actual extent of impact is less than that presented in **Table 17-7**: and the total cumulative loss of mapped potential sheetflow vegetation is 15%.

Table 17-7: Cumulative Impacts - Sheet Flow Dependent Mulga

Mine	Mapped Extent Area within the Development Envelopes (ha)	Total Impact Area (Indicative Footprint) (ha)
The Proposal	9,725.74	2,973.51
Koodaideri Iron Ore Mine and Infrastructure Project	3,745	301
RHIO Mine	26,850.68	920.89
FMG Christmas Creek Iron Ore Mine and Expansion	26,709.00	10,244.00
FMG Cloudbreak Iron Ore Mine and Life of Mine Expansion	24,393.00	6,144.00
FMG Eliwana Railway Project	1,888.90	165.92
FMG Solomon Mine	7,076	NA
FMG Eliwana Mine	0.00	0.00
Mulga Downs Hub and Rail (noting some overlap with the Proposal)	1,737.55	514.56
Murray's Hill	1,199.35	378.42
Marillana Iron Ore Project (MS 855)	NA	NA
FMG Pilbara Transmission Project (not assessed)	2186.26	96.46
Total (ha)	105,511.48	21,167.03
Proposal (%)	9.22	14.05
Cumulative Impact (% of extent within Development Envelopes)		20.06
Sheet Flow Vegetation Remaining		84,344.45 (79.94% remaining)

17.2.6 Priority Ecological Communities

The Development Envelope for the Proposal intersects an area of 407.50 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC of which 70.31 ha will be impacted.

There is 143,562.42 ha and 204,248.00 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC mapped within the Local and Regional Assessment Areas. The cumulative impact on this PEC is 24.66% of

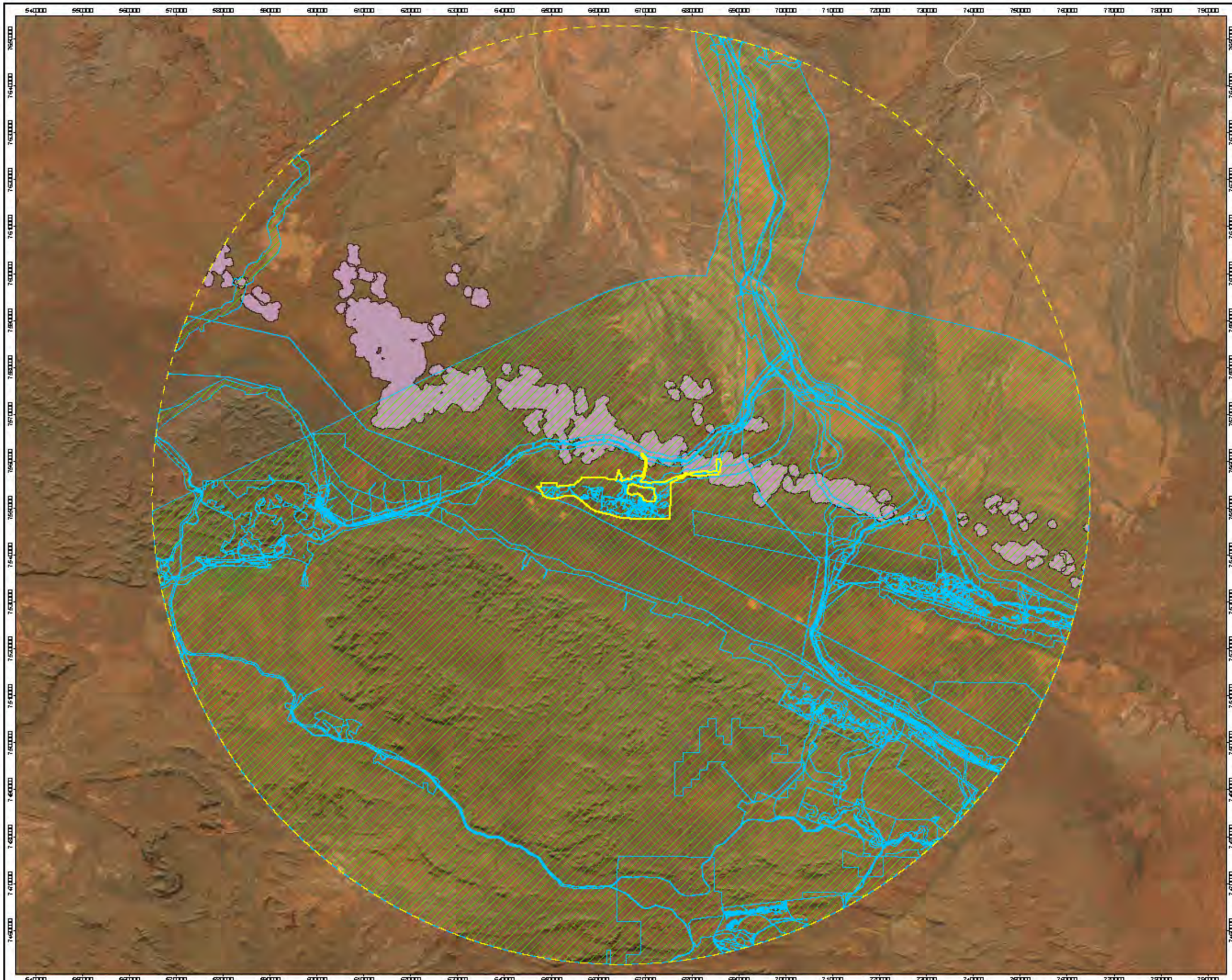
the known regional extent (**Figure 17-8** and **Figure 17-9**). The Proposal represent 0.05% of this impact, and is therefore a minor contributor.

17.2.7 Flora and Vegetation Cumulative Impacts

Based on the above predicted impacts, which utilised best available data from third party operations, the cumulative impacts of the projects considered in the assessment will contribute to approximately:

- The cumulative clearing of 10 land systems. The greatest cumulative impact is to the Jamindie System, with an estimated 3.45% loss of this land system from the subregion.
- Cumulative loss of between 1.77% and 35.38% of the individual vegetation associations, of which the Proposal contributes less than 1.24% of any vegetation association.
- Cumulative loss (of local mapped extent only) of between 0.04% and 15.86% of vegetation types, of which the Proposal contributes 14.79% of any vegetation type.
- Cumulative direct loss of 20.06 % of mapped sheet flow dependent vegetation within the project Development Envelopes of which the Proposal contributes 14.05%; and
- Cumulative loss (locally mapped information available only) of less than 15.45%, 23.06% and 0.001% and of Priority flora species *Hibiscus* sp. Mulga Downs (S. Hitchcock SH 638) (P1), *Triodia veniciae* (P1) and D*olichocar*pa sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3). As discussed in **Section 8**, the Proposal (and therefore cumulatively with other projects), will not have a significant impact on these species given their broad distribution.
- Cumulative loss of 24.66% and 34.02% of the known extent of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC within the Regional and Local Assessment Area respectively, of which the Proposal contributes 0.05%.

Figure 17-8: Cumulative impacts – TEC and PEC



Legend

- Development Envelope
- 100km buffer
- EPA Referred Significant Proposals (DWER-120)
- Clearing Instruments Proposals (Areas Applied to Clear) (DWER-075)

Threatened Ecological Communities (DBCA-038)

- Four plant assemblages of the Wona Landsystem (Priority 1)

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Job No: 67751

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Scale 1:740,000 at A3

0 10 20
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACTS - TEC AND PEC

FIGURE 17.8

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Image Reference: World Imagery: Earthstar Geographics

Figure 17-9: Cumulative impacts –Pilbara IBRA TEC and PEC

Legend

Legend
- Development Envelope
- EPA Referred Significant Proposals (DWER-120)
- Clearing Instruments Proposals (Areas Applied to Clear) (DWER-075)
- Pilbara IBRA region (DCCEEW)

Threatened Ecological Communities (DBCA-038)
- Four plant assemblages of the Wona Landsystem (Priority 1)

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Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Scale 1:1,900,000 at A3

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Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE IMPACTS -
PILBARA IBRA TEC AND PEC

FIGURE 17.9

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Image Reference: World Imagery: Earthstar Geographics

17.3 Terrestrial Fauna

All conservation significant fauna species that were recorded or are likely to occur within the Development Envelope will potentially be affected by cumulative impacts from existing or foreseeable future Proposals in the wider region.

Clearing of vegetation for the construction and operation of the Proposal will result in the loss of fauna habitat within the Development Envelope. Fauna habitat mapping has been completed for the Development Envelope. The Proposal will result in the clearing of up to 4,339.16 ha of native vegetation, comprising nine broad habitat types. Detailed mapping at the same scale is not available for the entire Chichester and Fortescue subregions. It is typically only completed to support the environmental impact assessment for projects that have been and will be developed across the Pilbara.

Land System mapping at a regional level by DPIRD provides an opportunity to assess cumulative impacts on broad landscape units as a surrogate for fauna habitat. The cumulative impacts on land systems have been considered for the Proposals identified in the cumulative assessment and are outlined in **Section 17.2**.

The greatest cumulative impact on land systems is the loss of approximately 3.45% of the Jamindie land system. As noted, this loss is conservative given the calculations were based on the approximate extent of the land system within the entire Development Envelope of each Proposal. The Jamindie land system is known to support Mulga Woodlands fauna habitat type. Mulga Woodlands are considered as low value generally offering minimal refugia to species of conservation significance. The Mulga Woodland has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Regionally this habitat type is generally well represented.

Each of the conservation significant fauna habitats identified as occurring or likely to occur within the Development Envelope are known to extend beyond the Development Envelope and throughout the broader Pilbara region.

The local impact to fauna habitats has been assessed using proposed impacts of the Proposal, Murray's Hill and Mulga Downs Hub and Rail to mapped fauna habitats (**Table 17-8**). More than 92% of any fauna habitat types mapped across the three projects will remain (i.e. total impacts are no more than 8% of the habitats within the local area).

Given the extent of fauna habitat that will remain within the Development Envelope and in surrounding areas, cumulative impacts to fauna habitats and conservation significant fauna species associated with the Proposal are unlikely to be significant.

Table 17-8: Local Cumulative Impacts to Fauna Habitat

Habitat Type	The Proposal	Murray's Hill	Mulga Downs Hub and Rail*	Total Mapped Extent (ha)	Total impact across all projects (ha)	% Impact of all projects
	Extent within the Indicative Footprint (ha)	Extent within the Indicative Footprint (ha)	Extent within the Indicative Footprint (ha)			
Mulga Woodland	2,824.74	275.06	24.26	43,575.10	3,124.06	7.17
Rocky Hills	520.80	83.94	0.00	11,982.01	604.74	5.05
Stony Spinifex Plains and Hillslopes	813.97	35.35	83.35	62,690.54	932.67	1.49
Chenopod/ Cracking Clay Floodplain	15.72	0.00	0.00	983.20	15.72	1.60
Drainage Line/Floodplain	56.69	14.71	11.54	38,141.21	82.94	0.22
Gibber Cracking Clay	56.69	0.21	22.91	3,556.27	79.81	2.24
Rocky Plains and Footslopes	0.00	0.00	1180.68	32,444.58	1,180.68	3.64
Snakewood	8.04	0.00	14.91	731.62	22.95	3.14
Cracking Clay	28.10	0.00	160.57	5,529.69	188.67	3.41

**Maximum extent of either alignment option and excluding the area of overlap (hub) with the Proposal. Implementation of the Proposal will occur prior to the Hub and Rail Spur Proposal.

17.4 Subterranean Fauna

Cumulative impacts represent the combination of 'combined' impacts, with impacts considered from known and reasonably foreseeable third-party operations surrounding the Development Envelope. This assessment is only possible when the direct impacts from these operations occur within the known range of troglofauna and stygofauna species and habitat values as detailed in **Section 8**.

There are no third-party mining projects within the immediate vicinity of the Development Envelope other than Murray's Hill and the Mulga Downs Hub and Rail Spur projects. The Mulga Downs Hub and Rail Spur does not involve mining or excavation and water requirements are not such that it would cumulatively add to dewatering impacts from the Proposal.

Surveys were undertaken for the Murray's Hill project and an assessment provided in *ecologia* (2011). The data collected form Murray's Hill is already included in the MDIOM subterranean Fauna assessment and the impacts to any subterranean fauna collected is being assessed as part of the MDIOM.

Therefore, any cumulative impacts to subterranean fauna habitat values are as a result of the combined Proposal and Murray's Hill. Given Murray's Hill is above water table mining only, there are no anticipated impacts to stygofauna as a result of this project.

The key risk of cumulative impacts is therefore a result of removal of habitat for troglofauna. The habitat associated with the Murray's Hill pit has been considered as part of the assessment of the Proposal and has been found to occur along the Chichester Ranges and is extensive. The Murray's Hill project does not involve MAR and therefore there are no additional impacts to troglofauna habitat from this project as a result of groundwater mounding.

17.5 Air Quality

Construction and operation of the Proposal will result in emissions of dust that will contribute to the surrounding local and regional airsheds. In the context of the Proposal, the primary source of potential impacts to air quality are:

- Dust emissions associated with mining activities;
- Sources of airborne asbestos to be carried by the wind to off-site receptors due to Proposal activities.

17.5.1 Dust

Dust emissions may also be generated from both the Murray's Hill and the Mulga Downs Hub and Rail Spur projects, which are located in close proximity to the Proposal. Given their proximity, dust emissions from these projects may cumulatively contribute air quality (dust) impacts in the local and regional area. Each project may result in a minor, temporary increase in localised dust.

The Pilbara is a naturally dusty environment with wind-blown dust being a significant contributor to the airborne dust levels. The nearest community (the Wirrilimarra Community) is more than 7 km from the combined Projects.

Construction of all three projects are unlikely to occur simultaneously and will occur in a staged manner, limiting the cumulative dust impact. Given the expected localised impacts and noting that the Pilbara is a naturally dusty environment, significant cumulative impacts with other projects in the region are not anticipated.

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope over the life of mine. Dust emissions associated with construction and operation of the three projects will remain negligible and are unlikely to lead to an increase in the cumulative impact on local or regional airsheds.

Given the expected localised impacts and noting that the Pilbara is a naturally dusty environment, cumulative impacts with other projects within the 100 km cumulative impact assessment area are not anticipated.

17.5.2 Airbourne Asbestos

The ore bodies associated with the Proposal and Murray's Hill mine are located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, and therefore the potential for intersection of natural asbestiform minerals during mining is considered to be low. The Mulga Downs Hub and Rail Spur project does not involve mining or activities where potential natural asbestiform minerals may be intersected. Given this, the potential for cumulative impacts from mobilisation of airborne natural asbestiform minerals across the three projects is low.

The PESA undertaken for the Proposal included the Murray's Hill mine (**Appendix 13**). The assessment identified that asbestos impacts were likely limited to building materials within ancillary station infrastructure such as tank stands and bore infrastructure, the existing and classified asbestos contaminated area (registered ID 7303) associated with the former Mulga Downs homestead, the possible deposition of asbestos as a result of erosion from the Wittenoom mine area, and/or the potential importation of asbestos to the site for various reasons (including as a construction base for infrastructure or as dumped waste). The assessment concluded that there is a low risk of asbestos from existing structures, ground contamination (in-situ or from erosional deposition) or unexpected finds causing human health impacts at receptors through an inhalation pathway (JBSG 2023). The Mulga Downs Hub and Rail project is located within the Yule River catchment, north-east of both the Proposal and Murray's Hill. The Mulga Downs Hub and Rail project is located further from potential sources of asbestos, including the WAMA, and potential receptor locations. Based on the low risk of asbestos impacts across all projects, the potential for cumulative impacts is also considered low.

17.6 Terrestrial Environmental Quality

Cumulative impacts to terrestrial environmental quality have been considered in the context of Murray's Hill and the Mulga Downs Hub and Rail Spur Project, both of which are located in close proximity to the Proposal.

The Proposal has the potential to result in the following impacts to terrestrial environmental quality:

- Contamination of soils, surface water and groundwater from AMD, PAF and other activities which may result in spills, leaks or seepage;
- Redistribution of ACM that is present from historical anthropogenic activities.

17.6.1 Contamination

The risk of contamination of soils, surface water and groundwater from WRDs due to AMD is significantly reduced given that none of the proposed mine pits, including the Murray's Hill pit will intersect the basal Nammuldi and Roy Hill Shale/Jerrinah Formation stratigraphic units, as these have been shown to have the highest sulfur levels and are most likely to lead to the generation of AMD (**Appendix 16**).

Any contamination of soils, surface water and/or groundwater arising from failure, leaks or seepage from saline water pipelines and/or water storage dams is likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts. The potential for cumulative impacts with either Murray's Hill or the Mulga Downs Hub and Rail Spur projects on Terrestrial Environmental Quality due to contamination is therefore considered low.

All these projects will be subject to regulation under the Mining Act, which will also regulate impacts to the environment arising from spillage of reagents, chemicals and hydrocarbons and pipeline failures, leaks/seepage via setting appropriate environmental outcomes and performance criteria relating to land and soils and water resources. Through the Mining Proposal and Mine Closure Plan assessment and approval process, environmental objectives and performance criteria will be established to ensure mining operations meet DEMIRS' environmental objectives for mining, which include land and soil and water resources as key environmental factors.

17.6.2 Asbestos Mobilisation

As noted in **Section** 3.9 the ore bodies associated with the Proposal and Murray's Hill mine are located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, and therefore intersection of natural asbestiform minerals during mining is considered to be low. The Mulga Downs Hub and Rail Spur project does not involve mining or activities where potential natural asbestiform minerals may be intersected. Given this, the potential for cumulative impacts from mobilisation of natural asbestiform minerals is considered low.

Given the above, it is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM. The implementation of, and adherence to, an AMP, including procedures for the safe decommissioning and removal of ACM structures and an unexpected finds procedure can adequately manage ACM risks to Terrestrial Environmental Quality to ensure the EPA's objective for this environmental factor can be met.

17.7 Greenhouse Gas Emissions

The projected GHG emissions from the Proposal, cumulatively contributes to GHG's in a global context and therefore contributes to climate change. The contribution of the Proposal emissions to State, national and global emissions has been examined and discussed in **Section 12**.

The United Nations Framework Convention on Climate Change (UNFCCC) provides the framework for international cooperation to reduce global GHG emissions and limit temperature increases. The UNFCCC Paris Agreement entered into force on 4 November 2016, and Australia is committed to reducing GHG emissions by 26 to 28% below 2005 levels by 2030 (UNFCCC, 2016). Australia's Nationally Determined Contribution under

Article 4 of the Paris Agreement was subsequently updated, in 2022, to a more ambitious commitment to reduce greenhouse gas emissions 43% below 2005 levels by 2030 (Commonwealth of Australia 2022).

The Greenhouse Gas Emissions Policy for Major Projects documents the State Government's commitment, to working with all sectors of the WA economy to achieve net zero GHG emissions by 2050 (GoWA 2024). The Western Australian Climate Change Bill, introduced to Parliament on 30 November 2023, will legislate the State target of net zero emissions by 2050. Furthermore, the bill will require interim 1 year point targets and 5-year cumulative emissions budgets for Western Australia (for 2035. 2040 and 2045) to be set.

The GHG emissions associated with the Proposal are not significant in the context of state or national emissions and will not impede the State GHG Policy aspiration of net zero emissions by 2050 given the relatively low emissions predicted as a result of the Proposal. It is also noted that GHGs accumulate over time and mix globally (IPCC, 2014), therefore the impacts of emissions from the Proposal on climate change cannot be assessed individually or in isolation. However, Scope 1 emissions (noting there are no Scope 2 emissions) associated with the Proposal, will contribute approximately 0.23% of state, 0.04% of national and 0.0004% of global GHG emissions, which represents a very minor contribution to any increases in emissions. At this scale, it is not possible to quantitatively assess the impact of the Proposed Changes to any local, state or global climate change.

17.8 Social Surroundings

The Development Envelope is located within the Banjima Native Title Determination Area which covers an area of 1,018,525.4 ha (**Figure 17-10)**. This native title claim is overlapped by pastoral leases and major industrial and mining developments. The Proposal will cumulatively add to the impacts to Banjima Country through disturbance to heritage value of sites of cultural significance and Aboriginal heritage places and the loss of access to these sites and other places or importance. The value of and the significance of these impacts will be determined through ongoing consultation with Banjima and the Proposal's contribution to those cumulative impacts will be considered during the co-development of the SCHMP.

Historical pastoral activities may have degraded aspects of cultural heritage, but these effects are not well understood. Similarly, there are no publicly available records of registered heritage sites disturbed or destroyed under Section 18 of the AH Act, therefore making it difficult to assess the potential cumulative loss to Traditional Owners. Future surveys and consultation with Traditional Owners will assist with developing a greater understanding of the significance and extent of values and will inform future design and approvals under the AH Act. Sites will be avoided where possible, including implementation of an appropriate buffer, through the final design of the Indicative Footprint for the Proposal. HPPL will manage any sites of Aboriginal heritage significance that cannot be avoided in accordance with the AH Act.

In addition to the Proposal, the following projects assessed under Part IV of the EP Act intersect the Banjima Native Title Determination Area:

- APA – Port Hedland Power Station;
- Australian Aboriginal Mining Corporation;
- BHP Billiton Iron (excluding the strategic proposal boundary);
- Brockman Resources (Brockmand Iron Ore Mine and railway and associated infrastructure);

- Chichester Metals Iron ore Mine;
- Ferrus Pilbara Project;
- Hamersley Iron;
- Mount Bruce Mining (water transfer pipeline to Koodaideri);
- Mineral Resources (Bulk Ore Transport System);
- Pilbara Transmission Project;
- Rio Tino – Hope Downs 1;
- Robe River Mining;
- Pilbara Infrastructure Project;
- Goldfields Gas Pipeline JV;
- Murray's Hill; and
- Mulga Downs Hub and Rail Spur.

Given the extent of overlap with Part V Purpose Permit areas with projects assessed under Part IV of the EP Act (refer to **Figure 17-10**) and the fact that Purpose Permit application areas are generally significantly higher than the actual extent of clearing proposed, calculations have not been provided for Purpose Permit applications.

Impacts in the Banjima Native Title Determination Area for projects assessed under Part IV of the EP Act are presented in **Table 17-9** and shown in **Figure 17-10**. The area of approved impact is 37% of the Banjima Native Title Determination Area and the Proposal will contribute an additional 0.4%.

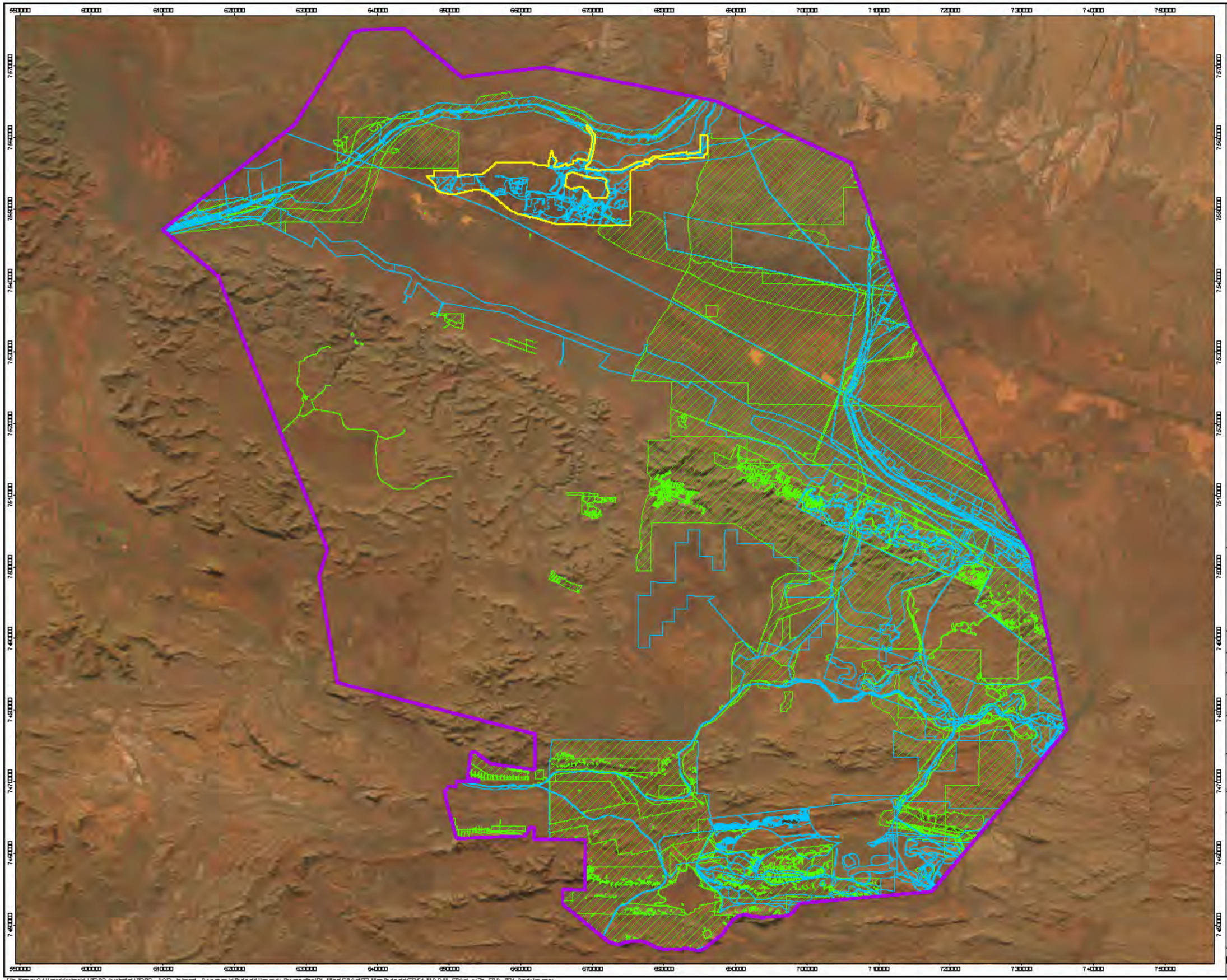
Table 17-9: Cumulative Impacts – Banjima Native Title Determination Area

Impact Type	Extent (Ha)	% Impact of Native Title Determination Area
Approved Projects (Part IV)	385,073	37%
Proposal	4,339.16	0.4%
Total	**441,909.16**	**37.4%**

[1] Note the Development Envelope boundary is not reflective of the actual clearing extent and as such is expected to be an over-estimate

Potential cumulative impacts to Traditional Owners will be managed through ongoing consultation with Traditional Owners and the co-development and implementation of an SCHMP.

Figure 17-10: Cumulative Assessment – Banjima Native Title Determination Area



Legend

- Development Envelope
- Clearing Instruments Proposals (Areas Applied to Clear) (DWER-075)
- EPA Referred Significant Proposals (DWER-120)
- Native Title Determination (LGATE-066)
- Banjima People

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 30-Mar-2025
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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CUMULATIVE ASSESSMENT - BANJIMA NATIVE TITTLE DETERMINATION AREA

FIGURE 17.10

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Image Reference: World Imagery: Earthstar Geographics

17.8.1 Noise and Vibration

LGA (2024) undertook an assessment of the worst case cumulative noise emission scenario with the Proposal and the Mulga Downs Hub and Rail Spur Project. The worst case cumulative scenario is when mobile mining teams are working in the northernmost pit (Fridge Hill) combined with modelled process plant and Mulga Downs Hub and Rail proposed operations. The results are summarised in **Table 17-10**.

Table 17-10: Cumulative Predicted Noise Levels, L_{10} dB(A) (LGA 2024)

Receiver	Approximate Nearest Distance to Mine	Predicted	Adjusted	Criteria Level	Assessment
Bat Caves	100 metres	68	68	70	Complies
Homesteads	33 km	-	-	35	Complies
Auski Village	23 km	-	-	35	Complies
Karajini Eco Retreat	37 km	-	-	35	Complies
Munjina East Gorge	36 km	-	-	35	Complies
Communities	8.5 km	20	25	35	Complies
Heritage Sites	150 metres	55	60	60	Complies
Private Mining Camp	21 km	-	-	35	Complies

Noise is predicted to be compliant at all highly sensitive receptors at less than 35 dB(A), noting that the Hooley Station homestead, Fig Tree Crossing, the northeast private mining camp and the Youngaleena Community are more than 20 km away and therefore levels are so low as to be incalculable by the noise model.

Predicted noise levels at all heritage sites are also compliant with the prescribed maximum of 60 dB L_{10} apart from those heritage sites within 100 m of the Haul Road. The nearest heritage site is within 40 m of the haul road, therefore is predicted to receive the highest level of noise at 72 dB(A). Given these sites are located within the Development Envelope, access will be controlled and negotiation with the Traditional Owners who are the custodians of these areas is in process. While many sites are not likely to be inhabited for long periods by people, some may be sensitive to vibration levels caused by mining activity. The next closest site is 200 m away from the haul road and receives 65 dB(A). All other heritage sites receive no more than 40 dB(A).

17.8.2 Air Quality and Dust

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope over the life of mine. The Proposal may result in a minor, temporary increase in localised dust. Given the expected localised impacts and noting that the Pilbara is a naturally dusty environment.

Cumulative impacts are not anticipated with the Proposal and the Murrays Hill project as mining activities will not occur at the same time. Cumulative impacts may occur however with the Proposal and the Hub and Rail Project given the overlap of construction and operations activities.

Haulage of ore from the Proposal was originally proposed either via Fenceline Road or via the Mulga Downs Hub and Spur project. The revised Proposal excludes Fenceline Road, replacing that haulage option with the Northern Haul Road, which is both further away from sensitive receptors (Youngaleena and Wirrilimarra communities) and common to both Proposals (i.e. the Northern Haul Road is common infrastructure for transport of ore associated with both the Proposal and the Hub and rail Spur project which may accept ore from third parties) thereby reducing the cumulative impact.

18 Holistic Impact Assessment

This ERD provides a detailed assessment of the potential environmental impacts associated with the Proposal and the management strategies for each environmental factor. This section provides information regarding the key themes Land, Water, People and Air and how these connect and interact between the environmental factors identified for the Proposal.

The key environmental factors relevant to the Proposal are:

- Inland Waters (Section 7);
- Subterranean Fauna (Section 8);
- Flora and Vegetation (Section 8);
- Terrestrial Fauna (Section 10);
- Terrestrial Environmental Quality (Section 11);
- Greenhouse Gas Emissions (Section 12);
- Air Quality (Section 13); and
- Social Surroundings (including Aboriginal heritage) (**Section 14**).

HPPL acknowledges the relationships between environmental factors and that those interrelationships may require consideration and management to achieve good environmental outcomes. The Development Envelope contains important environmental values that relate to multiple factors, as demonstrated in **Figure 18-1**. **Table 18-1** provides a summary of the connections and interactions between the key environmental factors (grouped by the relevant EPA theme) and proposed mitigation that reflect the connections and interactions (shared with mitigation proposed for individual environmental factors). The connections and interactions between environmental factors have been identified and the mitigation proposed in this ERD and supporting management plans is considered sufficient to meet the principles contained in the EP Act and the EPA's objectives for individual factors, as set out in **Sections 7** to **14** respectively. Where a significant residual impact has been identified in the assessment, offsets are proposed. These impacts and proposed offsets are summarised in **Section 16**.

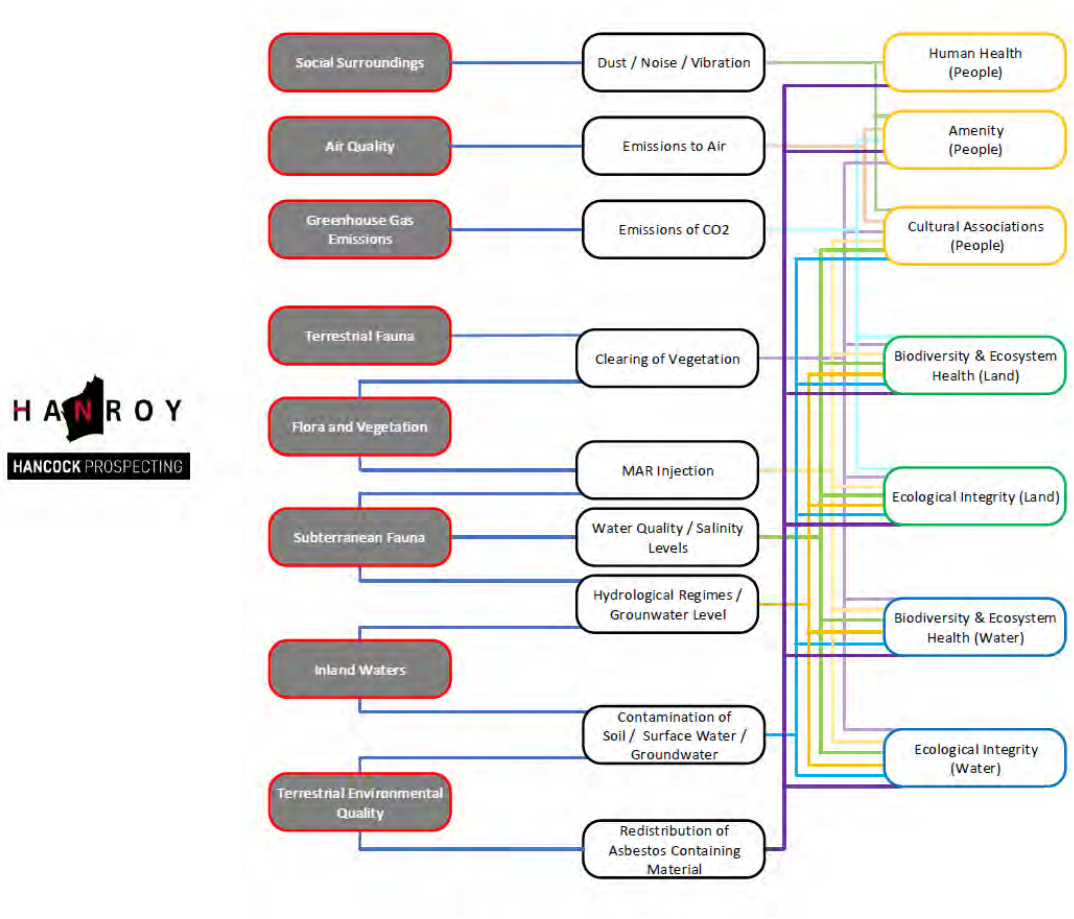


Figure 18-1: Relationships between environmental factors

Table 18-1: Connections and interactions between key environmental factors and predicted outcomes

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
Land	Flora and vegetation	• Provides habitat to terrestrial fauna. • Contributes to maintenance of subterranean fauna habitat (through the loss of energy transfer to the subterranean environment). • Contributes to maintenance of inland water quality, terrestrial environmental quality and landforms (e.g. through erosion prevention, sediment management, dust reduction). • Assists in bio sequestration (GHG). • Contributes to social surroundings (e.g. maintenance of air quality or inherent cultural values).	**Avoid** • Establishment of a FHEZ) which avoids impact to 1,320.82 ha of native vegetation and a FHEZ corridor which avoids impacts within an additional 991.45 ha area, both of which includes drainage lines to avoid fragmentation in that area of the Development Envelope. • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided. **Minimise** • The Development Envelope and Indicative Footprint has been revised and reduced through iterative mine planning to reduce the extent of clearing required where possible resulting in a 5,288.84 ha reduction in impacts to native vegetation. • Utilise areas of existing disturbance before clearing of new ground where possible. • Proposal elements have been located to minimise impacts on environmental factors.	The significant residual impact of the Proposal to Flora and Vegetation, after the application of the mitigation hierarchy, is: • Clearing of up to 4,296.93 ha of native vegetation in Good to Excellent condition; • Loss of up to 2,973.51 ha of potential sheet flow dependent vegetation; • Loss of up to 4.31 ha of riparian vegetation; and • Loss of up to 70.31 ha of the 'Four Plant Assemblages of the Wona Land System' Priority 1 PEC. This significant residual impact is proposed to be offset via monetary contribution to the PEOF at the relevant rate. The Proposal can be managed to meet the EPA objective for flora and vegetation through the implementation of key mitigation, management and offset strategies.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Phase the works to enable progressive clearing and where possible progressive rehabilitation. • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • Ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal GDP. • Located Proposal elements to minimise impacts to Priority flora species and locally significant vegetation communities. • Implement induction and education of the workforce with respect to flora and vegetation protection and management. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with an internal GDP. • An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire. • Ensure compliance with the *Bushfire Act 1954*.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Compliance with internal Hot Works Procedures. • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks. • An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment. • Dust management measures will be utilised to minimise dust emissions and subsequent deposition on retained native vegetation in proximity to disturbance. • Dust control measures will be implemented throughout the life of the Proposal and may include: • Saline water (> 5000 mg/L TDS) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation; • Dust suppression techniques (e.g. water trucks) shall be used on unsealed roads	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			and access tracks, cleared areas and at locations of high dust risk; • Vehicle speeds on haul roads, work and camp sites shall be reduced where necessary to minimise dust emissions; • Vegetation clearing and earthworks during high winds (>50 km/hr) shall be avoided; and • Zones for saline water use will be in place. This includes, for instance, using saline water on heavy vehicle roads that do not cross a drainage line or creek crossing, whilst not allowing saline water to be used on roads that cross drainage lines without an appropriately sized windrow, not using saline water on topsoil stockpiles etc **Rehabilitate / Monitor** • Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout LoM. • Decommissioning and rehabilitation of disturbed areas at the end of LoM.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Topsoil will be collected in windrows and stored for rehabilitation of temporary construction areas. • Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation. • Topsoil will be progressively re-spread over temporary construction areas or utilised for future rehabilitation. • Rehabilitation will occur with vegetation comprised of native species of local provenance in accordance with a DEMIRS approved MCP. • Consultation with Banjima to determine which species are ideal for seed collection. • Decommissioning and rehabilitating of Development Envelope at end of LoM. Topsoil will be recovered and stockpiled to a maximum height of 2 m to preserve the soil physical/chemical properties and seed bank for use over temporary construction areas or for future rehabilitation.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Consultation with Banjima to determine which species are ideal for seed collection. • Progressive rehabilitation will be undertaken as areas become available. • Ongoing monitoring and management of weeds within the Development Envelope. • The MCP will detail specific weed management measures in rehabilitation areas. • Impacts to vegetation as a result of altered hydrological regimes will be managed through the implementation of the Water Management Plan. • Conduct rehabilitation in accordance with the MCP. • Weed monitoring.	
	Terrestrial fauna	• Disperse and pollinate flora. • Contributes to social surroundings: • scientific and cultural value.	**Avoid** • Establishment of a FHEZ which avoids impact to 1,320.82 ha of habitat (including native vegetation). • Establishment of FHEZ Corridor which both avoids and minimises impact within 991.45 ha of habitat (including native vegetation).	The significant residual impact of the Proposal to Terrestrial Fauna, after the application of the mitigation hierarchy, is: • Loss of up to 1,406.03 ha of high value habitat for conservation significant fauna species, comprising Rocky Hills; Stony Spinifex Plains and Slopes; and Drainage Lines / Floodplain.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided which provide important habitat for migratory species. • Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor. • Freshwater Claypans of the Fortescue Valley P1 PEC is outside the Development Envelope. This is habitat for Migratory species when inundated and foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat, Northern Quolls and potentially the Night Parrot. • Establishment of the FHEZ and FHEZ Corridor protecting breeding and foraging for conservation significant fauna and allowing dispersal across high value Rocky Hills Habitat. **Minimise** • Implementation of the CSFMP. • Utilise areas of existing disturbance before clearing of new ground where possible.	This significant residual impact is proposed to be offset via monetary contribution to the PEOF at the relevant rate. The Proposal can be managed to meet the EPA objective for terrestrial fauna through the implementation of key mitigation, management and offset strategies.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Where possible Proposal elements have been located to avoid and minimise impacts on environmental factors. • Removal of Mulga West Borefield from the Development Envelope which reduces the extent of clearing and associated impacts. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with a GDP). • No more than 4,339.16 ha of clearing within a Development Envelope of 16,848.53 ha. • Phase the works to enable progressive clearing and rehabilitation. • Manage construction and operational works through an EMS. • Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • No permanent mining activities will be undertaken within the FHEZ corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Implement the Water Management Plan. • Appropriate permits will be obtained under the RiWI Act. • Blasting requirements will be designed to meet vibration thresholds of susceptible caves. • All machinery and vehicles shall be cleaned down of all soil and vegetation material prior to arriving or entering on site. Any soil and vegetation removed from machinery or vehicles during clean down upon arrival, but prior to entry on site shall be collected and disposed of offsite. • All vehicles and machinery mobilised to site shall be inspected prior to entry to site and issued with a Weed & Soil Hygiene Certificates. • Imported fill or other potential weed mediums to be certified by the supplier as being free from weed free sources prior to arrival on site. • Areas of known weed-infestation will be identified and managed separately to weed free areas. • Where areas of weed-infestation are to be disturbed or cleared, material will be	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			stockpiled/placed in windrows separately from weed-free material. • Targeted control of infestations. • An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire. • Ensure compliance with the *Bushfire Act 1954*. • Compliance with internal Hot Works Procedures. • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks. • An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment. **Rehabilitate / Monitor** • Implementation of the CSFMP. • Construction areas no longer required for operations will be rehabilitated upon completion of construction.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Progressive rehabilitation of operational areas no longer required, throughout LoM. • Decommissioning and rehabilitation of disturbed areas at the end of LoM. • Consultation with Banjima to determine which species are ideal for seed collection, as informed by the ethnobotanical surveys. • Implement the Water Management Plan. • Rehabilitation of areas of land utilised for construction purposes will occur upon completion of construction. • Progressive rehabilitation of temporary disturbance areas will be undertaken (such as borrow pits and temporary construction areas).	
	Subterranean Fauna	• Potential filtering and maintenance of subterranean ecosystem by recycling nutrients (Inland Waters) • Contribution to social surroundings: scientific and cultural value.	**Avoid** • Complete avoidance is not possible for this Proposal; however, the Proposal has been designed so that excavation is contained to seven designate mine pits as per mining schedule. • Excavation of troglofaunal habitat is contained in seven mine pits.	The significant residual impact of the Proposal to Subterranean Fauna, after the application of the mitigation hierarchy, is: • The loss of up to 96,048,900 m^3 of troglofauna habitat from the excavation of pits. • A reduction of up to 274,648,900 m^3 of troglofauna habitat as a result of changes to the groundwater levels from MAR reinjection.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• The number of pits has been reduced and mining output has been reduced from20 Mtpa to 12 Mtpa avoiding troglofaunal habitat. **Minimise** • Excavate no more than 66,731.74 m^3 of Tertiary/Detritals identified as likely troglofauna habitat. • Limit the reduction of habitat to 274,648,900 m^3 of troglofauna habitat primarily in the CID/Pisolite. • Undertake pit construction in stages to manage dewatering and MAR requirements – optimise the West to East mining scenario as outlined in Water Management Plan. • Maintain the current beneficial use of groundwater as per the Water Management Plan, to limit the extent of groundwater extraction (and associated drawdown and MAR). • Maintain groundwater levels such that there is no surface expression of groundwater (as a result of MAR) limiting troglofauna habitat. • Implement management actions as defined in the Water Management Plan.	• Loss of up to 370,648,900 m^3 of stygofauna habitat from dewatering of mine pits for LoM. • The loss of stygofauna habitat as a result of changes to groundwater salinity from MAR and dewatering drawdown. • There is potential to impact up to six species of troglofauna which have not been found outside the mine pit and mounding areas. • No stygofauna taxa will be lost. The data shows dispersal is possible from areas of impact to areas outside any impact from the Proposal. Up to 14 have been found to be restricted, however there is no evidence of isolated or fragmentated habitat where these taxa were found. • Surveys for both stygofauna and troglofauna for this Proposal have been extensive and the area has been characterised in respect to significance as subterranean habitat. The likely habitat for stygofauna and troglofauna has been assessed and found to be extensive and continuous, dispersal has been displayed by the subterranean fauna at MDIOM.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Apply the developed habitat assessment model to updated species list. • Loss of no more than 370,648,900 m3 of stygofauna habitat from extraction of mine pits for LoM. • Implement mine schedule of staged pit excavation (optimise West to East mining scenario as per Water Management Plan). • Limit dewatering profile to that which is necessary for mining. • Limit MAR profile to that which is necessary for mining. • Backfilling of pits to reduce ex-pit WRDs. • Minimise the clearing of vegetation required where possible. • Design of potential contaminating facilities (landfill, WRD, TSF) to prevent seepage to surface water and/or groundwater. • Adhere to works approval and licence conditions under Part V of the EP Act. • Storage of contaminating materials in Australian Standard compliant locations	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			with bunding, spill controls and leak prevention. • Saline water (> 5000 mg/L TDS) shall not be used for dust suppression unless approved by the Environmental Manager and where approved, dribble bars shall be used to control overspray onto adjacent vegetation. • WRD to be designed in accordance with the MCP. • Design and construction of WRD with appropriate seepage and leachate control structures. • Management of chemical and hydrocarbons, appropriate types and quantities of spill response equipment will be maintained. • Manage any spills including any contaminated material, in accordance with the internal procedures; and investigate and report incidents in accordance with internal procedures, to prevent the recurrence of incidents of the same or similar nature. • Limit mounding to that which is necessary for mining. **Rehabilitate / Monitor**	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Develop and implement a MCP as approved by DEMIRS (as per the requirements of the Mining Act and DEMIRS Guidelines for Preparing Mine Closure Plan, March 2020). • Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. • Monitoring program targeting troglofauna which have the highest level of endemism. • Implement monitoring as detailed in the Water Management Plan and SFMP. • Backfilling of pits to ensure backfill is above the water table after settlement, and as such pit lakes will be avoided. This will be further informed by future infield study work as part of the closure planning process. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Conduct periodic inspections of chemical and hydrocarbon storage areas to confirm compliance with Licence conditions and applicable Australian Standards.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Ongoing groundwater monitoring and modelling will be undertaken for the mine and borefields throughout the mine in accordance with the Water Management Plan.	
	Terrestrial Environmental Quality	• Inland Waters: contamination resulting in reduced water quality. • Changes to water quality affects: • Habitat for terrestrial fauna and potential to impact on fauna health. • Flora and vegetation impacts as a result of contamination and changes to water quality. • Subterranean fauna habitat impacts as a result of contamination and changes to water quality. • Social surrounding: human health (mobilisation of asbestos), water use and cultural significance.	**Avoid** • As a result of the AMD risk posed by elevated sulfur material at depth, HPPL purposely designed the pits to exclude basal Nammuldi Member subunits and Jeerinah Formation (Roy Hill Shale). • The Development Envelope avoids the WAMA. • The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access. **Minimise** • The Proposal has been designed to avoid direct impacts to areas prone to ASS, such as wetlands. • Surface water diversions have been designed to ensure surface water flows avoid contact with WRDs.	• It is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM. • Other regulatory processes such as DEMIRS' Mining Proposal and MCP will ensure waste structures such as waste rock dumps are designed, operated, decommissioned and closed to meet the EPA's objectives for Terrestrial Environmental Quality.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Storage of contaminating materials in AS compliant locations with bunding, spill controls and leak prevention. • Appropriate siting of landfill facilities to avoid interaction with surface drainage. • If PAF material is encountered during mining, PAF material will be managed according to the Waste Management Plan to ensure final landform is non-acid forming. • Ongoing waste characterisation studies. • Waste rock material will be used as pit backfill to minimise the need for surface waste rock landforms. • Low stability or material the Uncertain or PAF classification waste rock material will not be placed on waste rock landform surfaces. • Competent waste rock material will be used to armour waste rock dump surfaces. • Waste rock landform design, including heights, slope lengths, batter angles and surface water control structures account for physical and chemical properties of waste rock. • Design landforms and infrastructure to contain sedimentation where possible.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			Toe bunds and sediment basins will direct and contain sediment runoff to prevent excessive scour and increased sediment volumes to the downstream environment. • Adherence to Dangerous Goods licence conditions and Australian Standards • Adherence to EP Act Part V licence conditions with respect to bulk chemical storage and landfill management. • Disposal of waste to landfill will be a last resort. Materials will be repurposed or recycled where practicable. • Adherence to the Asbestos Management Plan. • The Proposal has been designed to avoid impacts to areas where ACM has been confirmed or is suspected, where practicable. **Rehabilitate / Monitor** • If unexpected PASS is encountered, disturbed soils or low pH waters will be neutralised prior to discharge. • Excavation or dewatering will cease until suitable management measures are employed.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria. • Monitoring of surface and groundwater quality in accordance with a Water Management Plan to detect any adverse changes in water quality between the mine and sensitive receptors, with 'early response' criteria, 'trigger' criteria and 'threshold' criteria. • Progressive rehabilitation to be undertaken in accordance with a MCP assessed and approved by DEMIRS, as per requirements under the Mining Act. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Pipelines, water storage dams and landfills will be appropriately decommissioned and disturbed areas rehabilitated, unless there is a specific agreement in place with a third party to take ownership and responsibility of the infrastructure post mining. The requirements will be regulated as per a MCP to be assessed and approved by	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			DEMIRS, in accordance with the Mining Act. • All chemical and hydrocarbon storage areas will be appropriately decommissioned and closed as per DEMIRS requirements of the MCP, in accordance with the Mining Act. • ACM-contaminated areas will be rehabilitated where appropriate, and asbestos management will be subject to monitoring through the AMP.	
Water	Inland Water	Hydrological regimes support: • Terrestrial fauna. • Subterranean fauna. • Flora and vegetation. • **Social Surroundings:** Culturally and ecologically significant. • Beneficial water use.	**Avoid** • Minimisation is considered to be the key measure as complete avoidance is not possible for the Proposal. • Divert surface water flows away from mining areas to avoid the potential for contamination. **Minimise** • The Water Management Plan will be implemented. • Surface water management during construction, mining and closure will be designed to minimise adverse impacts on the natural function and environmental value of watercourses, water quality and sheet flow downstream of the mine area.	• After the mitigation hierarchy has been applied, no significant residual impact to environmental values supported by hydrological processes or water quality are expected and HPPL considers that the Proposal can be managed to meet the EPA's objectives for inland waters.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Adherence to permit requirements under the RiWi Act. **Rehabilitate / Monitor** • Implement the monitoring as outlined in the Water Management Plan. • Implement the approved MCP. • Temporary infrastructure will be removed and natural flow paths, and catchments, reestablished in these areas.	
People	Social Surroundings	• Culturally and ecologically significant: • Flora and vegetation. • Terrestrial fauna. • Inland waters. • Amenity (visual, dust, noise). • Access.	**Avoid** • Development Envelope excludes the lodged Mungurrdu site. • Heritage sites will be demarcated and identified as no-go areas for site personnel prior to ground disturbing works. • Aboriginal cultural heritage, or suspected Aboriginal cultural heritage, must not be removed from any heritage place under any circumstance, unless authorised under the AH Act. • Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi Country. • Indicative Footprint amended to avoid key heritage sites with ongoing	Overall, with the implementation of mitigation actions as formalised and detailed within management plans, impacts to Social Surroundings are considered manageable and that the EPA's objectives for this factor can be met. This will be managed via ongoing consultation with Banjima Traditional Owners and other relevant stakeholders. The post-mining landform will be consistent with features in the wider surrounding landscape, indicative of mining operations within the Pilbara and will be managed in accordance with MCP(s). Impacts to amenity (dust, noise and visual impacts) can be managed through industry standard measures.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			refinement of the Mine Plan to maximise site avoidance and avoid access restrictions. • Avoidance buffers of 25 m (individual sites may have additional buffers applied in consultation with Banjima traditional owners) will be established around retained heritage sites within the Development Envelope, in consultation with Traditional Owners. These avoidance buffers will be demarcated and managed in accordance with appropriate site procedures. This will be monitored via the GDP process. • HPPL will consult with the Banjima Traditional Owners regarding asbestos management. The Proposal is located outside of the WAMA. HPPL is not proposing to undertake any mining in proximity to Wittenoom and has no intention to reopen Wittenoom. • Direct impacts to claypans (including Koodjeepindarrnna and Ngarlganoona pools) and Fortescue valley are avoided through Proposal design. **Minimise**	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Facilitate Banjima Traditional Owner involvement in monitoring activities where possible. • Minimise clearing areas as far as practicable. • Ongoing consultation with Traditional Owners during the Proposal. • Waste dumps will be designed to blend in with the surrounding landscape. • Noise, dust and vibration mitigation measures to be implemented. • Implement the CHMP. • Implement water management measures, including implementation of the Water Management Plan. • Engagement with Traditional Owners to identify sites of cultural significance and avoid impacts to these sites where possible. • Minimise, as far as practicable, interactions with significant water features and impacts to surface water flow, including changes to the hydrological regimes of culturally significant water sources. • Minimise clearing and access restrictions within areas used for	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			cultural purposes or areas that have cultural significance (e.g. at watercourse crossings). • Ensure sediment controls are in place during construction at waterway crossings. • Implement a SCHMP that is co-developed with the Banjima Traditional Owner group. • Implement Waste Rock Management Plan. • The Proponent will implement standard dust management measures to minimise potential airborne dust emissions and associated impacts to amenity. This includes (but is not limited to) use of dust suppression on access roads and open areas, water sprays for ore processing, transport and stockpiles, limiting the number and height of stockpiles, controlling/reducing trip distance and ensuring vehicles are confined to designated routes with speed limits strictly enforced. • Operating noise, vibration and potential mitigation measures (e.g. sound	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			absorption devices) must be considered when selecting equipment. • Equipment must be fitted with appropriate noise reduction devices (where necessary) to comply with Proposal HSE and regulatory requirements. • Blasting activities must be undertaken in accordance with Mines Safety Inspection Regulations 1995 and Noise Regulations. • Regularly inspect, maintain and replace mobile equipment so that noise levels are minimised during the equipment life. • Implement HPPL's Drill and Blast near ACH Procedure. **Rehabilitate / Monitor** • Personnel must not enter an Aboriginal Cultural Heritage site or a HRZ without prior consent. • Ongoing engagement with Traditional Owners to understand key impacts and avoid where possible. • Appropriate education of the workforce will occur through the implementation	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			of a Cultural Awareness Training program. • Adherence to internal GDP procedures. • Maintenance of Traditional Owner access to culturally significant places where safe and practical. • Implement a CHMP. • Implement HPPL's Heritage Management Framework; a suite of management procedures. • Maintenance of access to culturally significant places where safe and practical. • Impacts to specific sites of cultural and heritage significance, if unavoidable, will be discussed with Traditional Owners and Approvals sought under the AH Act. • Salvage of heritage material will be undertaken, where appropriate, in consultation with Traditional Owners, prior to direct impact. • Repatriation and restitution of salvaged Heritage material will be undertaken in consultation with Traditional Owners.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Post-closure access to sites of cultural significance will be maintained. • Post-closure access restrictions will be limited only to areas immediately adjacent to remaining open pits (due to safety reasons). • Monitoring for dust, noise and visual impacts will be ongoing. • Monitoring surface water quality in accordance with a Water Management Plan. • WRDs at closure will be rehabilitated to ensure they are stable, non-poluting and revegetated. • Closure landforms are designed to minimise long-term impacts to hydrological regimes associated with sites of cultural significance. • Groundwater recovery will be investigated and incorporated into the final MCP, to be submitted to support the Mining Proposal. • Monitor sites of cultural and heritage significance and the avoidance buffer zones. Report new or unauthorised disturbances to culturally sensitive sites and avoidance buffers.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners, including incorporation of bushtucker/ medicine species, and habitat for traditional hunting species and the objectives of the MCP, as required under the Mining Act. • Seed collection prior to/during construction and operations for use in rehabilitation with involvement of Traditional Owners.	
Air	Air Quality	• Terrestrial Environmental quality (asbestos) • Social Surroundings: • Amenity.	**Avoid** • Complete avoidance of volatile emissions and dust is not possible. • Asbestos contaminated areas will be clearly demarcated and access restricted. • Known asbestos contaminated area (abandoned infrastructure area) has been excised from the Development Envelope, and access to site structure containing ACM will be restricted. **Minimise**	• No significant changes to ambient air quality are predicted at sensitive receptor locations due to the implementation of the Proposal. • Low risk of activities associated with the Proposal causing disturbance to ACM and asbestiform minerals within the Development Envelope. The EPA objective for this factor can therefore be met.

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Standard dust management measures will be utilised to minimise dust emissions, including: o Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; o Vehicle speeds on haul roads, work and campsites shall be reduced where necessary to minimise dust emissions; o No vegetation clearing and earthworks during wind speed greater than 50 km/hr; and o Clearing activities will be staged to minimise areas of exposed surfaces. • Induction and education of the workforce and contractors with respect to dust minimisation. • Adherence to the AMP. **Rehabilitate / Monitor** • Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities.	

Theme	Environmental Factor	Connection and Interaction Pathway	Mitigation	Environmental Outcome / Significant Residual Impact
			• Any dust complaints received will be reported to HPPL and entered into the incident management system. • If ACM is found onsite during construction and operation, it will be remediated as per AMP. Asbestos management will be subject to monitoring through the AMP.	
	Greenhouse Gases	• Social Surroundings: • Amenity.	Avoid – avoid emissions through best-practice design; Reduce – reduce emissions over the project life; and Offset – offset some or all residual emissions.	The Proposal will contribute to global greenhouse gas emissions.

19 Abbreviations

Abbreviation/Acronyms	Definition
AH Act	*Aboriginal Heritage Act 1972* (WA)
ACHM	Australian Cultural Heritage Management
ACM	Asbestos Containing Material
AMD	Acid Mine Drainage
AMP	Asbestos Management Plan
ARI	Assessed on referral information
AS	Australian Standard
AWS	Automatic Weather Station
BESS	Battery Energy Storage System
BIF	Banded Iron Formation
BNTAC	Banjima Native Title Aboriginal Corporation
BoM	Bureau of Meteorology
CEO	Chief Executive Officer
CHMP	Cultural Heritage Management Plan
CID	Channel Iron Deposit
CR	Critically Endangered
CS Act	*Contaminated Sites Act 2003* (WA)
Cth	Commonwealth
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DMA	Decision Making Authority
DMIRS	Department of Mines, Industry Regulation and Safety(-2023)
DEMIRS	Department of Energy Mines, Industry Regulation and Safety (2023-)
DPIRD	Department of Primary Industries and Regional Development
DSO	Direct Shipping Ore
DWER	Department of Water and Environmental Regulation
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EN	Endangered
EP Act	*Environmental Protection Act 1986* (WA)
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ERD	Environmental Review Document
ESA	Environmentally Sensitive Area
ESD	Environmental Scoping Document
EWB	Ecohydrological Water Model

Abbreviation/Acronyms	Definition
FHEZ	Fauna Habitat Exclusion Zone
FMG	Fortescue Metals Group
GDP	Ground Disturbance Procedure
GHG	Greenhouse Gas
GL/a	Gigalitres per Annum
ha	Hectares
HanRoy	HanRoy Iron Ore Project Pty Ltd
HPPL	Hancock Prospecting Pty Ltd
IBRA	Interim Biogeographic Regionalisation of Australia
IPCC	Intergovernmental Panel on Climate Change
kL	Kilolitres
kL/d	Kilolitres per day
km	Kilometres
LoM	Life of Mine
LpA	Sound pressure level
LTUs	Lower Taxonomic Units
LV	Light vehicle
m	Meters
MAR	Managed Aquifer Recharge
MCP	Mine Closure Plan
MDI	Mulga Downs Investments Pty Ltd
MDIO	Mulga Downs Iron Ore Pty Ltd
MDIOM	Mulga Downs Iron Ore Mine
MDIOP	Mulga Downs Iron Ore Proposal
MMIF	Marra Mamba Iron Formation
MNES	Matters of National Environmental Significance
mRL	Meters Relative Level
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Mega watts
MWh	Megawatts
NGER Act	*National Greenhouse and Energy Reporting Act 2007* (Cth)
OTUs	Operational Taxonomic Unit
P	Priority
PAF	Potential Acid Forming
PCD	Proposal Content Document
PEC	Priority Ecological Community (WA listing)

Abbreviation/Acronyms	Definition
PEOF	Pilbara Environmental Offsets Fund
PER	Public Environmental Review
PESA	Preliminary Environmental Site Assessment
PMCP	Preliminary Mine Closure Plan
RHI	Roy Hill Infrastructure Pty Ltd
RoM	Run of Mine
Roy Hill	Roy Hill Holdings Pty Ltd
S43a	Section 43a
SAQP	Sampling and Analysis Quality Plan
SBA	Stand Basal Area
SCHMP	Social Cultural Heritage Management Plan
SRE	Short-range endemic
t CO_2-e	tonnes carbon dioxide equivalent
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
VU	Vulnerable
WA	Western Australia
WAMA	Wittenoom Asbestos Management Area
WMP	Water Management Plan
WoNS	Weeds of National Significance
WRD	Waste Rock Dump
WWTP	Waste Water Treatment Plant

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Appendix 27 LGA 2024

Appendix 28 PSM 2024

Appendix 29 Subterranean Fauna Monitoring and Management Plan (removed as of Rev 5 of this document)

Appendix 30 Banjima Social Surroundings Assessment (May 2024)

Appendix 31 Peer Review Salinity Memo

Appendix 32 Peer review Report 595. Updated dataset

Appendix 33 Analysis of stygofaunal associations with groundwater salinity and potential salinity tolerances based on observations, for the Mulga MIOIM (in preparation)

Appendix 34 Targeted troglofauna survey 2025 (in preparation)

Appendix 35 Waste Rock Management Plan